TRANSACTIONS

OF THE

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Semi-Centennial Memorial Volume.

1849-1899

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SIR WILLIAM EDMOND LOGAN, (1798-1875).

Founder of the Canadian Geological Survey.

FIRST PRESIDENT OF THE CANADIAN INSTITUTE.

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PREFACE.

THIS volume is intended as a special memorial of the completion of the first fifty years of the history of The Canadian Institute. The introductory article by Sir Sandford Fleming deals with the origin and early days of the Institute, and is of special interest as a record of affairs in which he was an actual participant; affairs as to which he can more than any other now living say, *quorum pars magna fui.* He brings the record down to 1853, when the Institute had passed the critical stage of infancy and was fairly launched on a career which, with the vicissitudes which attend all mundane things, has on the whole been satisfactory. It is not intended to detail the subsequent history of the Institute; that would be too tedious, and would possess but little interest, except perhaps to a few. It may be well, however, in this place to note a few facts by way of summary.

In 1855 took place the union with the Toronto Athenæum. This brought a considerable accession to the membership, and the books belonging to the Athenæum were the nucleus of a library that has now become, perhaps, the most nearly complete scientific reference library in the Dominion.

In the same year the Hon. G. W. Allan presented the Institute with a site for a building on Pembroke Street. It was gratefully accepted but was afterwards re-conveyed to Mr. Allan and the present site on Richmond Street was purchased in 1863. Plans for a building were at once prepared, but the Institute did not find itself financially able to proceed with its construction until 1875, when the work was begun and carried to completion in 1876, very largely through the persistent efforts of Professor Loudon, now President of the Toronto University.

It is somewhat curious to note that in 1859 there was a proposal to change the name to The Royal Society of Canada, or The Royal Academy of Sciences of Canada. The Governor-General did not look on the proposal favourably and it was dropped.

In 1863 a Medical Section was formed in connection with the Institute. Meetings were regularly held and papers read, but after some time the medical members branched off and became a separate organization.

Somewhat similar and about the same time was the origin of the Entomological Society.

In 1871 a Historical Section was proposed, but no definite action was then taken. The same may be said as to proposals in 1874 for a Field section and a Numismatic Section.

In 1885 occurred the amalgamation with The Natural History Society. This union was of great advantage to both societies. For certain purposes the Natural History Society maintains its separate corporate existence, but as the Biological Section of the Institute it brought with it a valuable museum of Natural History and its members continue to do good work, especially among young men, by encouraging study and original investigation.

In 1886 on the suggestion of Professor Ellis, who was then President, five other sections were formed, an Architectural, a Photographic, a Philological, a Historical, and a Geological and Mining Section, as also an Ornithological sub-section of the Biological Section. These continued for some time to do good work, and out of the Architectural, the Photographic and the Historical Sections, independent societies have developed, which still maintain a vigorous existence.

In 1887 the Ontario Government commenced making an annual grant for Archæological research. The fund was for some years administered under the supervision of the Institute, and entirely through the energetic labours of Mr. David Boyle a splendid Archæological Museum has been founded. The collection soon became far too large to be properly exhibited in the Institute building, and it was therefore transferred to more ample quarters in the Department of Education.

In 1888 a Sociological Committee was formed on the initiation of Mr. T. B. Browning, who, as chairman, conducted a series of enquiries into the social and political systems of our North-West Indians, the result being a considerable amount of interesting information.

Summer sessions were held in 1890 at Niagara and in 1891 at Penetanguishene.

A few words may be said in conclusion as to the Institute's publications. The first series of "The Canadian Journal" comprised three quarto volumes; the second, fifteen octavo volumes. In 1879 began "The Proceedings of the Canadian Institute," which extended to seven volumes. "The Transactions of the Canadian Institute" began in 1890 and have now reached the sixth volume. A new series of "The Proceedings" has extended to nine numbers, forming one volume, and part of a second.

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TRANSACTIONS

OF

THE CANADIAN INSTITUTE.

THE EARLY DAYS OF THE CANADIAN INSTITUTE.

By Sir Sandford Fleming, K.C.M.G., LL.D., F.R.S.C., Etc.

Fifty years is a small space in the life of a nation, or in the history of the human family; as a unit to be employed in chronological computations, it is, however, of appreciable extent. If we employ it according to the method of a surveyor of lands, in measuring through the vista of the past, eight such units will bring us to the days of Cabot, when the continent was first seen by European eyes; and if we continue our exact survey into earlier days, but forty units of fifty years will extend our measurements to a date in history a century before the beginning of the Christian era.

As denizens of the new world where so much is modern on every side, we cannot view the Canadian Institute as a new society, seeing that it took its origin half a century back. We feel bound to consider that this association has passed into its adolescence, and having reached that stage, the mere fact implies that the body is in possession of a degree of robust vigour and vitality. Since the birth of the Canadian Institute, great changes have been witnessed in everything around us. At the time of the first appearance of the Society the Dominion had no political existence; it scarcely entered into the dreams of the most sanguine of men. Canada was but a province, or at most, two provinces united. The name which they bore in those days applied only to a limited extent of territory forming part of the basin of the St. Lawrence. Now the appellation of Canada is associated with half a continent extending from the eastern to the western oceans.

The founders of this Institute designed that it should have a wide sphere of usefulness. They were not satisfied that it should be a local Society merely, with its membership confined to the citizens of Toronto. The name chosen, the first presidents elected, and the first list of members published, furnish evidence of a higher ambition. As the years have passed the significance of the name originally given to the Institution has kept pace with the expansion of Canada. At first it was provincial, it has since then assumed a national character.

Among the many vicissitudes which time has wrought since the Society received its name, there is almost a complete change in the population. In the course of events the old inhabitants have for the most part passed away, and other people appear on the scene, only a small percentage of whom were born into the world fifty years ago. Of the men who took an active part in establishing the Canadian Institute, three only survive, and as one of the three, the writer has been called upon to give a brief outline of the origin of the Societyand his recollections respecting it. In consequence of this invitation he has the great satisfaction and high privilege of submitting the following paragraphs.

The character of the Canadian Institute has not always been what it is to-day. In its first inception the design was to organize a Society of Surveyors, Engineers and Architects. The special objects of its formation are set forth in the first constitution, and prominence is likewise given to them in the Royal Charter. The Institute has, however, long abandoned the exclusively professional character of its origin and adopted general scientific aims. This change has been effected without any up-rooting or revolutionary process. No ground gained by the founders and friends has ever been lost; the wise policy has been adopted of always going forward and never backward. The reformation of the Society was effected simply by opening its doors to the world and ceasing to be professional and exclusive. To this policy may be attributed the measure of success which has attended the operations of the Canadian Institute for half a century.

The first germ of the Institute may be traced to a gathering of a few gentlemen in a room near the corner of King and Yonge streets, on June 20th, 1849. The room was used as the office of one of the surviving founders, Mr. Kivas Tully. The gentlemen present on that occasion were architects, land surveyors and civil engineers, practising in and around Toronto, who considered it desirable to establish an association in order to unite members of the three professions throughout the province. The meeting was at least remarkable from the day upon which it was held. The Queen had been on the throne twelve years, and by the merest accident this meeting, the first to which we can trace the inception of the Canadian Institute, was held upon the anniversary of the day upon which Her Majesty was crowned. This fact may be characterized as a happy coincidence, and in truth it was nothing more, but subsequent events give evidence that it was an augury for good.

This preliminary meeting was adjourned for a month. At the adjourned meeting a committee, specially appointed, submitted a report. After discussion this report was referred back to the Committee with instructions to prepare a prospectus of the proposed society. The meeting was further adjourned to August 31st, and again until September 22nd. On the latter occasion it was finally resolved "that a Society be now formed in accordance with the principles set forth in the Prospectus," and it may here be noted that the principles referred to are embodied in the Royal Charter, granted two years later (November 4th, 1851). At the meeting held September 22nd, 1849, Hon. H. H. Killaly was chosen president, but subsequently that gentleman declined to accept the appointment. The following appointments were also made and accepted: Charles Rankin, of Owen Sound, Vice-President, J. Stoughton Dennis, of Weston, Hon. Secretary. It was further resolved that Sandford Fleming. J. O. Browne, F. W. Cumberland and Kivas Tully be a Standing Committee for the purpose of conserving the interests and assisting to carry on the ordinary business of the Institute.

The next meeting was held on November 4th, when a constitution was submitted by the Standing Committee. On discussion, it was referred back for amendment, with instructions to report at an adjourned meeting to be held on February 8th, 1850.

- On the latter date the meeting was attended by two members only, Mr. F. F. Passmore and the writer. The prospects of the young Institute were not brilliant, but the two determined to act with energy, if not with entire regularity. After much silence and long waiting in vain for other members to appear, the one addressed the other in these words, "This looks bad—we must, however, proceed, as the saying is, to make a spoon or spoil the horn. Let one of us take the chair and the other act as Secretary," and so agreed, dispensing in the emergency with a quorum, they passed a series of resolutions with complete unanimity. No amendments were offered and time was not spent in long discussions; those present deemed it a dispensable formality to have "movers" and "seconders" to the motions submitted. As appears by the minute book the meeting simply "Resolved" this or that. One resolution adopted and formally placed on record reads: *Resolved*, "That the members of the Canadian Institute do after this "date meet once a week, on each Saturday at 7 o'clock p.m., in the "Hall of the Mechanics' Institute;—and that the first subject for discus-"sion be the act for regulating the admission of land surveyors and the "survey of lands throughout the Province. The first meeting to take "place on Saturday next, February 16th."

No fault was ever found with the action taken on that occasion. It was generally recognized that circumstances justified it. Meetings had been called once a month ever since June 20th, 1849, having in view the establishment of a Society. These meetings at first were well attended, but the attendance was not maintained, and at last it dwindled to two, (shall we call them?) devoted members or over zealous and not over particular young men. Be that as it may, matters appeared to them desperate, a crisis had been reached, and it became, in their minds, necessary to take vigorous action. The resolutions passed were printed in circular form and sent to all interested. Happily, the young Society was galvanized into life. The meeting held the week following was well attended and discussions on various subjects were continued for several hours. The same may be said of succeeding meetings. February 8, 1850, has proved to be a red letter day in the annals of the Canadian Institute. At no meeting before nor since have resolutions more far-reaching been passed. Then was inaugurated the practice of meeting weekly each Saturday evening, and for nearly half a century the Society has regularly maintained the practice during the sessions extending from November to April.

On the second weekly meeting (February 23rd, 1850), the constitution of the Society, which had been prepared by the Standing Committee, was adopted.

The first session came to an end on April 13th. Mr. Killaly having declined the office of President, Mr. Charles Rankin, at one of the weekly meetings, received the appointment.

The second session began on Saturday, November 16th, 1850. At this meeting a prospectus of "The Canadian Journal, a Record of Industry, Science and Art," was submitted by the Standing Committee and cordially approved. It was designed to be the official organ of the Canadian Institute and the medium of publication of its transactions.

A sentence may be quoted. "The objects of the Journal are essentially of a useful character. It is intended to minister to the wants, and to promote the interests of a young, yet enterprising and rapidly advancing people, and to fill up a blank in Canadian literature, the existence of which has been deeply regretted, and has of late been most seriously felt by artisans, manufacturers and the public generally throughout the province."

The Standing Committee submitted the first annual report of the Institute on December 7th, 1850. At this meeting the officers elected were: *President*, W. E. Logan; *Vice-President*, J. O. Brown; *Standing Committee*, Kivas Tully, Sandford Fleming, William Thomas and Thomas Ridout; the *Secretary*, F. F. Passmore.

At this date the membership counted sixty-four persons. It is well to preserve the names; some of their descendants may come to regard the list with interest.

MEMBERS.

Bridgland, James W., York,
Brough, Allan P., Toronto,
Browne, George, Montreal,
Browne, J. O., Toronto,
Burwell, Lewis, Brantford,
Clendenin, J. K., St. Catharines,
Cumberland, F. W., Toronto,
Dennis, J. Stoughton, Weston,
Devine, Thomas, Toronto,
Ellis, Joseph, "
Fleming, Sandford, "
Fraser, W. H., "
Gibson, David, York,
Grant, John, Darlington,
Hanvey, D., St. Thomas,
Howard, J. G., Toronto,
Keefer, Samuel, "
Leather, W. B., "
Lynn, Robert, York,
Lyons, James, Cobourg,
Maxwell, J., Hamilton,
McCallum, R. Markham,
McPhillips, Geo., Thornhill,
Parr, Richard, Chatham,
Passmore, F. F., Toronto,
Prosser, T. C., Albion,
Rankin, Charles, Owen Sound,
Ridout, T., Toronto,
Robinson, W., Toronto,
Rubidge, F. P., "
Schofield, W. C., Bentinck,
Shier, John, Oshawa,
Smith, William, Glanford,
Storm, W. G., Toronto,
Thomas, William, "
Thomas, W. T., "
Tully, Kivas, "
Vidal, Alexander, Port Sarnia,
Walsh, F. L., Vittoria,
Walsh, Robert, Lloydtown,
Wells, Robert, Dundas,
Wilkinson, C. A., Sandwich,
Woodruff, S. D., Port Robinson,
Young, Thomas, Toronto.

ASSOCIATES.

Allanson, John, Toronto,
Bird, James, Peterboro,
Hall, James, M.P.P., Peterboro'
Ellis, John, Toronto,
Hutchinson, John, Toronto,
Logan, W. E., Montreal,
Lowe, F. C., Toronto,
March, Peter, "
Meyer, Hoppner, Toronto,
Parkes, Vincent, "
Worthington, T., Wellington.

GRADUATES.

Boulton, W. T., Toronto,	O'Brien, Charles, Toronto,
Bristow, Arthur, "	Rykert, G. Z., "
Grist, John, "	Stewart, George, "
Legge, Charles, "	Thomas, C. P., "
Moberly, Walter, "	

The Institute met regularly each Saturday during the winter of 1850-51, when various papers were read and discussed, On February 15th the subject of a Charter was submitted and referred to a special Committee. The Charter Committee reported on March 1st, again on April 12th, when the Institute resolved to petition His Excellency, the Governor in Council, in respect thereto.

The Session ended on May 10th with a conversazione. One of the cards of invitation to guests has been preserved, a full size *fac simile* of which is here reproduced.

First
Annual Conversazione.

The favour of your company is requested on SATURDAY, the 10th Instant, at Eight o'clock, in the Mechanics' Hall

The proceedings of the Evening will commence with the Vice-President's Address, recapitulating the transactions of the past session, and the objects and present prospects of the Institute.

F. F. PASSMORE,
Secretary.

To ——————————

Toronto, May 3, 1851.

The following brief notice which appeared in the "British Colonist" on May 13th will be read with interest:—"The first annual conversazione of the Canadian Institute was held in their room in the Mechanics' Institute building, on Saturday evening. We noticed several influential citizens among the visitors, and on the whole, the proceedings of the evening were of such a nature that the infant Institute may feel proud to refer to them hereafter. After giving the visitors time to inspect the various works of art, as well as the geological and mineralogical specimens in the museum, the Vice-President (Mr. J. O. Browne) addressed the assembly, explaining the objects of the projectors of the Institute. It was first suggested to organize a Society for the better improvement of surveyors, in order that much of that litigation which has of late and former years been so prolific in creating dissensions, may be prevented; but, considering that architects, engineers, artists, and others might also be benefitted, it was decided to establish a Society for the advancement of the Physical Sciences generally, and to be called the 'Canadian Institute,' the members of which would meet together weekly, during the winter months, and by imparting information to each other advance the arts and sciences in Canada. Several interesting papers have been read before the Institute during the present (its first) session, and he considered none more worthy of notice than a paper from Mr. Fleming, accompanied with diagrams and a plaster model of the entrance to the harbour of Toronto. In this paper Mr. Fleming shows conclusively that the formation of sand at the entrance is rapidly gaining every year —nay, every hour, and that if some measures are not adopted to prevent it, the harbour in a few years will be completely closed.

"The Vice-President read from other papers submitted to the Institute, a Treatise on the Formation of Artificial Harbours. Next he pointed out a design for a bridge called the 'Bow Bridge,' but in the absence of details, we were unable to understand the principle. A School of Design is in contemplation, and we hope will be shortly established. Mr. Browne then referred the company to three diagrams, showing the different strata about the Falls of Niagara, illustrating a communication from Mr. Ridout on the Geology of the Falls, and concluded his address by allusion to the liberality of the Mechanics' Institute, in whose building they are enabled to hold their meetings. The necessity of an increase to the museum was strongly advocated.

"In conclusion of our necessarily brief report we heartily wish success to the Canadian Institute in its legitimate pursuits, in the firm belief that no other institution is likely to be established that will do more to bring out Canadian talent in the arts and sciences than this. Such an Institute has long been wanted, and now that the ground is broken, we hope it will not be left to perish for want of support. The museum requires donations, and shall it not have them? We venture to answer the question in the affirmative—and will only say, at present, success to the Canadian Institute, and may the next conversazione be in a larger room."

The Institute having applied early in the year to the Government for incorporation, the members were gratified to receive in response a Royal Charter. At this day it cannot be held as revealing a great state secret to mention how it was obtained, although the circumstances have not hitherto been made public. The then first Minister, Attorney General the Hon. Robert Baldwin, became interested in the Society through a young friend and kinsman, Mr. Thomas Ridout, a member of the Standing Committee. Mr. Ridout explained what were the aims and aspirations of the promoters of the Institute, and so deeply interested Mr. Baldwin in their public and patriotic efforts that the Royal Charter was granted, November 4th, 1851.*

The Third Session commenced on December 6th, 1851, when the Royal Charter was read. The thanks of the Society were voted to Mr. Thomas Ridout for his good offices in respect thereto, and a committee was appointed to prepare regulations in order to carry out its objects.

Early in the Session several gentlemen retired from the Institute, resigning their membership, protesting against the new departure in opening the doors of the Society, and terminating its professional and exclusive character. This action was deeply regretted, and the regret was enhanced by the fact that among the protesting members appeared the name of Mr. Kivas Tully, in whose office the Canadian Institute was cradled. Mr. Tully was, however, re-elected Feb. 9th, 1878, and in the following year a member of Council, and on Feb. 16th, 1889, he was made an honorary member.

The Institute met regularly during the winter on each Saturday, until March 27th, 1852, when the following officers were duly elected under the Charter: *President*, W. E. Logan; *1st Vice-President*, Captain Lefroy; *2nd Vice-President*, J. O. Browne; *Secretary*, Sandford Fleming; *Cor. Secretary*, Frederick W. Cumberland; *Treasurer*, Dalrymple Crawford; *Curator*, Frederick F. Passmore. These officers, along with Edward L. Cull, William Thomas and Dr. Melville, constituted the Council. Some weeks afterwards the Council was strengthened by the addition of three other gentlemen, Alfred Brunel, Professor Cherriman and Professor Croft.

The second annual conversazione was held in the Mechanics' Hall and adjoining rooms, on April 3rd. Addresses were delivered by the Vice-President, Captain Lefroy, Dr. Melville, Professor Hind, Professor Croft, Professor Cherriman, Dr. McCaul, and the Hon. Robert Baldwin,

* The Charter is printed in full in Trans. Can. Inst., Vol. I., p. ix.

Attorney-General of the province. Many prominent gentlemen were present as guests, thirty-five of whom before they left the room, followed Mr. Baldwin's example and expressed their desire to become members. The admirable address of Capt. Lefroy was read from a paper in his handwriting which has been found among the archives of the Institute; as it has never been published with the Transactions, it may appropriately appear in this sketch along with other addresses on that occasion, after an interval of more than forty-seven years.

Proceedings at the Conversazione of the Canadian Institute held in Toronto on Saturday, April 3rd, 1852, on the occasion of the acceptance of office of the first officers and council elected under the Royal Charter.

In the absence of the President, Captain Lefroy occupied the Chair. The Secretary read the following report:

Gentlemen,—"Your Committee have much pleasure in reporting the continued successful progress of your Institution. A Royal charter has been obtained, by means of which, the objects and interests of the Society have been extended, and its powers established and increased.

Many new members have been admitted during the past session, and your committee are convinced that a more extensive publication of the Transactions of the Society alone is wanted to insure for it that substantial support which is necessary for its success, and they are strengthened in this belief by the expressions of favour and interest which have been accorded to it generally by men of education and scientific pursuits in the Province.

A focus around which the many individual efforts of practical science may be drawn is much needed in a country where communication and co-operation have not as yet been easy of attainment.

Your Committee are of opinion that the time has now come when every effort should be made to embrace as broad a field of practical science, in the future operations of the Society, as possible. They trust that the Canadian Institute may be made in practice, as well as in principle, to comprehend the various objects, which, in older and more populous communities, are commonly appropriated by distinct associations, under the title of Societies of Art, Academies of Science, and Literary or Historical Societies, in order that by facilitating an exchange of knowledge, and inducing a community of purpose and feeling between Scientific, Literary, and Practical men, and by uniting their efforts in promoting the purposes of the Charter, the capabilities of the Province may be more speedily developed, and its interests promoted on a sound and enduring basis.

The Committee in giving utterance to these aspirations desire to bring to your notice the encouraging overtures which have been made by parties connected with the Toronto Athenæum, in view of a union of the two bodies—and would recommend that they be met in such a liberal spirit as may result in the future co-operation of both Societies.

Several papers upon subjects of general and local interest, have been communicated during the two first sessions:—Amongst them, a review of the several clauses in the Surveyor's Act of 1849, by Mr. J. Stoughton Dennis.

On the use of the Telescope, as applied to field practice, by Mr. J. O. Browne.

Upon the ameliorating influences of the climate of Canada, by Mr. F. F. Passmore.

On the formation of the Peninsula and Harbour of Toronto, by Mr. Sandford Fleming.

On Lake Harbours, etc., by Mr. Edward L. Cull.

On the Mineral productions and geology of Canada, illustrated by the Map and Models of his Official Survey, by Mr. Logan.

On the effects of Tides, by Mr. Ellis.

On the application of wire to the construction of Bow String Bridges, by Mr. Hanvey.

On the Geology of the Niagara Falls, by Mr. Thomas Ridout.

On the Ebb and Flow of Water in American Lakes, by Mr. Brunel.

On the Management of Engineering Works, by Mr. Ellis.

On Piling, as practised and applicable to works upon our lakes and navigable waters, by Mr. Kivas Tully.

On the supply of water to Toronto, by Mr. Cull.

On Crib work, as applied for foundations and piers, by Mr. Brunel.

On the works at Portsmouth dock yards, by Mr. Cumberland.

On Tubular Bridges, by Mr. Brunel.

On the effects of different grades upon the economical working of railways, by Mr. J. O. Browne.

Amongst others promised and in preparation, are:

A paper upon concrete, as applied in foundations under water, by Mr. Cumberland.

On the economical application of native materials of construction, by Mr. Thomas.

On the varieties of native timber with specimens, by Mr. J. S. Dennis.

On the application of screw piles and moorings, by Mr. Brunel.

Your Committee recommend that so soon as the present session shall have terminated, active measures be taken to determine a programme of the papers to be read before the Institute, and of its general proceedings during the session of 1852 and 1853."

The Chairman then said:—"Had the philosopher who first uttered the aphorism about big books applied his remark to *long speeches*, I fancy a still more universal assent of mankind would have immortalized his wisdom. I do not rise now to inflict that '*great evil*' upon you; but as occupying, unworthily, this evening, in the absence of our President, the Chair, which I earnestly desire to see hereafter filled by some gentleman of far superior claims; it seems impossible to allow the Annual Meeting of this Institute, especially when it is the first Annual Meeting held under our recently-acquired charter, to pass, without offering some remarks in relation to the report which has just been read, and to the present and future prospects of the Institute. Indeed, if the custom of those societies in whose steps we hope to follow, had not prescribed this course, the presence of the many visitors we have the pleasure of seeing here to-night, would have made the temptation irresistible to take this opportunity of making better known what this Society is and what it aspires to become. Here I cannot do better than quote the exact words of the Act of Incorporation: 'A Society for the encouragement and general advancement of the Physical Sciences, the Arts and the Manufactures in this part of our dominions, and more particularly for promoting the acquisition of those branches of knowledge which are connected with the professions of surveying, engineering, and architecture, being the arts of opening up the wilderness and preparing the country for the pursuits of the agriculturist, of adjusting with accuracy the boundaries of properties, of improving and adorning our cities and the habitations of our fellow subjects, and otherwise smoothing the path of civilization, and also being the arts of directing the great resources of power in nature for the use and convenience of man as the means of production and of traffic both for external and internal trade, and materially advancing the development of the resources and commerce of the country; and have commenced the formation of a museum for collections of models and drawings of machines and constructions, new inventions and improvements, geological and mineralogical specimens, and whatever may be calculated, either as natural productions or specimens of art, to promote the purposes of science and the general interests of society.' It is to be regretted, I think, that general literature is rather implied than expressed, in the enumeration of objects whose cultivation it is hoped to encourage, by the powers conferred by this Charter. It was possibly considered that even as the 'king himself is served by the field,' so must every special department of knowledge derive its support from this which is the common parent of all. At all events, since no one now esteems it a 'kind of dishonour unto learning to descend to enquiry or meditation upon matters mechanical,' so neither (to borrow another quotation from the same author), does anyone now doubt that the men, (and we have such among us), who could obey the counsel of the alchemist, 'to sell their books and to build *furnaces*, quitting and forsaking Minerva and the Muses, as barren virgins, and relying upon *Vulcan*,' are on that account unwilling, unworthy, or indisposed, to listen to those of other tastes and other habits, when they offer them the fruits of their studies. Such then, is the character and the ambition of the Canadian Institute. It aspires as the report just read informs us, to supply to Upper Canada, the place of those societies, which every other civilized country possesses under the denominations of literary, or philosophical, or professional societies or academies, or whatever title they may prefer, to express ends which are essentially the same in all; but it aims to do this modestly and gradually, availing itself first. and principally, of those elements which offer themselves spontaneously in the progress of the country. Does any one here question that this populous Province, with its skilled and learned professions, its universities, its halls of education, possesses the intellectual resources upon which such a thing can be based, or believe that, possessing them, there is not spirit, energy or unanimity to turn those advantages to account? I cannot think so. It is surely time that what the sister capitals, Quebec and Montreal, have now possessed for many years should come into being here; that there should be in Upper Canada, a centre to which the treasures of experience, observation and discovery, of this generation should naturally flow; at which, as in a focus, the attainments of her most gifted sons, may, by degrees, be brought to bear on objects of universal interest, and by whose example and influence those pursuits may be encouraged, which extend the bounds of human knowledge, while they promote, in a high degree, the happiness of all who follow them. It is the distinctive character of this Institute, and in my opinion, the best pledge for its healthy and vigorous progress, that its commencement has been eminently practical. The gentlemen who founded it, satisfied a want of their own, before they extended their thoughts to a provision for a public want, and for posterity. I may refer to the *second clause* of the fifth section of the bye-laws, for the best proof which can be given of the spirit in which it has been formed. To disdain the day of small things,—to reject the seed pearls that are within our reach, because the pearls of price lie deeper than we can yet dive for them,—this is no design of the founders of this association, neither is it intended that the papers read here shall be laid by in the Secretary's desk, to be published in the Greek Calends, but on the contrary, by timely publication, to secure to all the members, absent or present, their share of instruction, their interest in its proceedings, and to the authors of papers, that pleasure, which like the charms of Cleopatra, 'age cannot wither, or custom stale,' of seeing them in print as soon as possible. Every year the plough is obliterating the last traces of our predecessors upon this soil. Every year the axe lays low some invaluable witness to the ages which have elapsed since populous villages of another race were scattered far and wide through our now lifeless forests. We are fast forgetting that the bygone ages even of the new world were filled by living men, and fast losing by neglect, all those delicate links in the chain of research, by which the archæologist of another generation may hope to trace out the origin and the fortunes of a great branch of the human family. If it has been found even in Great Britain, that scarcely five per cent. of the rare and interesting remains from time to time brought to light, are recoverable after a few years, unless they are lodged in some public museum, we may be very sure that a proportion even larger, of such remains as Canada furnishes, are lost for want of such an institution. There is reason to believe that there is at this moment in Canada, one of the most ancient and interesting of Scottish mediæval remains, the Quigrich—the Crozier of that favorite Celtic Saint St. Fillan, who flourished in the middle of the seventh century, still in the possession of the heirs of the family which has been honored with its custody 'sin the tyme of King Robert the Bruys and before,' since the days of the Bruce; we can nevertheless but regret that if it were possible to rescue it from the chances which befall all sublunary possessions; from fire, or theft, or the Sheriff, there should be no museum in which to deposit it. To return, however, to Indian antiquities, let me mention topography, or rather the naming of places. When the last *Pine-wood* of Chinguacousy (Chinquak kon sebi) is levelled; when art has provided another outlet than the river mouth in Nottawasaga; when a few generations more shall have hopelessly corrupted the spelling and pronunciation of those and many other aboriginal names still to be found on the map, of all monuments of a race and language, perhaps, the most enduring; how will philologists puzzle themselves over difficulties which hundreds now living could remove, but which to them may be as inscrutable as the language of Nineveh. I allude to these subjects here, because they offer an immediate field for the exertions of the Institute, and is one which it is peculiarly able to enter upon, as including among its members so many gentlemen whose pursuits must be constantly bringing them into contact with objects of the kind referred to. Then again in Natural History. Only last summer an American professor and his pupils, chose the neighborhood of Toronto for the scene of their search after new and undescribed *fishes*. I forget what the professor's success was, but the fact shews his remarkable confidence in our own neglect of the objects around us. I remember once, in the Island of St. Helena, sending a colored servant to a distant and somewhat inaccessible rock, called the Barn, to fetch me some specimens of land shell, reputed on the island to have been long extinct, but of which dead specimens were known to be abundant in that locality. To my own surprise, Joseph, who had no lazy theory to save his own exertions, brought me back half-a-bushel of living ones. The dwellers in Jamestown had reckoned much too confidently on the authority of their ignorance. And if their little island—smaller than any Canadian county, and settled by Europeans a century before an English foot had been set in Upper Canada—could yield such novelties, we need not deem our search hopeless here. Turn which way we will, enquiries meet us on which an active mind may employ its best energies, and yet glean but the surface treasures of that exhaustless mine which Art and Nature offer to human industry. But, gentlemen, we should undervalue this Institute if we regarded it merely as a means of amassing information, however valuable, or of contributing to personal distinction, however well-earned. It is in the refreshing influence of mind upon mind, in the re-union of those whom separate pursuits or different walks in life tend otherwise to put asunder,—in holding up to practice the mirror of theory, in animating theory with the life of practice, that societies like this, when actively conducted, exercise so beneficial an effect. Who can tell how much encouragement may be given by a word of sympathy; how often a friendly hint may clear up a difficulty, or timely discussion avert a blunder? Or what essential moral benefit it may be to some minds, in teaching lessons of modesty, of diligence, or of patience, to be brought into contact with other minds of greater gifts and higher attainments, and learn that the place they aspire to must be earned before it can be enjoyed ; that there is no royal road to knowledge in any of its branches? But I feel that in pursuing this theme I am in danger of mistaking the authority of my office as your Vice-President for the weight of the speaker. It is not for me before such an audience, to enlarge on subjects which many around me could enforce much better. Well has Bacon said, that 'all works are overcome by an amplitude of reward, by soundness of direction, and by conjunction of labour. The first multiplieth endeavour, the second preventeth error, and the third supplieth the frailty of man ; but the principal of these is direction.' Suffer me, gentlemen, to conclude my remarks by expressing the hope that few of those gentlemen whose responsible and honoured positions give us a right to appeal to them, will quit this room without resolving to give to our young Institute the weight of their support and the aid of their experience."

Dr. Melville, a member of the Council of the Institute, expressed gratification at seeing so many distinguished visitors present on the occasion of their first meeting after having obtained their charter. He was highly delighted at seeing the presidential chair so admirably filled, and begged to return the thanks of the Council for the eloquent address the Chairman had delivered. It had been said that this country was too young for such an Institution, but he thought a cursory glance around the room would nullify such an opinion. He believed that, with few exceptions, the models and works of art which so gracefully adorned the Hall, were the productions of residents in Canada. The list of papers which they had just heard read by the Secretary were an evidence of the energy and zeal brought to bear upon the objects of the Institute. Many a delightful and agreeable evening they had enjoyed listening to the discussions of these papers. It was true that the interests of general literature appeared to have been neglected by the charter ; but he trusted that this would be remedied, now that they had the prospect of being connected with the Athenæum. He begged to return the thanks of the Institute to the Hon. Attorney-General, whom he was happy to see present, for the great interest he had manifested in obtaining their charter, which, but for his exertions, they would not have obtained. As a proof of the energy displayed by the Institute he might say that the figure of a warrior they saw standing on the table to the left, was growing two months ago in the woods of Etobicoke. This, however, was but a small earnest of what would be accomplished through the instrumentality of this Institute.

The Chairman declared a truce of half an hour, during which, a pretty general promenade was made to an adjoining room, where tea, coffee and confections were amply provided. Others preferred examining the various articles in the Hall. Order having been restored,—

Professor Hind made some interesting remarks on the climate of this part of the Province. He said we were, he hoped, at the end of one of the severest winters that had been felt in Upper Canada for a great number of years. This same severity as regards temperature had, however, been felt over the whole of the United States. He then proposed and answered very fully the question,—What is it that, generally speaking, renders the Canadian peninsula less liable to suffer from the intensity of cold, and the extremity of heat that characterizes the United States? We had a climate singularly ameliorated by three or four vast bodies of water. Upper Canada formed a kind of peninsula among the lakes. He had prepared several diagrams by which to exhibit this distinction. Here Mr. Hind exhibited and explained at some length three diagrams to demonstrate that our temperature was not so extreme as that of the Western States. He contrasted the temperature of Fort Preble, on the Atlantic coast, in latitude 43 degrees, 38, and Fort Armstrong, Illinois, in latitude 41 degrees, 28, with that of Toronto; and showed that the mean temperature of Fort Preble, east of the lakes, was 46, 67, and of Fort Armstrong, west of the lakes, was 51, 64, while that of Toronto, subject to the ameliorating influences of the lakes, was 44, 39. Fort Armstrong is fully two degrees south of Toronto, yet its mean temperature in January is nearly a degree lower than at Toronto, while the mean temperature of the hottest summer month is upwards of eleven degrees higher there than at Toronto. Fort Preble, in the east, about the same latitude as Toronto, has a mean temperature for January of three degrees lower than Toronto, and for July upwards of three degrees higher. The influence of climate on agricultural productions was also estimated by the humidity of the atmosphere during the agricultural months. The rapid growth of vegetables in Western Canada was due to the serenity of the summer sky, and the uniform distribution of rain over the agricultural months In the Western States, generally, the unequal distribution of rain throughout the year renders the cultivation of wheat, the grasses, and the root crops, more hazardous than in Western Canada. The mean annual number of clear days on the lakes is about 120, remote from the lakes 210. Cloudy days on the lakes 140, remote from the lakes 75.

The Chairman in thanking Professor Hind for his address, said that he felt himself bound to take up the cudgels in defence of this much abused winter. He believed that the memory of the oldest inhabitant was at fault in this instance, as within the space of twenty years there had been four winters more severe than the present; these were the winters of 1830, 1835, 1836 and 1842. The last if it was not more severe was nearly similar, and the accounts were about balanced. So it was not that this winter was the most severe, at least as far as could be tested by the thermometer, but there might have been some unhealthy influences in the atmosphere of which the medical gentlemen present might be able to give them some account.

Professor Croft explained at some length the manufacture of water gas. He said a great many plans had been adopted, but most of them were entirely involved in mystery. The process he would allude to was that of a French chemist; it seems to promise well. The material from which the gas is prepared is so much cheaper than coal, that if it can be employed at all it will be an immense saving. The gas does not require so much purification as gas from coal, it also possesses little disagreeable smell, and the little that it does possess can be removed with the greatest ease. The discoverer took advantage of a well known principle in connexion with hydrogen gas. If you prepared hydrogen gas and caused it to burn, the flame produced by it gives out scarcely any light at all, but if you introduce a substance of a solid nature, such as a piece of platinum wire the light will become exceedingly brilliant. The Professor here explained that the gas might be made in the same retorts as other gas by passing the vapour of water through the retorts filled with red-hot charcoal. It was purified in the same way and might be burned in the same jets, with this difference, that over the jet was placed a platinum wire to throw out the light. This gas he considered far superior to coal gas both as regarded ease of preparation, cheapness of material and purity of flame. One point, however, rendered it doubtful whether it could be employed generally—that is—when hydrogen gas becomes mixed with atmospheric air it will explode violently, and the explosions which would take place with the hydrogen would be very dangerous. If, for example, any leakage took place in the gasometers, there would be an explosion, and this substance possessed the property of escaping through very small crevices. He was afraid that serious accidents might result from the use of it. Its nature is said to be changed, however, by being catalyzed or by being passed through the oil of turpentine. The method adopted by Paine is nothing more than the naphthalizing of the gas, and its illuminating power is owing to the turpentine taken up and not to the nature of the gas itself.

The Chairman thanked Professor Croft for his interesting address, and stated that he would again vacate the chair for half an hour, that the company might adjourn to the refreshment room or examine the various specimens of art. On resuming the chair he announced that Professor Cherriman would address the meeting.

Professor Cherriman said the subject proposed for a brief discussion was one of more than common interest, as it professed to be the discovery of a new planetary law, by an American gentleman, Mr. David Kirkwood, of Pennsylvania. It was propounded by him in a letter to Professor Walker who seized upon it with enthusiasm, and read a demonstration of it before the American Society in 1849, being followed by Dr. Gould in the same track. These gentlemen and Professor Peirce spoke of it "as being the only discovery since Kepler's time which at all approached to the character of his three physical laws; as affording striking evidence in support of Laplace's nebular hypothesis, and as entitling Mr. Kirkwood to take rank beside Kepler as the discoverer of a great planetary harmony." If this praise were not exaggerated it must follow that the new world had at last produced in the teacher of Pennsylvania, one of those giants of science whose birthdays are epochs in the history of the world. Professor Cherriman gave the statement of the law, or as it is called "Kirkwood's Analogy," and explained at length the alleged new discovery, proving in a quiet and happy manner that it was entirely fallacious; and concluded by remarking on the singular fatality which had attended all attempts at the numerical verification of Laplace's nebular hypothesis, instancing that of M. Comte, who had wasted much industry and skill in proving what turned out to be an identity or truism; while to this present attempt of Mr. Kirkwood's could not even be awarded the small praise of numerical correctness.

The Chairman very happily thanked the Professor for his elaborate treatise, and said they were glad to welcome among them a gentleman who had attained the highest honours at Cambridge, and they appreciated his kindness in coming forward on the present occasion. The chairman then called upon Dr. McCaul to fulfil a promise he had made.

Dr. McCaul, amidst great applause, and after testifying to the extreme pleasure he had felt with the evening's entertainment, said it was a matter of rejoicing to find so large an assemblage, as it gave a practical demonstration of the progress of the Society, a progress which, although the Society is but in its infancy, gives indication of a vigorous manhood. He alluded to the previous addresses that had been delivered and said the subject to which he would briefly allude was the origin of our being able to decipher the Egyptian hieroglyphics. It is a subject of national importance, and has been a matter of contention between England and France. In general it is believed that the origin of being able to decipher these hieroglyphics is due to Champollion; but Dr. Thomas Young, of England, by devoting his mind to the subject, had discovered a key to open this lock that had defied the vigorous attempts of all previous philologists. It is strange that there was a passage in the writings of Clemens of Alexandria which stated the way in which these monuments should have been read. He stated distinctly that in Egypt there were two languages, the language of the priest and the language of the country. On each monument were found three inscriptions—the hieroglyphic inscription—the language of the country, and beneath it a Greek inscription. For some time considerable attention was devoted to try to decipher these three inscriptions. Dr. Young got a fac-simile of one of these tombstones with the three inscriptions. The Greek inscription was easily read, but in his studies he discovered that some parts of the inscription were enclosed in a sort of oval or cartouche. No one could tell the age of the stone or the event it was intended to commemorate. He thought that before entering upon the subject it would be necessary to have some knowledge of Coptic. From this study he conjectured there was something in the inscription which indicated that it was executed during the reign of the Ptolemies. On commencing with these cartouches he found that they repeated; the first discovery he made was that of the name of Cleopatra. The Dr. here said that the mode by which the phonetic power of the hieroglyphics is established is this. In representing the name GEORGE, they represented the G. by a Greyhound, the E. by an Eagle, O. was an Ox, and R. a Rabbit, the G. and E. were again repeated, thus using a full symbol for each word they intended to represent. Such was the origin of the reading of this wonderful system, which has been followed up by Champollion the younger. He (Dr. McCaul) felt convinced, however, that Dr. T. Young, long before Champollion the elder wrote any pamphlet upon the subject, had discovered these inscriptions, which, while they immortalized those persons that made them, have tended to dissipate those infidel speculations about the truth of Christianity in reference to these monuments having existed so long before the Bible account of creation, and have shown that they were written absolutely not more than two or three hundred years before the birth of our Lord. The Doctor, in conclusion, alluded to the universality of science and literature; they belonged to every age and every country, and even in the past year we had a glorious example of the national unity which existed, when men of all nations united together in glorious rivalry to do honour to science, and when all were glad to unite in that one song—"Glory to God in the highest; on earth peace and good will to men."

The Vice-President thanked Dr. McCaul, on behalf of the Institute, for his address, and referring to the excellencies of the addresses delivered that evening, said, " Is there a man in this room, or in Canada, who will now say that this country is not ripe for such an Institution ?" and he was happy to announce that the contrary was further proven by the fact that upwards of thirty gentlemen, among whom were the most distinguished of their visitors, had placed their names on the lists for ballot of admission.

The Hon Robert Baldwin then rose and said that he would have addressed the meeting earlier in the evening, but that the Vice-President had announced that some distinguished scientific gentlemen were expected to speak on the occasion, and lest it should be imagined that he had been included in that category, he had postponed his remarks until the close of their proceedings. He alluded to the flattering manner in which his name had been mentioned by Dr. Melville, and said that he had done nothing more than his duty as regarded the obtaining of the Charter for the Institute ; but he *did* feel warm sympathy for its objects. He was a lover of science, although he could have no pretensions to be a scientific man ; and perhaps in this respect he was like a lover of another kind, who was not famed for very precise appreciation of the merits of the object of his love, but like that other kind of lover, although blind in his attachment, he was not the less sincere. As an earnest of it he would have inscribed his name earlier as a candidate for membership, but had he done so he would have been deprived of the pleasure of returning thanks on behalf of the visitors for the honour of being invited to this very interesting meeting—and that he might not again appear here in the capacity of a stranger he begged that his name might at once be inscribed on the list of proposed members.—Great applause.

On the Saturday following the conversazione of April 3rd, 1852, the Institute met as usual, when a long list of candidates for membership was announced. The weekly meetings were continued until May 8th, when Mr. A. Brunel and Professors Cherriman and Croft, having been previously nominated, were duly added to the Council. At the same meeting the prospectus of The Canadian Journal was formally approved, and authority given to arrange for its publication in connection with the Institute under the control of the Council.

The fourth Session commenced under favorable auspices. The first weekly meeting was held on December 4th, 1852, in Old Government House. On that occasion sixty new members were proposed. The annual general meeting was held the following week, when the officers and council were elected and Captain Lefroy was appointed President. The weekly meetings were regularly continued until April 2nd, 1853, when the third annual conversazione took place, in the chamber of the Legislative Assembly. In addition to the members of the Institute a large number of guests were present. The city press described the conversazione in glowing terms. *The Colonist*:—"This Society entertained "a large number of their fellow citizens. * * At eight o'clock nearly 300 "gentlemen had assembled, among whom we observed the Bishop of "Toronto, the Chief Justice, Mr. Justice Draper, Vice-Chancellor Spragge, "*Dr. McCaul, Dr. Beaven, Dr. Ryerson, Dr. Cronyn, of London, many* "members of the Corporation, the professors of both Universities, and "indeed a representation of all the public bodies in the city. After "having partaken of the hospitality of the Society, the meeting was "called to order by the President. He expressed the pleasure which "the Society had in receiving their fellow-citizens on these annual "occasions, referred to the progress which the Society had made during "the past year—alluded to the valuable papers which had been com- "municated at the weekly meetings of the session now closing—and "enlarged upon the advantages resulting from such societies as this, not "only in relation to the cultivation of Science and the Arts, as affording "opportunity for closer relations between scientific and professional "men, but in a social view, as an agreeable and profitable link uniting "those who, although engaged in widely different paths, possess con- "genial tastes and aspirations. He made a graceful and feeling allusion "to the portrait of himself which the Society had secured in anticipation "of his departure, and expressed a confident belief that the Institute "possessed elements guaranteeing its permanent stability and success." The Hon. Justice Draper, the Rev. Professor Irving, Dr. Hodder, the Rev. Dr. Scadding, Mr. T. Henning, each spoke on interesting topics. Professor Cherriman, one of the Vice-Presidents, placed on the table a beautiful silver vase which the members of the Institute desired through him to present to Captain Lefroy on the occasion of his farewell to the Society. He also read an address which was signed on behalf of the *Institute by himself and the second Vice-President,* Mr. F. W. Cumberland.

"To Captain Lefroy, R.A., F.R.S., President of the Canadian Institute:

TORONTO, April 2nd, 1853.

"DEAR SIR,—This being the last occasion on which the members of "the Institute may hope to have the honour of your company and presi-

"dency, we cannot let it pass without some attempt to express to you "our earnest thanks for the services you have rendered the Institute, "and our great regret that the call of duty should summon you away "from us. We feel, Sir, that not only the Institute, but the Province "itself, owes you a heavy debt of gratitude, and in your departure will "sustain a loss not easily to be repaired. The zeal and ability with "which you have discharged the difficult and laborious duties that "devolved on you in carrying out the system of magnetical observations "established by the liberality of the Imperial Government; the "investigation of magnetical and meteorological phenomena, with which "your name is inseparably associated; and the various scientific memoirs "that proceeded from your pen during this period, have not only been "of invaluable service in promoting the interests of science in the "Province, but have also caused the name of Canada, and of Toronto in "particular, to be honoured in all parts of the world where science is "cultivated.

"We must not forget, also, that to you is mainly due the rise and "progress of this, the only active Scientific Society in Upper Canada, a "result brought about not only by your own exertions and example, but "also by that unfailing courtesy and kindness which has always marked "your intercourse with us and which has inspired us all with the "strongest feelings of esteem, and permit us to say, of affection towards "you.

"We thank you, Sir, for having acceded to our request that we might "be permitted to retain a memorial of yourself, in the form of your "portrait, which will always serve to remind the Society of how much it "owes you, and will be treasured by it as a choice heirloom.

"We now beg of you to accept the accompanying piece of plate as a "slight token of our esteem and gratitude, receiving with it an earnest "assurance that, much as we deplore your departure, our best wishes for "your happiness and welfare go with you."

The writer is glad to be able to reproduce this address in extenso, it so well sets forth the grateful esteem in which the distinguished gentleman was held, and how much this Society owed him for countenance and support at a critical stage in its existence. The useful career of this early friend of the Canadian Institute did not terminate with his residence in Canada. General Sir John Henry Lefroy was called to serve the Empire in other parts of the globe, notably in Tasmania and Bermuda.

The list of presidents shows that General Sir Henry Lefroy was succeeded by gentlemen of the very highest standing and culture. His two immediate successors in the presidential chair were Chief Justice Robinson and the Hon. G. W. Allan, who since that date has so long and so worthily filled the position of Senator in the Canadian Parliament. The first was chosen president at the annual general meeting December 17th, 1853, again in December, 1854. The latter was first elected in December, 1855, and remained president two years.

The writer does not propose to extend the narrative into the fifth Session, which commenced in December, 1853. Before that date a public event occurred which may be noted. Mr. Robert Stephenson, M.P., an engineer of world-wide fame, visited Canada in connection with bridging the St. Lawrence, where the Victoria Tubular Bridge was afterwards erected. A banquet was tendered him in Toronto by members of the Institute and others. It was given in the Legislative Assembly Hall on a scale worthy of the distinguished guest, and described in the press as "the most splendid that ever took place in Toronto." This occurred on August 26th, 1853. On that occasion the Council of the Institute presented him with a congratulatory address, and at the same time asked him to allow himself to be nominated a life member.

In the foregoing narrative the writer has endeavored to bring together in consecutive order his recollections of past events and incidents, and he has supported them by references to documentary evidence, and he has embellished them by reproducing the words of distinguished men, once associated with the Institute, who have long since passed away. The writer trusts that these facts and reminiscences may prove of service to the historian when he comes to weave into some other and more enduring form the annals of the Canadian Institute. The zeal and ardour infused during the period described undeniably gave the Society a great impulse, and if the membership be taken as any index of success, the progress and prosperity of the Institute may be judged from these data:—In 1850 the members numbered 64; in 1851, 112; in 1852, 263; in 1853, 282; in 1854, 350; in 1855, 508.

The writer vividly recalls with great satisfaction the words and acts of the earnest well-wishers of literary and scientific progress, with whom he had the happiness to co-operate in establishing the foundations of this Society. It is indeed a high privilege, at the dawn of a new half century, to be permitted to allude to them and pay respectful tribute to their memory. He feels that he cannot better conclude this brief sketch than in the words of one who may be regarded as perhaps the greatest benefactor of the Canadian Institute, the late General Sir Henry Lefroy. "This Society has a dignified, an honourable, "and a patriotic object before it; the field is wide and ready "for the harvest, if the laborers are still few; and if much of "that knowledge, contingent upon a thousand advantages never as "yet brought within our reach, which alone can truly appreciate or "encourage their exertions, is at a low point among us, let us not doubt "that it will gain ground with rapidity and receive new impulses and "new rewards from every endeavour we make to carry into effect the "objects of our incorporation."

To-day, the objects before us are not less dignified, not less honourable, not less patriotic than when these words were spoken on January 8th, 1853. The field is wider, the harvest more advanced, the labourers more numerous—every advantage has been increased and multiplied during long years of patient progress. The Canadian Institute unquestionably stands on better vantage ground than it did half a century ago. From this new starting point are we not encouraged to look forward to greater and greater usefulness? May we not anticipate a career in harmony with the progress of Canada in education, in material advancement and in every phase of prosperity?

MEMOIR.

BY KIVAS TULLY, C.E.

In preparing the special memorial volume for the semi-centennial year of the Canadian Institute, it is assumed that extracts from the minutes will be given connected with the formation and progress of the Institute to the present time. My remarks, therefore, will be confined to a few extracts from the inaugural address which I read at the first meeting of the Engineers' Club, on June 6th last. This club was formed with similar objects to those which were originally proposed at the formation of the Canadian Institute, and I regret to state that Sir Sandford Fleming, K.C.M.G., Thomas Ridout, C.E., and myself, are the only surviving members of the original society. At the first meeting of the Engineers' Club, a resolution was unanimously passed, "That an address of congratulation to the Canadian Institute from the Club should be prepared during the summer recess, and passed at the next meeting in September." The following are a few extracts from the address:—

"It should be borne in mind that Toronto was a wilderness in 1793, and the population was not 25,000 in 1849, fifty-six years later, (the population is now estimated to be about 200,000). There were no railways in Ontario; there are now nearly 6,700 miles. In the year of Confederation 1867, there were 2,087 miles of railway in the Dominion, and according to the latest statistics, the number of miles of completed railway in 1898 was 16,870, besides 2,248 miles of sidings; the paid up capital amounts to $941,297,037.

"The St. Lawrence canals were only opened in 1847, the traffic between the Upper and Lower provinces having been previously accomplished by Durham boats and bateaux, until the route by the Ottawa and Rideau canals was opened in 1832. The total expenditure on the several canals of the Dominion was $87,067,096.31, including repairs, maintenance and operation to June 30th, 1898, and it is expected that the recent enlargement to 14 feet will be completed this year.

"The first telegraph line in the Dominion was put up by the Toronto, Hamilton, Niagara and St. Catharines Company in 1847. In 1895 there were 28,815 miles of line, 68,244 miles of wire, and 2,556 offices.

"In connection with the early history of Canada, it is right to mention, that to the Province of Quebec belongs the credit of having built the first steamship that crossed the Atlantic from either side. The steamship was called the *Royal William* commanded by Capt. McDougall, and sailed from Quebec on August 5th, 1833, arriving at Gravesend, England, on September 11th, having steamed the whole distance. In compliance with a resolution passed by the Canadian Institute on December 17th, 1892, proposed by Sir Sandford Fleming, and seconded by myself, a brass tablet was placed in the wall of the corridor leading to the Library of Parliament, at Ottawa, with the following inscription: 'In honour of the men by whose enterprise, courage and skill the *Royal William*—the first vessel to cross the Atlantic by steam power—was wholly constructed in Canada and navigated to England in 1833—the pioneer of those mighty fleets of ocean steamers by which passengers and merchandise of all nations are now conveyed on every sea throughout the world. (Ordered by the Parliament of Canada, June 13th and 15th, 1894.)' Having read a paper on this subject on December 1st, 1877, at the Canadian Institute, in which I referred to original letters from various parties, since deceased, and in order that the records should be preserved, I recently handed a scrap-book to James Bain, Junior, Public Librarian, and a past secretary of the Institute, containing the original letters and full particulars of the event.

"The first steamer on the St. Lawrence, between Quebec and Montreal, was the *Accommodation*, built by Hon. John Molson. The first Lake Ontario steamer, the *Frontenac*, was built by Robert Hamilton.

"The first Atlantic cable was laid in 1858, and the first message was sent by Her Majesty Queen Victoria across Canada to the President of the United States, August 12th, 1858. In a history of the battle of Queenston Heights, edited by John Symons, Esq., published in 1859, I find the following note in reference to the war of 1812: 'The United States declared war on June 18th, and the revocation of the Orders in Council, (regarding neutral commerce and the right of search), took place on June 17th. Had the Atlantic telegraph been then in operation a disastrous war might have been avoided.' The majority in the House of Representatives at Washington for declaring war was 79 against 49—only 30 majority. Had the Atlantic cable been laid at that time, there would have been no war, and the lives of Sir Isaac Brock, Lieut.-Col. McDonell, and other brave men on both sides, would have been saved. Eleven cables have been laid across the Atlantic ocean between Europe and America, and there are now 273 miles of cable in Canada. When the cable will be laid across the Pacific ocean from Vancouver to Australia, of which Sir Sandford Fleming is the principal promoter, supported by the Dominion of Canada, the girdle round the world, as prophesied by *Puck*, will be completed, by British enterprise, and controlled by British capital.

"The next discovery that should be recorded is that of the Bell Telephone of 1875, and the first line working any distance was one set up in that year by Professor Grahame Bell between Paris and Brantford. The returns for 1895 gave 44,000 miles of wire and 33,000 instruments.

"Electricity was first used as a motive power in Canada in 1883—a short piece of track was laid on the grounds of the Toronto Industrial Exhibition. In 1885 the track was lengthened, and the overhead trolley and wire were used. The first practical street railway was successfully demonstrated by the Ottawa Electric Railway Co. in 1892. An electric banquet was served to 75 guests in the Windsor Hotel, Ottawa, in 1892, the entire bill of fare being cooked in an electric oven, the invention of Mr. Ahearn. This was the first time an electrically cooked banquet was provided. In 1896 there were thirty railways in Canada the motive power of which was electricity, with 569 miles of railway.

"Electric light was first used in Montreal in 1877, by the Harbour Commissioners, and in July, 1886, the streets of Montreal were first lighted by electricity. In 1888 the first incandescent lights were supplied. The first arc lights, used for street lighting in Ottawa, were started December, 1883."*

The above are a few of the inventions and improvements which have taken place during the last fifty years, not the least of which are the applications of electricity for the production of heat, light and power, and notably for the invention of the telephone, and its adaptation for business and domestic purposes. The telephone is universally admitted to be a Canadian invention, and Professor Grahame Bell, of Brantford, is solely entitled to the honour of being the inventor of what is now considered to be an indispensable article in business and private houses.

When the Royal Charter of Incorporation was granted to the Canadian Institute on November 4th, 1851, and accepted by the Society of Architects, Engineers, and Surveyors, it was considered by many of the original members that the professional character of the Institute was absorbed by the more extended views and liberal interpretations as

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* "Alphabet of first things in Canada."—*Johnson.*

embodied in the charter, which admitted and recognized as members all who were distinguished in literature and science, though not belonging to the professions previously explained. As one of the surviving original members, I rejoice at the success and world-wide distinction which the Institute has attained, and trust that it may progress in the future, as it has in the past, to the advantage and improvement in literature and science.

THE IROQUOIS BEACH.

BY PROF. A. P. COLEMAN, PH.D.

(Read November 19th, 1898.)

THE effect of wave action in cutting cliffs, spreading materials as terraces, and heaping up beach sands and gravels is so easily recognised that old shore lines, where well marked like those of the Iroquois beach, quickly attract attention. Mr. Thos. Roy, a land surveyor in the early days of "Upper Canada," was the first to refer to the Iroquois beach, in a paper on the "Ancient State of the North American Continent," read by Lyell before the Geological Society of London in 1837. In this paper* Roy describes a series of "terraces or level ridges" to the north of Lake Ontario, the first at 108 feet above the lake, the second at 208 feet, and a series of higher ones, the last rising 762 feet above Ontario, or 996 feet above the sea. It is probable that the beach described as two and a half miles north of the lake and 208 feet above it must be looked on as the Iroquois beach, though later measurements make its height only 170 feet. Roy's other beaches have not been found with certainty by later observers, and it is doubtful if he was correct in his inferences, the densely wooded character of much of the country making it more difficult in those days to recognise an old beach.

In 1842 Lyell visited Toronto, largely to examine these terraces, and rode in company with Roy about twenty miles north, *i.e.*, to the old moraine of the Oak Ridges, and reports having seen in all eleven of these apparent beaches, the highest 680 feet above Lake Ontario; but he is not certain that all of them were due to wave action. He says, however, that "with the exception of the parallel roads or shelves in Glen Roy and some neighboring glens of the western highlands of Scotland, I never saw so remarkable an example of banks, terraces and accumulations of stratified gravel, sand and clay maintaining over wide areas so perfect a horizontality as in the district north of Toronto." He mentions that the second beach, the one at 208 feet, has a shore cliff rising fifty to seventy feet, and is covered with boulders; characters which we find on the Iroquois beach near Yonge street, in the northern part of Toronto.†

Roy accounted for this series of supposed beaches by the former presence of an immense lake 1,000 feet deep, dammed to the east and

* Proceedings Geol. Soc., London, Vol. II., No. 51, pp. 537 and 538.

† Lyell, Travels in North America, Vol. II., pp. 105-106.

south by ranges of mountains. As the dam was cut away the water fell step by step to its present level. Lyell prefers to think that these ridges and other marks of ancient water levels were formed by the sea, since he cannot imagine where the barrier assumed by Roy could have existed.* It is evident that in 1842 the long discussed question as to the marine or fresh water origin of the Iroquois and other raised beaches had already taken its place as one demanding solution.

On the south shore of Ontario this beach was clearly recognised in 1843 by Hall, who describes the gravel ridges used as roads, and states that these beach gravels contain wood, and, as he was informed, shells also; the first fossils noted from beds of Iroquois age.

It was sixteen years later before much further attention was directed to this old beach, A. C. Ramsay mentioning briefly the Iroquois terrace north of Toronto in 1859;† while in the following year Charles Robb, C.E., of Hamilton, Ontario, describes a succession of ridges of sand and gravel, seven in number, seen as one goes inland from Lake Ontario. He refers particularly to the old Burlington beach and heights, stating that they rise 110 feet above the lake, a more correct estimate than Roy's of the same beach at Toronto. He looks on the drift as due to iceberg action.‡ In 1861 Professor E. J. Chapman, of Toronto University, describing the drift deposits of Western Canada (meaning Ontario), mentions the fresh water shells found on old beaches near Collingwood and elsewhere, and thinks that an immense fresh water lake formed these beaches in succession as it gradually fell, evidently holding a view somewhat like Roy's.§

In the same year Sandford Fleming gave a good account of a portion of the Iroquois beach northwest of Toronto in a paper read before the Canadian Institute, describing the terrace plain at the foot of Davenport ridge (which is an old shore cliff), and the gravel spit near Carlton station. He gives a rough but fairly correct map of the spit, and of a bay of old Lake Iroquois to the north.‖

In 1862 Newberry described "the ice wall of the retreating glacier as forming the northern shore of the fresh water inland sea,"** and so introduced an entirely new element into the discussion. In 1882 Dr. Spencer published his work on the Iroquois beach north of Lake

* Lyell, Travels in North America, Vol. II., p. 108.

† Quart. Jour. Geol. Soc., 1859, p. 203; and Can. Nat. and Geol., Vol. IV., p. 328.

‡ Can. Jour. New Series, Vol. V., 1860, p. 509.

§ Ibid, Vol. VI., 1861, p. 228.

‖ Ibid., pp. 247-253.

** Prof. Fairchild's presidential address before the Geol. Sect. of the Am. Assoc. Proc. Am. Assoc., Vol. XLVII., 18[illegible], p. 33.

Ontario, giving the beach its name, and bringing out clearly its differential elevation toward the northeast, crediting G. K. Gilbert with similar work on the south shore of the lake, and furnishing for the first time a correct idea of the shores of this old body of water.* Spencer looks on the Iroquois water as having been a prolongation of the Gulf of St. Lawrence, and so reverts to the theory of marine origin. Gilbert, on the other hand, prefers the lake theory, and places an ice dam across the wide stretch toward the northeast, where no beach can be found.

The work of Spencer and Gilbert practically settled the area and general character of the shores of the Iroquois water, and settled also that the region has been elevated toward the north-east, so that the old beach is now 115 feet above Lake Ontario at Hamilton, 170 at Toronto, and 385 at Trenton. The rate of increase in elevation per mile toward the west end of the lake is 1.6 feet, while in the neighborhood of Watertown, N.Y., according to Spencer, it is five feet.† The rate of elevation per mile as shown on the north shore is 1.8 feet between Burlington and Toronto, two between Carlton and Scarboro', and 2.3 between Scarboro' and Trenton, showing that the deformation increases toward the northeast. Beyond the Ottawa and St. Lawrence valleys it has not been found, but there is no land high enough to receive it, even if there were no ice dam at the north-east end of the lake to close its work at that point.

In order to represent graphically this increase of deformation toward the northeast, the following curve of elevation of the beach has been prepared by Dr. Ellis and myself, the heights of the beach above sea level, taken mainly from Spencer's History of the Great Lakes, being used as ordinates, and distances from Hamilton at the west end of the lake as abscissæ. After numerous trials, it was found that the direction north 17° east harmonized the elevations on the two sides of the lake most satisfactorily, and this has been adopted in the diagram. In reality, as shown by Gilbert,‡ the isobases or lines of equal uplift are not straight, but gentle curves, concave towards the north-northeast.

The shore of Lake Iroquois lies outside the area of Lake Ontario everywhere except for half a mile at Scarboro' Heights, where a promontory extended south beyond the cliffs of the present shore.

THE IROQUOIS SHORE AT TORONTO.

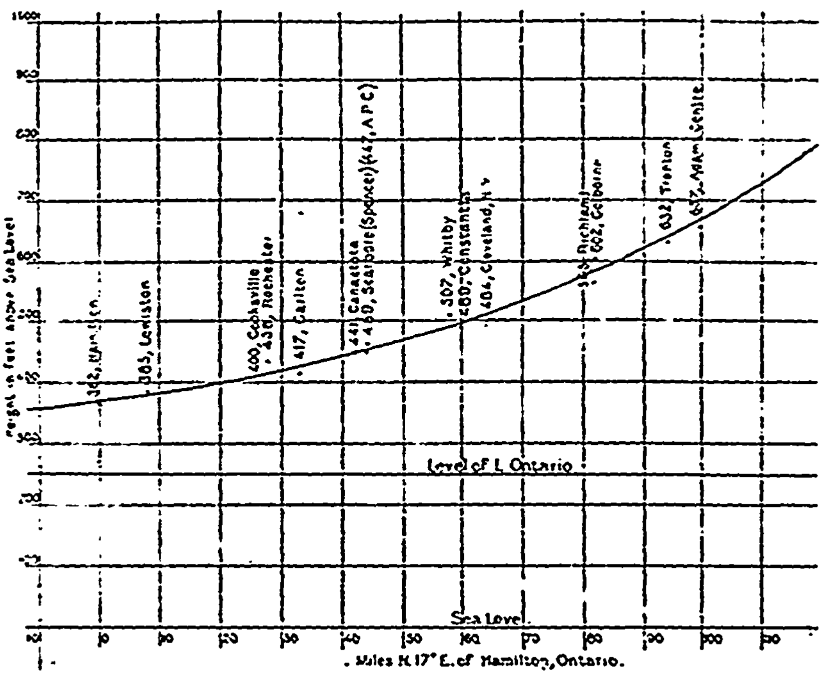
During the past two years the increase in building operations in Toronto has caused the opening of a number of sand and gravel pits

* The Iroquois Beach, Trans. Roy. Soc. Can., Section IV., 1889, p. 121, etc.

† History of the Great Lakes, pp. 47 and 48.

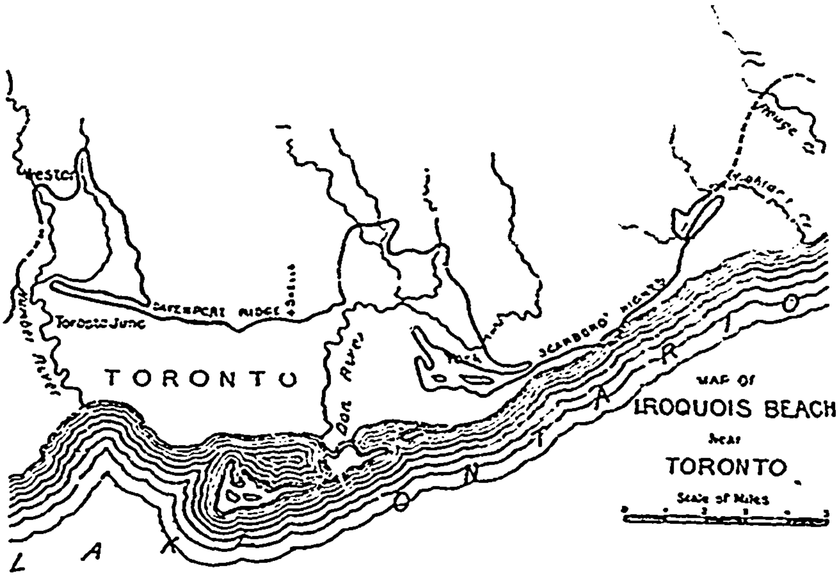
‡ Recent Earth Movements in the Great Lakes Region, U. S. Geol. Sur., 1898, p. 604.

in beach deposits of Iroquois age, and the finding of fossils in some of them has made it worth while to give this part of the Iroquois shore more careful study than it has hitherto received. The results are shown in the accompanying map of the beach in the County of York. It will be seen that north and northwest of Toronto it keeps a distance of about two and a half miles from the present shore, but toward the east approaches the lake until, as mentioned above, it is cut off for half a mile at the highest part of Scarboro' Heights, and then withdraws to the northeast.



Two large bays project to the north, one in the valley of the Humber and its tributary Black Creek, three miles long and about the same in width; the other in the Don valley, with a length of two miles from north to south, and a width of about four miles. A bar of coarse sand and gravel, often crossbedded, stretches from the east side of each bay towards the west, leaving a wide opening on that side, like the present arrangement of Toronto island and bay. A smaller gravel spit is found extending northeast of Scarboro' Heights, enclosing a small bay, now the valley of a tributary of Highland Creek. As mentioned before, the bay in the Humber valley and its gravel bar were briefly described and mapped by Sandford Fleming in 1861. Both the Humber and Don bars are mentioned by Spencer, but not particularly described.

As one approaches Lambton from the west by the Dundas road, the old shore cliff of boulder clay rises fifty feet or more, and is very well marked. It then turns north as far as Weston, keeping about half a mile west of the Humber river, but is less distinct than before, wave action being of course much less effective in a bay than on a large lake. The shores are mainly low and of gently rolling till on all sides of this bay. The bar or gravel spit commences at Carlton station, rising fifteen or twenty feet above the level plain, and extending in a northwesterly direction two-thirds of the way across the mouth of the bay. It is easily distinguished by the pine and oak trees growing on its gravelly soil, which is unsuited for farming, and has been left wooded. Beach gravel of much the same kind is found resting on Hudson shale,



near the right shore of the Humber at Weston, probably a deposit formed before the spit began to close the bay and prevent wave action.

The valley cuttings of Black Creek and the Humber give evidence that the bay was deep at first, but was afterwards filled in with stratified sand overlain with clay, the whole being in places sixty feet in thickness, the upper ten feet of clay. Much of the loose materials which filled the bay during Iroquois times, have since been removed by the Humber and its tributaries, but the river leaves the old bay by a narrow ravine cut down about thirty-five feet into the Hudson shale and at points to the south showing walls of shale sometimes rising ninety feet above the river. No doubt the former stream passed out much to the east of the present one; which was crowded to the western side of the bay by the growth of the bar and so had to cut a steep walled channel through the shale with its layers of limestone.

Eastward of the Carlton gravel bar the beach is once more very sharply defined with a shore cliff of stratified sand capped by till rising seventy feet at some points, the so-called Davenport ridge, really the edge of a rolling plain of ground moraine. The Davenport road skirts the west end of this escarpment and the Canadian Pacific railway the eastern end as far as Leaside junction. The greater part of the city of Toronto stands south of the Davenport ridge on the gently sloping sub-aqueous plain of Lake Iroquois, once thickly strewn with boulders washed out of the promontory of till by wave action, as mentioned by Lyell and Ramsay many years ago. At present few of these boulders are left, most of them having been used for building material or road metal, and soon all will have disappeared. Most of them were Archæan and some were of large dimensions.

At Leaside Junction there is a short bar of gravel pointing eastwards and then the wide Don bay opens toward the north with low shores of till showing little wave action. It seems that this bay was never very deep, for the ravines of the Don and its tributaries cut below its plain show very little stratified material, but thick sections of till. The eastern end of the Don bay comes within a quarter of a mile of Lake Ontario, where the Kingston road climbs Scarboro' Heights; and from here gravel ridges extend with an outward curve for three miles to the northwest, well shown at York Station on the Grand Trunk railway. There are two main ridges with hollows between, ancient lagoons; and the greatest width of the gravel beds is about a mile, the towns of York and Norway being on the old island. In form this group of ridges much resembles Toronto Island in Lake Ontario, and the mode of formation was doubtless the same, gravel and sand being drifted westwards along shore from the Scarboro' cliffs. The map shows that the outlet of the Don, like that of the Humber, has been crowded to the western side of its bay by the growth of the gravel bar in that direction.

Beyond the Don bay the shore becomes more marked, until at the highest point the old cliff is cut off by the undermining action of Lake Ontario, which has formed here the highest cliff on its whole circumference, with an elevation of 350 feet above the water. The Iroquois terrace once more shows itself half a mile beyond with a fine shore cliff, at one point 170 feet high. From this toward the northeast the Iroquois beach deserts the shore of Lake Ontario, and is sometimes hard to follow owing to the wooded ravines of Highland Creek and its tributaries. At the crossing of the river Rouge however, it is distinctly shown; but has not been traced in detail beyond this, although its elevation and general direction have been determined at a number of points toward the east by Dr. Spencer.

From the sketch just given of the Iroquois beach within York county it is evident that the old shore is a quite mature one, almost as much so as the present shore of Ontario, and probably implies as long a time for its formation.

The beach deposits vary greatly in thickness and character, according to the circumstances of the shore. The greatest thickness observed is about 100 feet, just west of the Hunt Club at Scarboro', where the materials are coarse and fine sand with a little gravel; but thicknesses of fifty or more feet are not uncommon. The two bays described above were almost completely filled with sand and silt behind the gravel bars, so that now they present the appearance of plains greatly dissected by the ravines of the present watercourses. That large quantities of materials were deposited at other points on the shore of Lake Iroquois is proved by the stratified gravels of this age at Burlington and on the Niagara river.

Fossils of the Iroquois Beach Deposits.

In general the Iroquois beach is very barren of fossils as might be expected where loose sand and gravel uncovered by an impervious layer of clay are exposed to the weather for thousands of years. It is only at comparatively low levels, or where the gravel has been cemented by lime that fossils are likely to be preserved. The earliest finds recorded are those mentioned in 1843 by Hall in New York State, where wood and, as he was informed, shells also were found in gravel ridges of this age.* The Geology of Canada states that the shells were unios. The cutting of the Desjardins canal at Burlington Heights, where the Iroquois beach deposits, chiefly coarsely stratified gravel, partly cemented by carbonate of lime, have a thickness of 107 feet with Erie clay beneath, disclosed a number of bones of mammals, including *Euclephas jacksoni* (the mammoth), horns of *cervus canadensis* (wapiti) and the jaw of *castor fiber* (beaver). The mammoth bones occurred seventy feet above the present lake and the other remains seven feet higher;† or from thirty to forty feet below the level of Iroquois beach.

A few years ago the Toronto, Hamilton and Buffalo railway made a deep cutting on Hunter street, Hamilton, in order to obtain convenient access to the centre of the city. This cutting has since been covered over and is called the Hunter street tunnel. When examined by the writer the cutting passed through thirty feet of coarse stratified gravel,

* Loc. cit.

† Geology of Canada, 1863, p. 914.

often cross-bedded, sometimes containing boulders two feet in diameter, the equivalent of the Iroquois beach gravels at the Desjardins canal a mile or two northeast. Below this there were two feet of brown unstratified clay followed by eight feet of blue till containing few stones. Considerable quantities of rather decayed wood occurred in the brown layer, probably an old soil, the upper weathered portion of the blue till beneath; and specimens kindly examined by Professor Penhallow were determined as *Larix Americana* and a *Picea*, probably *nigra*. The workmen in the cutting found a number of bones, so far as could be ascertained, in the same layer of brown clay; and it was stated that shells were obtained in the clay a little distance off.

That indefatigable collector, Col. Grant, writes that several partly decayed bones of an elephant were found buried in the blue Erie clay at the base of the cutting, some of them being now in the museum at Hamilton, others apparently carried off by onlookers. He states also that some well preserved timber, recognized as belonging to trees still living in the vicinity, was found in the clay. "The shoulder blade of a moose or large deer was obtained from a sandy beach bed about a yard or so above the clay according to the workmen. I got a decayed rib of an elephant in a Slabtown gravel pit previously. Some years ago I paid a visit to the old gentleman who had the contract for the Desjardins canal excavation. He mentioned that horns, etc., of a buffalo or bison were carried away by a bystander in addition to the animal remains secured by Sir W. Logan for the Survey." From Col. Grant's account it is somewhat doubtful if the elephant remains from the Hunter street tunnel came from Iroquois beach deposits or from an old land surface of pre-Iroquois age. The wood obtained by myself appears to be older than the Iroquois beach deposits.

In regard to the shells reported to have been found in this cutting, it may be said that they turn out to be Silurian brachiopods from boulders contained in the till below the old lake gravels.

A description of the Hunter street section is given by Mr. A. E. Walker in the Journal of the Hamilton Association, in which he states that he obtained the lower jaw of some carnivorous animal, probably from the sand overlying the till,* and also partly carbonized wood. While the Hamilton fossils appear to be of an age greater than the base of the Iroquois beach gravels, and those from the Desjardins canal occur somewhat high up in them, most of the fossils found near Toronto occur comparatively near the surface.

Fossils have been reported from four localities near Toronto, the

* Jour. and Proc., Ham. Assoc., 1895-96, p. 150.

Carlton gravel spit, Reservoir park, the sandy plain east of the Don, and the gravel deposit at York; and there are a few other localities in which fossils occur which may prove to be of Iroquois age, but are not certainly so. The only fossil recorded from the gravel pits at York is a mammoth's tooth. The dune-like sand plain east of the Don between the end of the York gravel spit and Gerrard street east, which stands a little below the level of the Iroquois beach, but forms a part of the same gentle lakeward slope, has yielded to Dr. Wm. Brodie, of Toronto, the following shells: "*Succinea avara* (?) or near this species, *Planorbis complanatus*, *Limnea palustris* (doubtful—very much broken, but no doubt a limnea), *Unio complanatus* (?) (complanatus doubtful, but certainly a unio)." The shells, which were found in street cuttings, are bleached and fragile. There is of course a possibility that these shellfish lived in some pond later than the Iroquois stage, though there is no direct evidence to show that they were not really inhabitants of Lake Iroquois.

During the past two years a gravel pit opened just east of the Canadian Pacific viaduct at Reservoir park in Toronto, has disclosed a deposit of cross-bedded sands and gravels occupying the position of the Iroquois beach and having a distinct shore cliff of till twenty-five feet high just to the north. Two openings have been made, one just north of the railway and the other just to the south. The latter is the deepest and in it a considerable number of fresh water shells have been found, *Campeloma decisa* being much the commonest and best preserved; though pleuroceras, probably of more than one species, sphæriums and badly worn pieces of unios occur also. It was at first thought that these gravel beds were interglacial, but the thin clay which in places overlies them has evidently slipped down from the adjoining low cliff of till, and the whole appearance of the deposit corresponds to that of the Carlton or York gravels, their upper surface occupying the right level for the Iroquois beach at that point, if below water and not raised as a bar, viz., 170 feet, five feet above the railway. The Don inter-glacial beds, half a mile away to the southeast, are about 100 feet lower down and contain a different set of fossils, campeloma being very rare, and unios very common. It has been suggested by Dr. George Dawson that the shells may have come from a stream flowing into the Iroquois water and simply have been buried on the shore with other materials washed down. The sharp clay bank rising in the rear and reaching a height of seventy feet a quarter of a mile to the east shows no sign of a stream bed, though the ravine crossed by the railway viaduct just to the west has possibly removed evidence of the sort that may have existed. Without direct proof to the contrary, however, the probabilities are strongly opposed to the supposition that these shells found from ten to fifteen feet below the surface of the shore gravels did not inhabit the body of water in which the beds were laid down.

The Carlton sand and gravel spit has long been known to contain deer horns, though so far as I am aware they were never mentioned in print before 1884, when Samuel Thompson wrote as follows:—"While speaking of the Carlton gravel ridge, it is worth while to note that, in taking gravel from its southern face, at a depth of twenty feet, I found an Indian flint arrowhead; also a stone implement similar to what is called by painters a muller, used for grinding paint. Several massive bones, and the horns of some large species of deer, were also found in the same gravel pit, and carried or given away by the workmen. The two articles first named are still in my possession. Being at the very bottom of the gravel deposit, they must have lain there when no such beach existed, or ever since the Oak Ridges ceased to be an ocean bed." * Mr. Bain of the Toronto Public Library was good enough to call my attention to the passage just quoted. Mr. Thompson is dead, and enquiries as to the arrowhead and muller referred to have been fruitless. It is possible that the Indian remains reached their position through burial, or were covered by a land slip, though there is no proof of this. The finding of a hearth of stones with ashes and charred sticks on the Iroquois beach in New York State gives support to Mr. Thompson's evidence of man's presence in Iroquois times.†

Last summer several horns were found in a gravel pit on the north side of the same spit at a depth of from twelve to twenty feet below the surface, the best preserved, just above a layer of clay, perhaps at the base of the gravel deposit. They are horns of caribou or reindeer, and are so fragile that unless handled very carefully they fall to pieces. The specimens which have reached me have been treated with glue by Mr. Archibald Pride of the Biological museum and are preserved in fair condition. Mr. Pride reports that the large horn first found is a "shed horn of a reindeer, apparently young, from the right side, slender and delicate in form, about three feet three inches in length, measured by the curve, or two feet six inches from burr to tip, making allowance for the point of the horn which is broken off." The second, "a fragment of another reindeer's shed horn found near the former but on a different level, has the same characteristics as the almost entire antler above described."

"The last horn [illegible] upon close examination undoubtedly that of a reindeer, is a right shed horn, worn by water and sand, and probably from a fine large male. The first, or brow antler, a palmated or

* Reminiscences of a Canadian Pioneer, 1884, p. 286.

† 6th An. Rep. State Res. Niagara, Dr. Gilbert, p. 84.

turned up snag, is broken off; the second, also broken off, is inclined to be flat on the inside surface. The measurement of girth between the two snags is six inches. Sufficient remains of the horn to show the sweep of the beam; and the slight flattening at the attachment of the tine is characteristic." As there was some doubt of the nature of this imperfect horn, which at first was thought to be a worn wapiti horn, Mr. Pride compared it carefully with Dr. Pike's fine set of caribou horns. He found that it corresponds closely with a pair of caribou horns from an animal shot by Dr. Pike a number of years ago in Nova Scotia. The shape is much the same, and the girth of the Nova Scotia horn is 6⅛ inches between the front antler and the first branch as compared with six inches in the specimen from Carlton. It is evident from Mr. Pride's work, that caribou or reindeer differing much in character of horns frequented the Carlton bar, but he thinks the horns examined are more like those of the Barren Ground than the woodland caribou. Numerous other horns and bones of deer are reported from gravel pits of the region, but apparently none have been preserved.

The man in charge of the main gravel pit states that shells occur in the gravel, but we were unable to find any, and as the gravel is loose and uncovered with clay it may be that shells formerly present have been completely crumbled or dissolved.

The only other fossiliferous deposit which will be referred to is one found quite recently while sinking a well near the Don above Taylor's first paper mill for the purpose of determining the relationships of the glacial and interglacial beds in connection with the work of the committee appointed by the British Association for the investigation of the Canadian Pleistocene. The well was started on a hill side thirty-five feet below the Iroquois level, and penetrated sand and gravel, sometimes cemented by carbonate of lime into impervious layers, for a depth of thirty-eight feet. Below the cemented layers at a depth of about seventy feet beneath the Iroquois terrace, freshwater shells occur, portions of unios, sphæriums and pleurocera having been obtained. The stratified sand rests on what appears to be a weathered surface of interglacial peaty clay, and is perhaps of Iroquois age, though the shells are found at a lower level than those obtained in Iroquois deposits at other points near Toronto.

Freshwater Shells from Other Lake Deposits.

From the instances given above, it will be seen that a considerable number of fossils are known from the Iroquois beach gravels, but many of them are horns or bones of mammals or fragments of wood, giving no hint as to the freshness or saltness of the water. With the exception of the unios said to have been found in beach ridges of New York State, no shellfish have been discovered except in the neighbourhood of Toronto. It is believed, however, that the Toronto finds are fairly conclusive that the water was fresh; and the evidence is strengthened by the fact that fresh water shells are found in deposits of most of the other great bodies of water that followed the retreat of the ice.

In the beaches of Lake Agassiz Warren Upham notes *Unio ellipsis* from Campbell, Minn.; and four species of shells occurring in considerable abundance near Gladstone, Manitoba, about 875 feet above the sea, *Unio luteolus*, *sphærium striatinum*, *S. sulcatum* and *Gyraulus parvus*. I have collected a unio, probably rectus, and two species of sphærium from the stratified clay of Rainy River, Ontario; deposits laid down in Lake Agassiz, according to Upham; but belonging to a separate lake, according to Tyrrell. Dr. Bell has found freshwater shells in old lake deposits north of Lake Superior; and Professor Chapman, formerly of Toronto University, names eleven species from Angus, south of Georgian Bay, in beds probably formed by Lake Warren, but possibly by Lake Algonquin. Chapman's list includes *Unio complanatus*, *Cyclas (Sphærium) similis*, *C. dubia*, *Amnicola porata*, *Valvata tricarinata*, *V. piscinalis*, *Planorbis trivolvis*, *P. campanulatus*, *P. bicarinatus*, *Limnæa palustris* and *Physa ancillaria*.* In my own collection made in the same region Dr. Dall has named eighteen species, including *Unio luteolus*, *Sphærium sulcatum*, *S. rhomboideum*, *Pisidium novaboracense*, *Valvata sincera*, *Amnicola limosa*, *Succinea avara*, *Goniobasis livescens*, *Planorbis deflectus*, *P. parvus*, *Limnæa decidiosa*, *L. elodes*, and *Polygyra monodon*, in addition to those found by Chapman. Similar shells are found at other points near Georgian Bay, and in the latter case as well as on Rainy River the shells are very widely spread and must have inhabited the waters in which the silts and sands containing them were laid down.

On the other hand there is no record of a marine shell being found in any of the old beaches of the Great Lakes region, though these are common on the St. Lawrence below Brockville, on the Ottawa to the northeast, and in raised beaches along the rivers flowing into Hudson Bay on the north. If the sea had formed our raised beaches one would expect to find marine shells in these just as we do along the rivers to the east and north.

There are a few organisms living in our great lakes identical with or closely related to marine species, and this has suggested to some writers that the Canadian lakes were once arms of the sea, *Reliktenseen* of the

* Geol. Can. p. 912.

Germans; but when this evidence is examined it proves to have little weight. Professor Ramsay Wright has been good enough to call my attention to the discussion of the whole question by Rudolf Credner in Peterman's Mitteilungen.* According to Credner, who quotes Stimpson, S. J. Smith and A. E. Verrill, two forms apparently marine occur in Lake Superior, *Mysis relicta* and *Pontoporeia Hoyi;* and five in Lake Michigan, the two just mentioned and three in addition, *P. filicornis*, *Triglopsis Thompsoni* and *T. Stimpsonii*. The late Professor Alleyne Nicholson found *Pontoporeia affinis* in Lake Ontario.† The two most important genera, *Mysis* and *Pontoporeia*, are tiny crustaceans which have been found also in numerous lakes in Scandinavia, and apparently easily accustom themselves to a life in brackish or fresh water, since they occur in such waters directly connected with the sea, and into which they have migrated. They or their eggs could readily be transported by waterfowl, and in fact might have passed up the canals to the upper lakes. Credner thinks that far too wide reaching inferences have been made from the finding in freshwater lakes of a very few species generally supposed to belong to the sea; and that the decision that a given lake is a *Reliktensee* must be reached only after obtaining clear proofs of a geological character, since the fauna alone is a very uncertain guide. There are marine forms to be found in small crater lakes high up in the mountains, such as the Alban and Nemi lakes in Italy, where there is no hint that the sea has ever been in geologically recent times.‡

The fact that many freshwater shells occur in the interglacial beds of the Toronto formation is of some importance in this connection; since the conditions under which these shell fish lived at heights of 140 or even 220 feet above the present lake must have been similar to those of the great post-glacial lakes referred to above.§

At first glance the finding of marine fossils along the St. Lawrence, *e.g.*, at Montreal, 550 feet above the sea, seems to imply a lowering of the northeastern part of the continent sufficiently to bring the surface of Lake Iroquois down to sea level; but an examination of the curve illustrating the differential elevation of the Iroquois beach on a previous page shows that horizontality would be reached considerably above sea level. It is probable, however, as shown by Gilbert and Taylor, that the sea entered the basin of Lake Ontario at a later time and at a much

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* Die Reliktenseen. Erganzungsheft No. 86 and 89. 1887.

† Ibid., No. 86, p. 65.

‡ Ibid., p. 107.

§ Bull. Geol. Soc. Am., Vol. 10, p. 170, etc.

lower level than the Iroquois beach,* though up to the present no marine shells have been found on these lower beaches.

AGE AND CONDITIONS OF THE IROQUOIS BEACH DEPOSITS.

Judging from the apparent maturity of the Iroquois beach as compared with that of Lake Ontario, one may suppose that the two beaches required about equal times for their production. If this be admitted, and if it be assumed that the Iroquois beach was begun at about the time Niagara Falls commenced its work, we may conclude that the waters retired from the Iroquois level about midway between the time of the retreat of the ice from the western end of the Ontario basin and the present. As this time is variously estimated at from 5,000 to 30,000 years or somewhat more, the Iroquois beach was probably abandoned from 2,500 to 15,000 years ago. Dr Spencer in conversation hase xpressed a belief that the beach is 17,000 years old, and this estimate may be looked on as representing the extreme limit of its age. It is possible that a more direct estimate of the time which has elapsed since the Iroquois water was drained may be made in the future, based for instance, on the present rate of erosion of the Scarboro' shore, or on the cutting of the Don or Humber valleys, and some observations and photographs have been made to serve as a starting point for such an investigation, but results that are of value have not yet been obtained.

The climatic conditions of the time were probably more rigorous than the present, though exact data to settle the point are not available. The two trees determined by Professor Penhallow, tamarack and spruce, belong on the whole to a relatively cool region, but both extend farther south than Toronto at present. In any case they appear to belong to an earlier time than the Iroquois beach, since they underlie its gravels. The caribou and elephants of the bars near Toronto suggest a distinctly colder climate than the present though not necessarily a glacial one; but there is not much in the structure of the beach itself to point in the same direction. Large boulders that might have been rafted by shore ice or carried by bergs have nowhere been found in the Iroquois deposits near Toronto. There are however, some crumpled beds of sand lying between horizontally bedded layers, which may have resulted from the grounding of ice floes; but it is not impossible that ice floes thirty-two inches thick, such as formed on Lake Erie last winter, may produce similar effects on beds of sand or clay along the shores of our present lakes when driven by violent storms.

Though the Iroquois climate was probably distinctly colder than that

* A Short History of the Great Lakes, Frank Bursley Taylor, 1897, p. 18.

of Toronto at present, the evidence available suggests that it was by no means Arctic, probably only cold temperate, in spite of the immense glacier generally supposed to have dammed its waters near the Thousand Islands. There are some interesting problems connected with this ice dam which held the water of Lake Iroquois for at least 2,500 years at a constant level in a climate apparently not Arctic. During the whole time its front seems to have retreated not more than fifty miles in a north-northeasterly direction, since the ice must have occupied the region near Kingston until the Iroquois water was drained to a lower level. If the Iroquois beach at Toronto required 2,500 years to form, the ice must have retreated in the direction N 17° E at the rate of about one mile in fifty years. If the time allowed for its formation is 15,000 years, the glacier retreated at the rate of one mile in 300 years. How many years were required for the ice to withdraw from its most southern point to Toronto, and how many more were needed for the retreat from the point where the Iroquois water was drained to the vanishing point in Labrador?

It is, of course, very improbable that the ice withdrew in a uniform manner. The great moraine of the Oak Ridges stretching across southern Ontario represents, no doubt, a prolonged halt in the retreat and is perhaps connected with the damming of the Iroquois water, since the moraine reaches Lake Ontario at about the point where the dam must have stood. Why should the ice have halted so long in a climate which seems not to have been Arctic? The Alaskan glaciers, it is true, present somewhat similar features, but they are Piedmont glaciers with an immense range of snowy mountains behind them as a source of supply, while the waning ice sheet of Northeastern Canada rested on a comparatively level plain.

Another point that has presented itself with considerable distinctness in the study of the Iroquois beach deposits is that their formation seems to have been preceded by a considerable period of low water. Under the thirty feet of Iroquois gravel at the Hunter street tunnel in Hamilton, the boulder clay has been weathered brown for a depth of two feet, and the time of low water was long enough for large tamaracks and spruces to grow. At that time the water must have stood at least thirty-five feet lower than the Iroquois level at Hamilton.

Near Toronto there is evidence not easily set aside suggesting that the till-covered surface was eroded into valleys and cliffs before the Iroquois water occupied its basin to the full depth. At the British Association shaft near the Don, stratified sand, probably of Iroquois age, is found resting on a brown, evidently weathered, surface of interglacial peaty clay, the overlying till having been removed, apparently, in this old valley, for a few hundred yards to the east blue till is seen overlying the same peaty clay at a higher level. There are other points also, one at a brickyard in the east of the city, where the peaty clay seems to have been cut into a cliff before the Iroquois sands were spread over it, and half a mile east at Price's brickyard, the same cliff of clay buried in stratified sand may be found, though not so distinctly. If this evidence be admitted, the water stood for a long time at least 100 feet below the Iroquois terrace after the laying down of the last till sheet.

It is generally held that during the last retreat of the ice the succession of high level lakes was unbroken, and that Lake Iroquois followed Lake Warren without any dry land interval. It has been shown by Gilbert that owing to differential elevation of the basin toward the northeast the water at the southwest end of Lake Iroquois at first stood lower than the later level of the beach.[c] Perhaps the difference at Hamilton may be sufficient to account for the weathered till thirty feet below the top of the Iroquois gravels, for Hamilton is the farthest point southwest of the line running through Rome, N.Y., representing the axis at which the water level suffered no change. Toronto is very nearly on that line, so that there would have been little or no oscillation of the Iroquois water level; nevertheless there are indications of Iroquois erosion and weathering seventy feet or more below the Iroquois beach. Before making positive statements regarding this, however, it will be well to examine all the localities likely to throw light on the subject, and up to the present only a few of them have been studied with this point in view. If the fact should be established it may be necessary to assume the withdrawal of the ice after the time of the Warren water long enough for the erosion and weathering observed, and then an advance of the glacial lobe of the upper St. Lawrence valley to the Thousand Islands, and a halt at the northeast end of Lake Iroquois sufficiently long for the formation of the beach. It would be of great value to examine the clay beds or rock underlying the Iroquois beach gravels at other points than Hamilton and Toronto, so as either to prove or disprove the existence of a low water stage between the time of Lake Warren and that of Lake Iroquois as suggested above.

This splendid old beach, so excellently preserved in both New York State and Ontario, whose bars and gravel ridges are traversed by main roads for many miles, on whose terraces towns and cities are planted, should receive more careful study than has been devoted to it of late years so as to solve the interesting problems it presents regarding the immediate past of the region.

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[c] 6th An. Rep. State Reservation at Niagara, pp. 70 and 71.

THE GEOLOGICAL HISTORY OF LAKE SUPERIOR.

By Dr. Robert Bell, F.R.S.

(Read April 15th, 1899.)

In the talk which I am about to give on the Geological History of Lake Superior I propose to endeavour to trace the origin and development of the lake itself rather than to sketch the geology of the surrounding country. The genesis of some of the great lakes, or rather of the depressions in the continent which they occupy, has been the subject of some investigation and of much discussion and speculation among geologists, but their researches and controversies have related mostly to the lower lakes, while but little has yet been written as to the geological history of Lake Superior. It was on this account, and because I have worked for many years on and around this inland sea and have paid some attention to this matter, that I have chosen it as the subject of my address to-night.

Before proceeding to speak of the basin of Lake Superior, I shall say a few words about the basins of the other great lakes, the origin of each of which has been similar to the others, but in some respects different from that of Lake Superior. Sir Andrew Ramsay and Sir William Logan supposed them to be due principally to glacial action; that is to say, that they had been scooped out of the rocks in which they lie, mainly by the denuding force of heavy and extensive masses of land ice. Although the eroding or excavating power of thick glaciers is very great, still it does not appear to have been sufficiently powerful to account for all that was formerly attributed to it. It has been pretty satisfactorily shown that during the glacial period their action in modifying the surface features consisted largely in the transportation of previously decomposed and loosened rock.

A former assistant of mine on the Geological Survey, Dr. J. W. Spencer, was, I think, the first to point out that the depressions now occupied by all the lakes east of Lake Superior represent the wide valleys or hydrographic basins of former rivers, more or less modified by subsequent glacial action, together with slight and widespread undulations or warpings of the crust of the earth. Although our lakes are so extensive and present such a conspicuous figure on the maps, they are quite shallow relatively to their area, and as the surface of this part of the continent is so generally level, a very small amount of denudation and a very slight undulation in the land would suffice to produce the shallow depressions which they fill.

Before the advent of the glacial period a great part of North America stood at an elevation of 3,000 feet or more above its present level, and the disintegration and removal of the rocks due to rainfall alone, which was facilitated by the greater elevation, went on for a vast length of time. This is proved by the existence of long and deep river valleys, some of them running down from the central parts of the continent to the present sea coasts, and beyond them into the depths of the ocean. The old valley of the St. Lawrence can be traced for 800 miles. The ancient bed of the Hudson has been followed by soundings, from its present mouth, down the slope of the bottom of the ocean far out to sea. The cañon of the Saguenay, and those of the Grand or Hamilton and other rivers of Labrador, as well as the channels of many of the long straight lakes and river stretches in the Archæan country to the north and northwest of us, are due partly to atmospheric and aqueous erosion during a long geological period while the land stood at higher levels. It can be shown that the grade of the Mississippi from its source to the sea was much steeper formerly than now, the present modification or lowering of the slope amounting to some 3,000 feet. The valleys thus excavated guided, to a considerable extent, the movements of the great glaciers which ploughed the surface of hill and dale, excavating and carrying forward vast quantities of the softened surface rock, together with harder portions in the shape of fragments, boulders and pebbles, which together constitute our till or hard-pan and other deposits, collectively called drift. The general tendency of the glacial action would be to enlarge the main valleys of the preglacial surface and to fill up or modify the smaller ones.

The geological structure and the relative resisting powers of the rocks were the primary or fundamental causes which predetermined the location, direction, extent, etc., of the valleys and basins thus formed by the combined action of aqueous denudation and glacial action.

The theory of preglacial river-erosion as the main factor in originating the lake basins may apply to all of them with certain differences in each case. The soundings show the existence in the bottom of each, of deep channels resembling river valleys on the land traversing their beds and leading to former outlets now closed up by drift materials, but which formerly drained these lakes or connected them with one another. We are indebted mainly to Professor J. W. Spencer for the discovery and location of these connecting channels. One of them, starting in Lake Michigan, runs eastward across the State of the same name, through the basin of Lake Huron to the northern extremity of the Indian Peninsula, thence down the bottom of Georgian Bay and across the neck of land to Lake Ontario. Another of these buried channels runs northward from Lake Erie to the western extremity of Lake Ontario. The basins of all the lower lakes are excavated in the softer portions of the almost horizontal palæozoic strata, so that their shapes and directions conform to some extent with the geological structure or arrangement of the strata. Lake Superior lies in a hollow almost surrounded by the primitive crystalline rocks. At one time it was probably filled with newer strata, which have been mostly removed by aqueous and glacial denudation; but small areas of those rocks still remain.

Lake Superior lies in the region of the general watershed or summit level of the continent east of the Rocky Mountains, although it is only 600 feet above the sea. From near its shores the water flows west to the Winnipeg basin, north to Hudson's Bay, and south to the Mississippi, while its own discharge is eastward to the St. Lawrence.

The drainage system, or catchment basin of Lake Superior proper, is consequently small, but it has a sort of extension or appendix in the basin of Lake Nipigon, which is really the uppermost of the Great Lakes of the St. Lawrence. This body of water measures eighty miles from north to south by fifty miles from east to west, with extensive bays on all sides. Its area is about half that of Lake Ontario, or between 3,000 and 4,000 square miles. Thirteen rivers and many brooks flow into it from various directions. One of its bays is only twenty-four miles from the nearest point of Lake Superior, and its surface has an elevation of 244 feet above the latter. The Nipigon river, which is the upward continuation of the St. Lawrence, is a clear-water stream and altogether the largest one flowing into Lake Superior. The larger number of the rivers and brooks falling into the great lake are darkly colored. Some of them look almost black as they enter its limpid water, the contrast being very striking. But the vegetable matter, to which the colour is due, soon becomes oxidized and disappears. There is a general absence of mud and also of dissolved mineral matter in the tributaries of Lake Superior, and hence its waters are not only singularly transparent, but also nearly chemically pure. The sounding lead has shown that the bottom of the Lake in nearly all parts consists of clay.

In tracing the origin of the basin of Lake Superior, we must go back to a very early period in the history of the solid earth. It appears to have begun with a depression in the original crust, even before the deposition of the oldest Huronian rocks, and probably before any water at all rested upon the heated surface of the globe. The great basin of Hudson's Bay is an example of a still larger depression in the first formed crust, which has persisted to the present day.

The vast Archæan region of North America, embracing perhaps one-third of its area, and which formed the nucleus of the continent around which the land has grown by the addition of one formation outside of another, has a general elliptical outline and extends from the north of Greenland in the far northeast to the State of Missouri in the southwest.

The depression of Lake Superior and that of Hudson's Bay and its connecting waters to the northward are within this ellipse. The earliest clastic deposits from the primeval sea might be looked for in these hollows and in the corresponding levels around the primitive nucleus of the continent, and hence, in these situations we find the Newer Laurentian and the Huronian systems largely developed and followed by the fossiliferous formations while the higher grounds or those more distant from these depressions as well as from the general periphere, consist almost entirely of the oldest gneiss which appear to be all modified from a granitic magma. The Huronian series, made up to a great extent of igneous rocks, are very largely developed to the south and west of Lake Superior in the States of Michigan, Wisconsin, Minnesota and Dakota, as well as throughout the country lying to the northwestern, northern and northeastern sides of the lake. During the succeeding Lower Cambrian period, the region of Lake Superior was the site of great outpourings of igneous matter, which formed the diorites, diabases, melaphyres, gabbros, amygdaloids, etc., of the Animikie and the Nipigon series. Between the Huronian and the older Cambrian periods, a vast interval of time elapsed, of which but little record has been left in the Lake Superior region. The upturned edges of the highly disturbed Huronian rocks were denuded down to a nearly level surface, and upon them were deposited the horizontal and undisturbed beds of the Animikie and Nipigon or the older Cambrian system, which have remained unaltered to the present day. The masses of granite of greater or less extent, which cut the Huronian and sometimes the Laurentian rocks around Lake Superior may have been erupted during this long interval, as we do not find them intersecting the Cambrian or any of the still newer strata, although they are themselves cut by dykes similar to those which traverse the Huronian. Geographically these eruptive granites are scattered around the lake outside of the area of the Cambrian igneous overflows, or in other words they lie, in a general way, between this area and the vast region of primitive gneiss beyond. Some of these granitic masses are large and are elongated parallel to the present coast lines, such as the one called the Giant's range, lying back from the northwest shore in Northern Minnesota and the Thunder Bay District, some of those near Nipigon Bay, Otter Head, and thence eastward to Michipicoten River, and Pointe Brule, from which a wide mass runs inland.

The Nipigon or Keeweenian formation, consisting largely of the igneous rocks already mentioned, occupies the outermost large points and islands all around the lake, such as those of Nipigon Bay, Keeweenaw Point, Isle Royale, Michipicoten Island, Gargantua and Namainse,* and it is probable that the bed of the whole lake consists mostly of this formation. The dip of both the Nipigon and the underlying Animikie rocks on both sides is towards the centre or deeper parts of the lake. The lake-basin existed before these rocks were laid down and it is probable that their present dip is partly due to a gentle inward slope of the surface on which they were deposited whether as sediments or volcanic sheets, but the higher dips which they have now assumed are believed to be owing to the slow sinking or caving-in of the crust following the removal, from beneath the basin, of such vast quantities of igneous matter to form the sheets of greenstones in the Animikie and the amygdaloids, etc., of the Nipigon formation, of which only fragments remain at the present day.

Those portions of the shores of Lake Superior which are occupied by the Laurentian, Huronian and older Cambrian rocks are noted for being traversed by great numbers of dykes of various kinds of greenstones. The larger fissures, marked by these dykes, may at one time have allowed great quantities of molten matter to escape to form the trappean overflows of the Animikie and the amygdaloids, etc., of the Nipigon series. On the other hand, these rocks may have been derived mainly from volcanic orifices now covered by the lake or represented by the plutonic necks to be found among the Huronian strata.

In the report on my survey of Lake Nipigon in 1869, I have shown that the immense horizontal cappings of diorite forming the upper part of the Nipigon series around that sheet of water appear to have flowed in from the direction of Lake Superior.

* Namainse, meaning the little sturgeon, is the proper spelling of this name, but it is generally incorrectly written, "Mamainse."

The central subsidence which has been referred to, ceased before the deposition of the Cambro-Silurian strata of the south shore, such as the red and grey sandstones about Grand Island, the Pictured Rocks and Sault Ste. Marie, as well as the small remaining patch of fossiliferous beds of Limestone Mountain on Keeweenaw Point, lying west of L'Anse, all of which retain the horizontal attitude of their original deposition.

It is to be noted that around Lake Superior, red sandstones of two formations come together, or nearly so, in different localities; and at one time they were confounded with one another and both supposed to be of the same age. The one set is associated with the Nipigon or Keeweenian formation while the other is newer. In the region of Keeweenaw Point their contact is not clearly seen, and there has been some discussion as to their relative ages. But here, as in other parts of the lake, the tilting of the one and the undisturbed condition of the other serve to distinguish them.

From what I have said, it would appear that in the earlier ages of the earth, or until the Cambro-Silurian period, the Lake Superior region was always one of volcanic activity. If we except the unaltered fossiliferous strata in the southeastern part, we shall see that in approaching Lake Superior as a centre from any point on the ancient crystalline rocks which everywhere else surround it, we have furthest out a great area of fundamental gneiss, followed by successive zones of igneous origin. The Huronian rocks, mainly of volcanic character, occupy large areas all around. Then come many masses of intrusive granite of various kinds. These are followed by greenstones of the Animikie formation and finally, inside of all the others, come the more recent amygdaloids, etc., of the Nipigon or Keeweenian formation. These zones are not complete or regular, but the above is the general order of their occurrence. This rude, concentric arrangement of different igneous rocks which become newer and newer as we approach the inner part, would indicate that there was here a deep-seated volcanic centre, dating back to very ancient geological times. The area of volcanic action had thus a great width in the early condition of the earth's crust, but it became more and more contracted as the world grew older and at length the active condition ceased altogether.

I have thus presented some of the fundamental geological reasons why the present site of Lake Superior was prepared to become a lake-basin, but between the stage in its history at which we have arrived and the next actual evidence as to how the basin was formed, there was a long interval, during which we can only surmise what was going on. Cambro-Silurian rocks, forming part of the northern margin of the great area of these strata lying to the southward, occupy the shore of the lake from Marquette to the outlet, a distance of 130 miles, and farther south they are succeeded by the Devonian and Carboniferous systems in their regular order. Patches of Cretaceous rocks, resting on the Archæan, occur in Minnesota at no great distance west of the lake. It is therefore probable that this part of the continent was submerged throughout much, if not all, of the time up to about the commencement of the Tertiary period. During this period there must have been a very long interval of erosion, in which the land surface was deeply sculptured and the present inequalities to a great extent produced. After this, when the glacial period came on, the deeply decomposed surface was ploughed up and its materials were transported to greater or less distances. Thus its removal from one part of the land and its deposition on another would add to the inequalities of the surface and might deepen and extend the larger existing lake-basins very much, while it would be the means of creating innumerable smaller ones. On the glaciated surface of the crystalline rocks, great numbers of lakes now show at a glance what their history must have been. We see the glacial furrows and striæ descending into the rock-basins on the one side and emerging on the other, while heaps of boulders and drift material are left wherever they could find rest or shelter from the moving ice or where they may have been deposited by the final melting away of the glacier. A few of the lakes have been formed by the damming up of valleys and partial basins by moraines of drift, but the great majority of them are complete rock-basins. There seems to be no limit to the size of the basins which may be formed in this way, and if we extend our conception of the power and volume of these old continental glaciers and imagine them to have acted upon a deeply softened surface, there is no reason why we may not believe that the greatest of our lake-basins might have been excavated in this manner. It is a question of what is most probable. If, in addition to these processes, we take into consideration the slow undulation, tilting or warping of the crust of the earth, which is known to have been going on, and which is still in progress all over this part of the continent, we shall have no trouble in accounting for the existence of our great lakes. When we remember how slight is their depth in comparison with their area, we see how easily they could be formed on this extensive plain of the continent. To give you an idea of the insignificance of the actual depth of these great sheets of water as compared with their extent, let us construct a vertical section through Lake Huron from north to south on a natural scale. If the horizontal distance be represented by one yard, we shall find it difficult to draw two lines on paper close enough together to show the difference between the surface and the bottom of the lake. In geological as well as engineering profiles we are accustomed to see the vertical measurements so greatly exaggerated that we are apt to overlook the true proportions.

To unscientific persons who have not given the matter a thought, it may be a surprise to learn that our great lakes with their present outlines and areas, and their existing outlets or connections with one another are all very new, geologically speaking. Indeed all lakes, whether great or small, and in whatever continent they may be situated, are necessarily unstable and transient even in their very existence, owing to the movements which are going on perpetually in the crust of the earth and which tend to either raise or lower their outlets—in the latter case tipping the water out—and partly to the fact that the discharging streams are constantly wearing their beds to lower levels.

The present great lakes of the St. Lawrence are only remnants lying in the deeper recesses of much larger ones which existed in comparatively recent times. There is plenty of evidence to show that in post-tertiary times a fresh water sea extended from the front of our Laurentian highlands southward to the Middle States, and that only a ridge west of Lake Superior separated it from another fresh-water sea which covered over all the lakes of the Winnipeg basin and also extended as one sheet, far up the low and level Saskatchewan and Red River valleys. The great valley of the Mississippi has been the site of numerous wide lakes, in the bottoms of which have been preserved the bones of a large number of species of curious and interesting mammals, all of which are now extinct. If the northern part of Hudson's Bay were raised a very little, and its southern part slightly depressed, so as to flood the low lands around it, we should have a fresh-water lake of unexampled extent, rivalling the Mediterranean Sea in area. It is possible that such a lake did really exist for a short time. Indeed the central part of our continent, all the way from the Rocky Mountains to the Appalachians and the Labrador Peninsula has been the region of the greatest lakes of the world in tertiary and post tertiary times, and even their degenerate successors of the present day retain respectable proportions.

So far as I am aware, Professor Chapman, late of Toronto University, was the first to recognize the former extension of the great lakes in one sheet as the probable explanation of the phenomena of the superficial geology of the whole lake region and surrounding country.

A great part of the work of excavating the lake basins was therefore completed before the glacial period and at its close, the land, which had stood at a considerably higher level than at the present day, had been depressed somewhat below its present position, and the relative elevations of different parts had been slightly but sufficiently altered to check the flow of the waters as continuous river-courses, and to flood extensive tracts and form lakes much greater than even the present ones.

The wide river-valley forming the bottom of Lake Ontario, about 700 feet below the present surface of the lake, was not continuous with its present outlet by the St. Lawrence, but turned southward opposite to Oswego, and was continued in the valley of the Mohawk and Hudson. The rivers, whose branching valleys now form Lakes Huron and Erie, probably discharged from the west end of the latter into the old Mississippi, as these lakes are known to have done by the Wabash at the close of the glacial period. The ancient river of the valley of Lake Michigan probably flowed south into the old Mississippi, as the lake itself did, at the close of the glacial period, and as it will do again very soon. Lake Superior appears to cover two valleys of ancient erosion, one lying under the western part and the other under the main body of the lake. The bottom or deeper part of the former runs from Duluth, at the head of the lake in a very direct course to Black Bay, keeping quite close to the northwest side. The land along this side of the lake is high and bold, so that with the portion under water added, the total depth of the valley is 2,000 feet. The other valley has several main branches spreading over the remainder of the lake, but all apparently leading also to Black Bay. The pre-glacial discharge of the valleys which now hold Lake Superior was most probably by way of Black Bay, the valley of Black Sturgeon River, Lake Nipigon, and thence northeastward directly into the sea, or by way of an ancient river which traversed the site of Hudson's Bay when the continent stood at a higher level. In considering this question, it must be borne in mind that during the period referred to the relative levels of the land to the north and south were reversed, as compared with the present day.

There is a possibility that the ancient drainage of what is now the basin of Lake Superior was southward, perhaps by way of Train River, near Grand Island. We have thus seen that the advent of the glacial epoch found all the eastern part of the continent standing perhaps 3,000 feet higher than at present, with a very old eroded surface totally unlike the present one, and with an entirely different topography. There was a general scarcity of lakes and few or no waterfalls or rapids in the larger rivers, as all would be worn down to base levels.

In whole districts the general course of the streams was in the opposite direction from the present. Several great rivers, which existed then, are now entirely wiped out, and the whole topography is so changed that, looking at the map of the present day, their courses would not be suspected. Take, for example, that of the old St. Lawrence as mapped by Dr. Spencer, starting from the middle of Lake Michigan, crossing the land to Lake Huron, thence through Georgian Bay, then across country to Lake Ontario, from which it again crossed country to the Mohawk and on down the Hudson to the Atlantic coast, which was then far to the east of its present position. About the same time, as I have stated, Lake Superior may have discharged through Black Bay and Lake Nipigon into the sea to the north. The present round-about arrangement of the discharge of the great lakes, which however is only temporary, has a very unusual appearance from a topographical point of view. The pre-glacial drainage of the valleys which now form the bottoms of three lakes, running in the various directions I have indicated, would be more in accordance with what we might expect from the general contour of the country, so that it is not at all extraordinary that it followed these lines. In a paper read to the Royal Society of Canada a few years ago, I sketched the hypothetical course and the branching of a great pre-glacial stream which finally flowed into the north Atlantic along the bottom of what is now Hudson's Strait, and which was probably larger than any of the existing rivers of the world.

The glacial epoch was of long duration and in these latitudes it was broken by interglacial periods, each of which probably lasted for a great length of time, and during them the vegetation, which had been driven south, partially returned and must have given the country something of the appearance of the present day. Although the glacial conditions have finally retreated as far as Baffinland and Greenland, many of the trees of North America are still in the process of returning as far as possible towards their original home in the north. But we have not the time this evening to pursue this interesting topic. In a general way the climate of these latitudes since the disappearance of the continental glacier has never been better than at the present day, but in certain deposits of more recent date on the north side of Lake Superior, I have found evidence of a milder interval which may nevertheless have been some thousands of years ago.

As the very existence of our great lakes, as well as their former extensions, their successive relations to each other and their drainage systems are all associated with the depression and subsequent elevation of the land, it will be in order for me here to say something of these movements. Geologists have not yet agreed as to what produced the glacial epoch—a unique event in the history of the earth—but they think the most probable cause of the depression of the northeastern part of the continent during and just following that epoch was the great weight of the mass of ice which had accumulated to a depth of one or two miles over a vast area. The oscillations of the land, as compared with the sea-level, which have always been going on in one part of the earth or another are mainly due to the shifting of the surface-load by its partial removal from one region to another through the agency of water, volcanic action, etc. The rocks, which appear to be quite rigid on the small scale are really not so, and on the large scale they yield slowly to pressure. The relatively small depression produced by this continental ice-sheet was less than might have been expected, and the rising of the land which is still going on, is the rebound, as it were, or the effort to regain its equilibrium after the load has been removed. Around any of our great lakes, one may easily observe abundant and distinct evidence of higher stages of the wate in the form of terraces, old beaches, ridges, curving spits and other shore phenomena. They are found at many different levels around all the lakes. The principal ones at various heights may be connected so as to show that the water stood long enough at each of these heights to wear into the land and leave these permanent records. But a curious fact about the beaches and terraces is that in a northeasterly and south-westerly direction they are not horizontal but slope upwards in the former at a rate which is sufficient to be easily measured, amounting to from five inches to three feet or more per mile. This important circumstance was first noted by a Canadian writer in referring to the terraces around Georgian Bay about 50 years ago, but I have forgotten at this moment where I read about it. The changes in the elevation of numerous well-marked beaches around the various lakes have been determined throughout long distances by several well known geologists, among whom I may mention G. K. Gilbert, F. B. Taylor, Warren Upham, Frank Leverett and Professor W. C. Chamberlain of the United States and Drs. J. W. Spencer and A. C. Lawson of Canada, both formerly assistants of my own. The bearing of the line of maximum rise was easily found after the rate of increase in elevation had been ascertained along various lines forming greater or smaller angles with it and Professor Gilbert gives it as N. 27° E. for the lower lake region. If we look in the opposite direction along this line we would speak of the movement as a depression. We have seen, however, that it is really a differential elevation towards the north-northeast, but the rate is not uniform and there may also be local warping of the crust.

Around the lakes of the Winnipeg basin, a similar phenomenon has been observed. On the western side of Lakes Manitoba and Winnipegosis, which were one sheet when the water was slightly higher, the ancient beaches are very well marked, and Mr. J. B. Tyrrell, formerly of our Geological Survey, has shown that in going northward they rise at the rate of about one foot per mile or 300 feet in the length of the two lakes.

Now lines drawn at right angles to the bearing of the maximum rise would represent isobases or axes along which there would be no change of level although the land might be rising to the northward or sinking to the southward.

The country is tolerably low and level about the outlets of all our lakes and there is no evidence of the former existence of any kind of obstruction to the outflow of the waters—not even of "ice-dams," which used to be convenient suppositions for getting over difficulties of this kind. Before the discovery of the earth movements, which have been referred to, there was thus great difficulty in accounting for the former extensions, higher levels, shifting of outlets and other changes to which we knew the lakes had been subject.

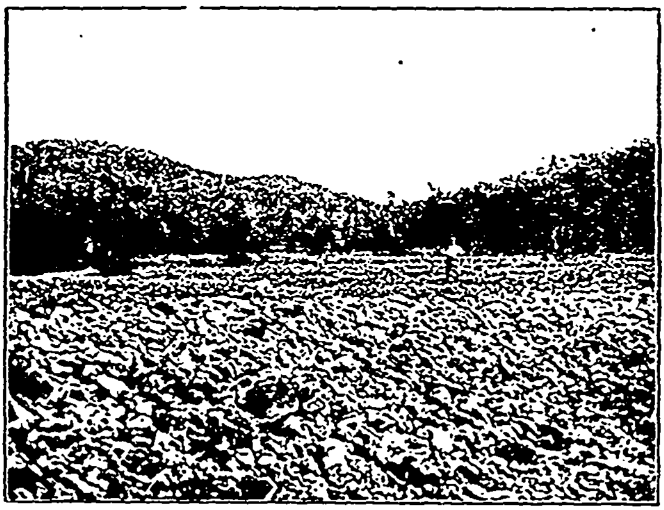
Around the northern shore of Lake Superior, Dr. A. C. Lawson has ascertained, by the spirit-level, the elevations at a considerable number of different localities of thirty-three of the most conspicuous of the terraces. These elevations range from near the present level up to more than 600 feet above it. In 1846, Sir William Logan described the remarkable set of distinct terraces at Les Ecrits or Terrace Bay near the mouth of Steel River or Schreiber, on the Canadian Pacific Railway, and Agassiz gives a picture of them in his "Lake Superior" published in 1851. Dr. A. C. Lawson ascertained that the highest water-mark in this vicinity was 418 feet above the present surface of the lake, but further west near the mouth of Arrow River he found terraces marking old beach lines up to 607 feet above the lake. If the water stood at any of these upper levels at the present day, there is no ground to the southward high enough to prevent it extending to the Gulf of Mexico. But if the sand and gravel in which these terraces are cut had been deposited by the sea, we would be pretty certain to find in them the remains of marine organisms, as we do in the post-glacial deposits of the province of Quebec. Fresh water, especially in a cold climate, produces few or no mollusks, and even if it did, their shells do not last as long as those of marine species when embedded in sand or gravel. It is, therefore, probable that at the close of the glacial epoch, an enormous sheet of fresh water covered the whole region of the great lakes of the St. Lawrence and extended far to the south, and that it was drained away to the southward by a slightly greater elevation of the land in the north. Geologists have named this vanished sea Lake Warren.

After a time, the land to the south of the general basin of the great lakes had become dry, but all the water above Lake Ontario was united in one body, which included Lake Nipigon and flooded the land north of Georgian Bay as far as Lake Temiscaming. Dr. Spencer has named it Lake Algonquin and it discharged by the Trent valley into his Lake Iroquois which covered the site of Lake Ontario and the surrounding country and flowed out to the sea by the Mohawk valley.

When the water had fallen to within about 100 feet of the present level of Lake Superior, it remained united with Lakes Michigan and Huron as one sheet in three lobes discharging by way of Lake Nipissing and the Ottawa River. Mr. F. B. Taylor proposes the name Great Lake Nipissing for this former inland sea. The fact that a differential elevation of the land towards the north-northeast has been going on and is still in progress is proved by the undoubted southward inclination of the ancient beaches around the great lakes which succeed one another and together record a movement which was continuous through a great length of time, and also by other phenomena which I have observed in the northern part of the Province of Quebec and in the Labrador peninsula. But we are not dependent on the geological records alone to establish the existence of this movement in the crust of this part of the earth. Professor Gilbert has carefully investigated the readings of various gauges which were placed many years ago at different points on the American side of the lakes and he has found that, after eliminating all disturbing elements, they agree in showing a steady fall in the water towards the north and a corresponding rise towards the south, which amounts to about .42 of a foot per 100 miles per century. I am of the opinion that both the amount and rate of the uplift increase for a certain distance to the northward or until we reach the centre of the maximum height of the ice during the glacial period; and consequently around Hudson's Bay and in the Labrador peninsula the elevation is going on more rapidly than in our lake region. This is only what we might naturally expect if our theory of the cause be correct.

As a consequence of this tipping up, or canting of the lakes, their northern shores are shoaling, while their southern ones are flooding.

The quantity of water in the lake will be increasing or diminishing according to the position of the outlet. If we draw a straight line through the outlet of each lake at right angles to the line of uplift, this isobase will represent the axes along which its surface is being tilted and on it there will be no change of level, while the further we go from it to the north the greater will be the fall and the further to the south, the greater the rise. This isobase of Lake Superior runs from Sault Ste. Marie to a point on the northwest side near the international boundary line. Heron Bay is the most northern and Duluth the most southern part of the lake in reference to this line. At the above rate of tilting, Professor Gilbert calculates that the fall in the lake at the former place is five inches and the rise at the latter six inches per century, or a

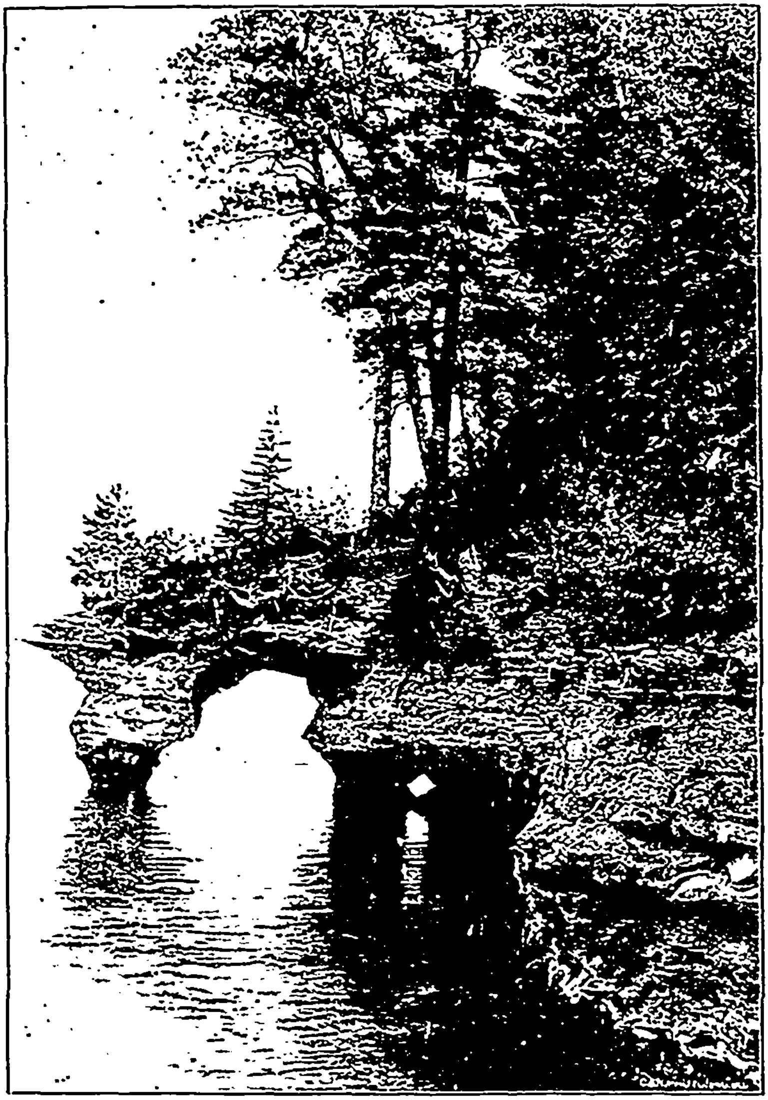


Modern Raised Beaches, Pointe Brulé, North Shore.

relative difference of nearly a foot per hundred years. This movement having been going on for a long time, the contrast in the appearance of the two sides of the lake is quite noticeable. On the north side, we see wide shores and many raised beaches, while on the south shore the lake is washing away the land or the waves are beating against the partly submerged cliffs and the coast has a generally drowned appearance.

The contrast between these two conditions is well brought out by the accompanying illustrations, one showing modern raised beaches on the north side and the other the rising water eating away the sandstone on the opposite shore.

Before closing I may say a few words in regard to a possible cause of the driftless area to the south of Lake Superior in Wisconsin. The great extent and depth of the basin of Lake Superior, which, as we have seen, was in existence before the advent of the glacial period, lying across the course of the on-coming land ice, must have had an important



View near Ashland, South Shore, showing gradual submergence.

effect in checking its progress. This influence of a great depression would be much enhanced by the very considerable height of the land on the south side of the greater part of the lake.

Along the eastern part of the south shore of Lake Superior, glacial striæ are not seen, the rocks being mostly buried under sand and other superficial deposits. The general trend of the striæ is increasingly deflected to the westward of south as we proceed towards the western extremity of the lake.

The drift or till which is very heavy towards the western part of the south side of Lake Superior is all red, owing to the colour of the sandstones, marls, etc., from which it has been derived, to the east and in the bottom of the lake. Around Thunder Bay and at other places on the northwest side of the lake, the glacial grooving has a westerly course and the debris of the red marl of the lake-basin has been carried out west over the land for a distance of fifty miles or more. In many places on the east shore, the striæ run up from beneath the water and continue inland with an easterly bearing. It is well known that the peculiar form of red jasper conglomerate, which, as far as we are aware, is found *in situ* only at the north end of Goulais Bay and north of the St. Mary's River, has been carried east with the drift all along the north shore of Lake Huron, from which it has been subsequently moved south and southwest by a more recent and probably lighter system of glaciation. Along the west side of Lake Michigan the striæ are reported to have a course west of south. The ice-sheet which produced the striæ either passed the side of the driftless area or did not extend to it. We may therefore conclude that to whatever extent the basin of Lake Superior was deepened or enlarged by glacial action the excavated material was carried mainly to the west and east and failed to reach the driftless area of Wisconsin.

THE ORIGIN OF GENDER.

By Prof. A. J. Bell, Ph.D.

(Read February 12th, 1898.)

"The foundation of grammatical gender is the natural distinction between the sexes in mankind and animals" is Hermann Paul's judgment on this question, a judgment representing the views of the dominant school of grammarians, and one which will, moreover, be accepted as natural by anyone who is acquainted only with the phenomena presented by grammatical gender, as it is found in English. And indeed, an Englishman, who has in mind the distinction, as it exists in his own language, will be inclined to wonder how any question can arise about the matter, and to regard the origin of the distinction as evident. This is because in English the use of grammatical gender has been to a great extent discarded, and is retained mainly for pronouns. The agreement of adjectives, that represents the high-water mark of its development, has quite disappeared, and in consequence with regard to nouns the question of their gender rarely arises, and it is usually only when we wish to substitute a pronoun for a noun, that this grammatical distinction claims our attention. Even then in making the distinction we follow pretty closely the lines of natural sex when persons are in question, using the masculine pronoun *he* for males and the feminine *she* for females, though there is a tendency to regard names of children as neuter, *i.e.*, to disregard the distinction of sex entirely when speaking of them. With regard to lower animals the distinction is usually disregarded, and when lifeless objects are in question, it is usually poets that venture to apply to them the masculine and feminine pronouns, while personifying them in a way that is, as a rule, quite arbitrary, though at times there appear some traces of a connection with an older state of things. So when the poet makes the sun masculine and the moon feminine, he is probably influenced, consciously or unconsciously, by the tradition of the sun god Apollo and the moon goddess Diana; and when a ship is regarded as feminine, which is commonly the case, the poet is following an old grammatical distinction which can be traced back to the primitive language of the Indo-European people. But this personification is usually governed by ideas that are entirely independent of the grammatical distinction of gender as it exists in the older forms of our language. So when the poet speaks of the bird seeking *her* nest, or the leap of "the roe when *he* hears in the woodland the voice of the hunter," or of the swan singing *her* death song, he is determined in his choice of genders neither by the gender of these words in the English of to-day, for then they are usually neuter, nor by the gender they have in Anglo-Saxon, where the words for bird and swan are masculine, while that for roe is feminine, but by a sense of fitness that is a law unto itself. In English, then, the grammatical distinction of gender has mainly disappeared, and where it does exist, is applied in what seems a natural and rational manner, especially if we accept Paul's opinion that the basis of grammatical gender is the distinction of sex.

But when an Englishman crosses to the continent he finds a very different state of affairs in this regard. Our poets, following their sense of the fitness of things, make the sun masculine and the moon feminine. the German does exactly the opposite. And the worst of it is that he does not confine his tendency for confusion, for such it may seem at first sight, to lifeless objects. In German the boy is masculine, it is true but the girl is neuter. The lady (*Frau*) is feminine, but the woman (*Weib*) is neuter. The spoon is masculine, the fork is feminine, and the knife is neuter; a tree is masculine, its buds are feminine, and its leaves are neuter; one's mouth is masculine, but his nose is feminine, and his eyes and ears are neuter. "Gretchen asks William, 'Where is the turnip?' 'She is gone to the kitchen.' 'Where is the beautiful English girl?' 'It is gone to the opera.'" As Mark Twain remarks, "there is no apparent sense or system in the distinction," and a German might well be pardoned for inquiring about the origin of a distinction that seems so senseless and absurd. And it must be owned that the contributions to the solution of this question have proceeded mainly from Germans, though it may be doubted whether their inquiries have been the result of any perception of the palpable absurdity of their language in this respect. For I well recollect the perplexity of a German girl who was just beginning the study of English, when she found that we spoke of a spoon as "it" and not "him," and if we regard the distinction of genders in German from the standpoint of what seems to me the origin of this distinction in the Indo-European family of languages, a German has some reason for feeling proud of his language, as showing not a few traces of the origin of this distinction.

In French the anomalies with regard to the gender of persons are far less marked, but here matters are complicated by the fact that the neuter gender has disappeared entirely, and all lifeless objects are masculine or feminine. Rules are not of much help in unravelling the entanglement; one must try to remember the gender of each word. The Englishman's Latin, that seemed so useless when he was learning it at school, may be of assistance to him here, though it may lead him astray too. For while *manus* is *la main* and *lacus* is *le lac*, *color* is *la couleur* and *flos* is *la fleur*. Then substantives neuter in Latin have become either masculine or feminine in French, ex.gr., *saeculum* is *le siècle*, *vinum* is *le vin*, *regnum le regne*, *trifolium le trèfle*, but *folium* is *la feuille*, *mare la mer*, *velum la voile*, and *debitum la dette*. In old French the lack of harmony was much greater, but it has been partially corrected in modern French by the influence of classical studies.

In Greek and Latin the confusion is in its general character much the same, and I need not multiply examples. The Latin words for a sword, *gladius*, masculine, and *ensis*, feminine, mean exactly the same thing; why should they differ in gender? and why should they not both be neuter? The answer given by the grammars is that words ending in *us* in Latin are usually masculine, but those ending in *is* are usually feminine. But *humus*, the ground, and *malus*, an apple tree, are feminine, and *pelagus*, the sea, is neuter, while *finis*, a boundary, and *orbis*, a circle, are usually masculine. And in Greek the irregularity here gave rise to the first question about grammatical syntax that was propounded in our western world.

Protagoras of Abdera, the greatest of the sophists, was the first, so Aristotle tells us, to distinguish the genders of nouns, dividing them into ἄρρενα, θήλεα and σκεύη, and noting the agreement of the epithet or adjective with the substantive. But he also noted that the distinction was not always logical or rational. Μῆνις, wrath, for example, the first word in the Iliad is feminine. So is πήληξ the helmet. Then, while in case of some animals, they had different words for the male and the female, e. g., λέων, λέαινα, or at least a word to distinguish the male from the flock, as in κριός and ὄϊς, ταῦρος and βοῦς, they had usually only one name for both, e.g., ἵππος the horse or the mare, ὄρνις the male or female bird, ἀετός the eagle, which is masculine, regardless of sex. Then while most words ending in ος are masculine, some like ὁδός a way, χηλός a box, σορος a coffin, λήκυθος an oil-flask are feminine. Protagoras would seem to have made some attempt to remedy these defects, and was ridiculed for this by Aristophanes in the Clouds (vv. 658 ff.) Strepsiades has come to Socrates, representative of the Sophists in the eyes of the average Athenian, and wants to learn the ἄδικος λόγος, or art of unfair pleading, that he may avoid paying his debts. He is told he must first learn grammar. The lesson begins with metres or measures, and Strepsiades is eager to learn about them, for the flour-dealer has recently cheated him of a couple of quarts of flour. But he is disappointed to find that it is all about trimeters and tetrameters, dactyls that are not fingers, and such stuff, and returns to his request for the ἄδικος λόγος. "But there are other things you must learn before this," says Socrates; "of four-footed beasts which are properly male." "Why, I know the males," he replies, "unless I have lost my senses; there are the ram, the bull, the dog, the cock (ἀλεκτρυών)." "You see what befalls you," rejoins Socrates; "the hen you call ἀλεκτρυών, and the cock you give the same name." "How, indeed? Tell me how." "You call them both ἀλεκτρυών." "Ay, by Neptune; and now how should I call them?" "The female ἀλεκτρύαινα, and the male ἀλέκτωρ." Strepsiades is delighted and promises to fill Socrates' kneading-trough with flour. But he has made another blunder, he makes κάρδοπος the kneading-trough feminine, while it is masculine by ending, and so he is instructed to say καρδόπη, because that is the way to form feminines. Such was the ridicule that not unnaturally assailed the first attempt to reform syntax on logical principles.

Thus the nature of gender seems to have been the first question in grammar that engaged the attention of the Greeks, and Protagoras had no doubt that it was based on the distinction of sex in men and animals, in which view he is followed by all the Greek and Roman grammarians: Dionysius Thrax in the oldest τέχνη γραμματική or art of grammar, that appeared in the western world,—a hand-book written in the first century B.C.—in three lines gives in substance all we learn from the ancient grammarians, Γένη μέν οὖν εἰσι τρία· ἀρσενικόν, θηλυκόν, οὐδέτερον, ἔνιοι δε προστιθέασι τούτοις ἄλλα δύο, κοινόν τε, καὶ ἐπίκοινον, κοινὸν μὲν οἷον ἵππος κύων, ἐπίκοινον δὲ οἷον χελιδών ἀετός. The Roman grammarians translated κοινὸν γένος by *genus commune*, and ἐπίκοινον by *promiscuum*, and to the five genders mentioned above, Priscian added a sixth of *nomina mobilia* ex. gr.: *bonus-a-um* or *filius*, *filia*, or the Greek λέων,λέαινα. (He confuses adjectives with nouns and the division of the adjective as a separate part of speech was unknown to the ancients, being first made in the Middle Ages). The question that interested the Roman grammarians and all grammarians down to our own century was not that of the origin of this distinction, which seemed obvious, but how far the neuter gender was a natural one. Perhaps the judgment on this point best worth quoting is that of Julius Cæsar Scaliger, who holds that the *genus neutrum* cannot be considered a natural gender, for under it come not merely objects without life or sex, but living sexual things, as *mancupium* the slave, or *scortum* the harlot. It does not state a lack of sex, then, but rather ignores or declines to assign sex.

With regard to the origin of gender no attempt at systematic investigation was made till our own century, when Jacob Grimm, the founder of Historical Grammar, assuming that sex is the basis of gender, tried to give a systematic account of German genders. Names of animals and lifeless objects, he thought, were assigned genders, according as the qualities characterizing them were appropriate to males or females. "Masculines," he said, "seem to be the earlier, greater, firmer, harder, quicker; the active, moving, begetting. Feminines are the later, smaller, weaker, quieter; the passive, the conceiving. Neuters are the produced, effected, material, general, undeveloped, collective." And Scherer is justified in thinking that his chapter on gender represents the high-water mark of his genius, such is the mastery of materials and acuteness of investigation he displays in it; and yet it is not convincing and becomes less and less so, as he descends in the scale of existence, till when he reaches abstract nouns he no longer attempts to arrange them in accordance with their meanings, but takes form and ending for his guide. Take for example, *Der See* the lake, *Die See* the sea or ocean. The ocean is greater than the lake, it is the active, the moving, probably the earlier; it seems to have the characteristics of the male and yet it is feminine, while the lake is masculine. So with the sun and the moon; but Max Müller thinks that the German gender here probably represents an older state of things, when men measured time by months rather than by years, and the moon took precedence of the sun. And while Grimm's theory is no longer dominant in grammatical studies, it still finds many advocates.

The theory that now holds the field is that presented by the so-called young grammarians, prominent representatives of whom are Brugmann and Paul. They have abandoned the line followed by Grimm in his investigations, and are trying to account for the gender of most words by the influence of Analogy. Grammatical gender, they think, probably corresponded originally to natural sex, and exceptions to this rule came about gradually and in the following way. The word *love*, originally neuter, is applied to a man or a woman to denote the beloved object, and so by association becomes masculine or feminine. So, too, words primarily neuter, but denoting males or females tend to become masculine or feminine. Diminutives are primarily neuter, e.g., *Mädchen;* but Wieland writes, "*Die hässlichste meiner Kammermädchen,*" making the compound of *Mädchen* feminine. So in Latin Terence writes *Mea*

Glycerium, and in Greek all diminutives that denote females are feminine, while many that denote males, e.g., *παιδίον*, *μειράκιον*, are neuter. So epithets of males are usually masculine and epithets of females usually feminine. A common ending for feminine epithets was *a*, as in *Theodora* and *Agatha*, and hence began a tendency to make all words ending in *a* feminine. These words further attracted others of similar meaning: *silva*, for example, attracted *arbor*, and all names of trees in Latin tended to become feminine, though many of them, like laurus, ficus, pinus, malus, pirus, have the masculine ending. So in Greek, *ἀγυιά*, a street, attracts to this gender *ὁδός ἀμαξιτός* and *ἀτραπός*. So that, while gender is primarily based on sex, it is soon determined rather by the groupings of certain words according to their meanings or endings. The gender of a word is at times determined by its meaning as in the case of *arbor*; at times by its ending, as in that of *silva*, while at times it wavers, owing to the counter-balancing force of these tendencies, as in *cypressus*, which is sometimes masculine, sometimes feminine.

This view is a distinct advance on that of Grimm, and seems to give a true account of the way in which names of lifeless objects become masculine or feminine. But why are personal epithets like *Weib* in German, or *παιδίον* in Greek, not feminine or masculine to begin with, if gender is primarily based on sex? In Latin, *servus* is masculine, but the legal term *mancupium* is neuter, as in *ἀνδράποδον* in Greek, and the latter seem to represent the older state of things. The answer will probably be, that *mancupium* is primarily "that which is held in the hand," and properly neuter. Weib is from O. H. G. *Wip*—inspiration, also a neuter. But according to the theory just stated, words used as epithets of males or females tend to become masculine or feminine. So in Sanskrit *ápas*, n., is the work, *apás* is the workman; *bráhma*, n., is worship, m., the priest. In Greek, according to Brugmann, *νεανίας*, the youth, is altered from the older form **νεανία*, youth in the abstract. In Latin, it is held, *agricola*, m., the farmer, is merely a personification of the older *agricola*, ploughing; and *optio*, f., choice, becomes m. when it comes to mean the centurion's assistant. An older answer, still commonly given, is that *mancupium* or *ἀνδράποδον* were not primarily persons but *res* or *κτήματα*, and hence were neuter. Is this true of *Weib* as well? We have every reason for thinking that the primary condition of woman is that assigned her by Roman law, i.e., she was the property of her husband. But if this is the true reason for the gender here, gender cannot be based on the natural distinction of sex, but on the artificial one of legal status.

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*Historical Syntax I., pp. 89, ff.

That the highly artificial system of genders found in Greek and Latin was not mainly a development in each of these languages, but that it can in great measure be traced back to the original Indo-European language, has been clearly shown by Delbrück in his Grundlagen der Griechischen Syntax, pp. 4 and 5. But his further examination of the correspondence between the classes of words in Greek or Latin that are masculine or feminine by meaning with the corresponding classes in Sanskrit serves to show how little a comparison of these languages can teach us here. Names of trees, for example, which in Greek or Latin are mostly feminine, follow the analogy of ὕλη and *silva*. But in Sanskrit they are mainly masculine. One curious correspondence he notes, is that, just as in Greek and Latin, while the names of trees are feminine, their fruit is denoted by a cognate substantive in the neuter, ex. gr., μηλέα and μῆλον, κερασία and κεράσιον, Latin *pirus* and *pirum*, *ficus* and *ficum*, so in Sanskrit *amra*, m., is the mango-tree, and *amram*, n., its fruit.

With regard to endings, we may adopt Brugmann's rule: All stems in *o* are originally masculine, all in *a* feminine; others are primarily indifferent. Masculines in ας in Greek and *a* in Latin are derived from corresponding feminine abstracts in *a*, as in νεανίας and *agricola*. The Latin does not usually add the personal ending *s* here, though Festus gives the forms *hosticapas* and *parricidas*.

Now it is clear from what has been said already, that the artificial systems of gender found in Greek and Latin represent an advanced stage in the development of grammatical gender; for very many names of lifeless objects in both these languages are masculine or feminine; in both most abstract nouns are feminine; and according to both the theories already outlined, which make sex the basis of gender, all these must have been originally neuter. In Greek and Latin neuter nouns are in a minority, when compared with either masculines or feminines. Hermes in a programme *Ueber das grammatische Genus** gives the following table of the comparative number of masculine, feminine and neuter substantives in Latin, Greek and Sanskrit:

	Masculine.	*Feminine.*	*Neuter.*
Latin	10	11	6
Greek.......	10	12	6
Sanskrit...................... .	10	5	8

This table shows that in Sanskrit the number of feminines is much smaller and the number of neuters considerably larger than in Greek or Latin, and indicates a gradual change from neuters to feminines. But we have signs, too, in Greek and Latin that neuters are tending to

*Berlin, 1851.

become masculine or feminine. Modern Greek has preserved the neuter gender, and the signs of its disappearance in ancient Greek are not so numerous or clear as in Latin, but we shall see some of them, when we come to speak of the primary force of the ending *a*. But in Latin the tendency is very clear, and we have an exhaustive statement of the shifting in Appel's *De Genere Neutro Intereunte in Lingua Latina*,* so that I shall content myself with citing a few of them here. *Gladius* has an older form, *gladium*; *pulvis*, m. and f., has an older form, *pulver*, n.; *sanguen*, the older form of *sanguis*, and *flumen* are old neuters, as is also *Venus*. Bücheler, comparing οἶνος with *vinum*, speaks of οἶνος as the older, as if wine were naturally masculine. But in the time of Nero *vinum* had become *vinus*, m.; for Petronius makes a peasant say *vinus mihi in cerebrum abiit*. *Fatum* has become *fatus* in Petronius. Jerome knows that *cubitum* is the classical form, but he uses *cubitus*, he tells us, to be generally understood. But the most striking proof of the extent of this process in popular Latin is the entire disappearance of the neuter gender in the romance languages.

In Greek or Latin, adjectives agree in gender with the substantives with which they are in apposition, whether this apposition be attributive or predicative. I specify in this way, for it seems to me that the adjective in the predicate is much slower to enter on this agreement than the attributive adjective. In German the predicative adjective is invariable, and probably the similar lack of agreement in Greek in such examples as οὐκ ἀγαθὸν πολυκοιρανίη point back to a time when this construction was the rule in Greek also. But with regard to their agreement in gender, adjectives in Greek and Latin fall into three classes: (1) Adjectives in most common use in Greek and Latin have three forms, one for each gender, ex. gr., ἀγαθός-ή-όν or *bonus-a-um*. But interesting are those in Latin like *celer-is-e*, where the distinction of the form *celer* as masculine from *celeris*, feminine, seems to have been a novelty even in classical Latin, where Lucretius (IV., 160) has *celer origo*, and Virgil (Aen. VI., 685), uses *alacris* as masculine. In archaic Latin Neue notes the wildest confusion, indicating that no such distinction existed then. Parallel to this is what takes place with regard to certain common nouns in classical, as opposed to archaic Latin: In classical Latin *lupa* is the she-wolf, as opposed to *lupus*, and *porcus* has a feminine, *porca*. But Cato and Ennius wrote *lupus femina* and *porcus femina*. So Petronius forms *apra* from *aper* and Horace makes *lepus* feminine. In this class, then, there is a manifest tendency to advance from a twofold to a threefold system of gender. (2) But the

*Erlangen, 1883.

majority of adjectives in Latin or Greek have only two terminations, one for the masculine and feminine and another for the neuter, e.g., *ἄλογος-ον* or *hilaris-e*. While these adjectives are not older than those belonging to the first class, they seem to follow an older type with regard to gender. We noticed already that some adjectives of three terminations had evidently but recently evolved the feminine form. We have in Homer forms like *ὀλοώτατος ὀδμή* or *ἀσπάσιος γῆ** which indicate that many Greek adjectives that usually have three endings belonged primarily to this class. Many adjectives, which have only two forms to begin with, develop a third, always a feminine. So *πρόφρων-ον*, develops a feminine form, *πρόφρασσα*, *πίων-ον* a feminine *πίειρα*. Comparatives like *ἀμείνων-ον* become in Modern Greek adjectives of three terminations. So in Latin *hilaris-e* changes to *hilarus-a-um*, *inermis-e* to *inermus-a-um*. In Greek the genitive dual of the article has *τοῖν* and not *ταῖν* for the feminine as well as the masculine; and Bücheler seems a little hasty, when he concludes from the inscription *hastis puris duobus* that *hasta* was once masculine, as it seems far more likely that we have here a trace of the older state of affairs, when *duobus* was used for the feminine as well as the masculine. (3) The third class of adjectives are those of one ending for all three genders, e.g., *μάκαρ* or *vetus*. Some of these are used as substantives as well as adjectives, e.g., *uber*, fertile, is primarily *uber*, the udder, and *vetus* is the same word as *ἔτος*, the year. But many of them cannot be accounted for in this way. Here, too, we have signs of a development of a second form; *μάκαρ* has at times a feminine *μάκαιρα*. The most noteworthy instance of this is in the case of Latin comparatives. In classical Latin, *maior* is masculine or feminine, *maius* neuter. But the difference of ending between *maior* and *maius* has nothing to do with the distinction of gender to begin with. *Maios* (the older form of *maius*) is related to *maior* precisely as *arbos* is related to *arbor*; that is to say, *maior* is the rhotacized form of the older *maios*, which follows the analogy of the remaining cases, *maioris*, *maiori*, etc., and in the historians of the second century B.C., we find such expressions as *prior bellum*, *bellum posterior*, showing that their forms were not then felt as representing different genders. The change from *hallec*, n., to *hallex*, m., seems to indicate that the form for the nominative of many of these adjectives, e.g., *felix*, is properly a masculine form, which is used for all three genders.

An examination of the forms for gender of adjectives seems to afford reason for the opinion that behind the three-fold system of genders, which we find in all Indo-European languages, lies a twofold system that does

*See Munro, Homeric Grammar, p. 112, for further examples.

not distinguish feminines, and behind that a still older state of affairs that shows no distinction for gender. If this be the case, the primary distinction for gender would be a distinction between the genders that we call masculine and neuter, and the feminine gender would be a later development. The distinction would, in the beginning, have nothing to do with sex, and the notion of sex would be connected with it only when the feminine gender was developed. What, then, would be the idea underlying the distinction between the two older classes of words? The grammarians of our day seem to think that to suppose that any idea underlies such a distinction is to introduce a dangerous element of speculation into a grammatical enquiry. Let me quote here the eulogy recently pronounced by Max Müller upon Rudolf von Ihering: "It was the leading principle of all his brilliant researches to discover in everything that has become formal its original substance, in what seems unmeaning its true purpose, in what is irrational its original *raison d'être*. This is the only principle that guides, or ought to guide, the student of language. He has always to try to discover in what is purely formal in language something that was in its origin full of life and meaning. He has to start with the conviction that there can be nothing in language that had not an intelligible purpose; that there is nothing that is now irregular that was not at first regular, nothing irrational that was not originally rational."* What is, then, the intelligible purpose that underlies this distinction? Grammarians have long felt that *mancupium*, a slave, was neuter, because it signified a *res* or chattel, not a person; that is to say, they based the grammatical distinction between masculines and neuters not on any distinction of sex, but upon a distinction which was the basis of the structure of Roman law, that between the *res* and the *persona*. Have we any right to suppose that conceptions of Roman law are based on the facts of life among the primitive Indo-Europeans? Ihering, in his *Vorgeschichte der Indo-Europaer*, shews, it seems to me, in a most convincing way, that many Roman religious and legal usages can be understood only when related to the conditions of life of the Indo-Europeans in their primitive habits or during their migrations; and speaking of the Romans, "No other of the Indo-European peoples," he says, "have so scrupulously retained the institutions of primitive times as solemn religious acts, even long after they had lost their place in private life." Probably it was this scrupulous conservation of primitive usages that specially fitted the Roman people to become the creators and teachers of law for the rest of the world. The distinction between *persona* and *res*, which Ihering

*In Cosmopolis, Sept., 1896.

does not mention, seems to me to have been one of primary importance, on which was founded the whole structure of Indo-European society. The head of the family, the free member of the tribe, was felt to be the *persona*, the only person who could act independently; and all the rest of the *familia*, his wife, children, slaves and cattle were simply his property. Primarily the names of *personæ* were the only masculines, and all others were neuter. But presently his sons, his freedmen or favorite slaves, his horse, his sword, the heavenly bodies, the mountains, the grandest and most striking natural phenomena, were personified and the bounds of the masculine gender accordingly extended.

It may be asked whether an examination of the usages found in languages not belonging to the Indo-European group, some of them very little developed in grammatical structure, throw some light on this question. I have no immediate knowledge of any of these languages and for details I venture to give here I am indebted to Winkler's *Grammatisches Geschlecht.** According to Winkler, many of the American languages do not distinguish gender at all. Iroquois distinguishes two classes of objects, a higher and a lower; to the higher belong all supernatural beings and men ; to the lower, women, animals and lifeless objects. Of the languages of Asia, the Ural-Altaic groups have no genders. But the languages of Burmah and Thibet show a distinction into two classes, which in the Kassir language exactly resembles that found in Iroquois. Where nouns are thus divided into two classes, I may add, the only mark of distinction in the noun itself is, that nouns of the higher class form a plural, while those of the lower do not. Generally speaking, in the languages of America and Asia, to the stage of development which presents no distinction of gender, succeeds a stage where the distinction corresponds so closely with what I have assumed as an older division in Indo-European, that the distinction between *persona* and *res* may be supposed to be essentially that which lies at the base of all primitive society. An examination of the languages of America and Asia, and of certain African languages, such as the Fulde, where grown men are distinguished from all other objects, seems to confirm very strongly the probability of a stage of development such as I have assumed in the Indo-European languages.

For Winkler finds that the languages of Asia, Africa and America present three types as regards gender, indicating three stages of development. We have, first, languages that show no variation for gender; second, languages that have a twofold division for men and lower objects ; third, languages that distinguish males and females, and

*Berlin, 1889.

at times lower objects as well, and having from two to six genders. It is interesting to see how feminines are developed in these groups. The development begins with adjectives and pronouns, extending to the verb, as a rule, before the noun is affected in any way. In the languages of America and Asia the division into masculines and feminines, where it appears, does not include all or even a considerable proportion of the nouns in the language, nor does it supersede the older division into higher and lower, or as Winkler is inclined to call it, living and lifeless, with what propriety will be seen when we recall that names of women usually belong to this so-called lifeless sex. But in Africa the older state of affairs is superseded by the new, and to the division found in the Fulde language, where grown men are opposed to all other objects, succeeds a division into masculines and feminines, neuters disappearing entirely. How this takes place seems apparent from Hottentot, where lifeless objects may remain without gender, or may be transferred to the masculine or feminine according as they are strong or weak. For example, *tseb*, m., is a great day, *tses*, f., an ordinary day, while *tsei*, the older and indifferent form, is a day. So in the language of Il-Oigob, *ol-alem* is a large knife, *en-alem* is a small knife, *ol* being the ordinary sign of the masculine and *en* of the feminine in this language. The Hamitic and Semitic languages, in which no trace of the neuter gender remains, seem to represent the highest point of this development.

All these languages begin to distinguish masculines and feminines in the adjective, the pronoun and the verb, and the distinction is evidently one that appears late and is superimposed on the older division, which in Hamitic and Semitic it supersedes entirely. In Indo-European languages, on the other hand, the division evidently began with nouns, for personal pronouns have originally no inflection for gender, and accordingly we find no such distinction in the verb, where the personal endings are pronominal in origin. The division into masculine and feminine does not compete with or supersede the older division, but the new feminine gender develops naturally out of the old division, the *a* feminines, the oldest form, representing a special use of the so-called neuter plural in *a*.

The relation between neuter plurals in *a* and feminine singulars in *a* has been investigated by Johannes Schmitt in his Pluralbildungen der Indo-Germanischen Neutra,* and Brugmann is strongly inclined to approve his theory, admitting that no difference in form can be found between the feminine singular ending *a* and the neuter plural ending *a*. It is a question how far this ending is really plural, for it takes a singular

*Weimar. 1889.

verb in Greek, and the view suggested by Coleridge that this is not properly a plural, for while "there can be *multiplicity* in things, there can be *plurality* only in persons," seems still more probable when we recall that in the languages of America and Asia neuter nouns are distinguished from masculines solely by the fact that they have no plural. That it is not a plural but a sort of augmentative or collective is confirmed by its meaning, when it appears side by side with cognate forms with the ending of the masculine plural; a comparison of Iliad IV., 460, with Iliad V., 464, makes it plain that while *μηροί* means individual thighs, *μηρά* is collective, meaning a lot of thighs. That *loca* is collective as opposed to *loci* is a commonplace of Latin grammar, and the difference between *κέλευθοι* and *κέλευθα* seems essentially the same. The plurals *σῖτα* and *Τάρταρα* seem collectives rather than plurals. But these Greek so-called plurals in *α* become at times feminine singulars. Homer has *οἶκος*, m., singular, and *οἰκία*, n., plural, both meaning a house. But in Attic *οἰκία*, a house, is f., singular, and has formed a new plural, *οἰκίαι*. So *ἡνία*, which is n., plural in Homer, has become f., singular, in Attic, and has formed a new plural, *ἡνίαι*. In Oscan we find *terum*, a bit of land, the plural of which is the Latin *terra*, properly a collection of bits of land, but now f., singular, and meaning a country. So *opera*, f., in Plautus, has the same meaning as *opera*, the plural of *opus*, and it is only later that it takes its usual meaning of care or attention. There seems to exist a similar relation between *mendum* and *menda*, *acinum* and *acina*, *repulsum* and *repulsa*. The process of thought that brings about the change from neuter plural to feminine singular may be illustrated from *mendum* and *menda*. *Mendum* is an individual fault, *menda* a lot of fault, then faults in bulk, then the abstract idea of fault. A significant coincidence is the fact that in the only words in Latin where we have feminines formed by the ending *æ* (older *ai*), in *quæ* and *hæc*, the neuter plurals take the same peculiar ending. But Schmidt's conclusion that neuter plurals in *a* were originally feminine singulars and that that is the reason for their use with a singular verb in Greek, is not justified by the examples he cites; for in every case he cites it is plain that the feminine is more recent than the neuter plural, and he admits that he is unable to find a feminine in *a* which has become a neuter plural. The natural conclusion from the examples he cites is that the neuter plurals are older, and that their construction in Greek with the singular is due to the fact that they are not properly plurals at all, but rather collectives or augmentatives.

The natural process, by which they become feminine singular, is that outlined in the case of *mendum*, but it remains to be explained why *menda*, becoming an abstract noun, should become feminine, and why abstracts are generally feminine in Indo-European languages. Why should *virtus*, manhood, be feminine? Not surely through its meaning, as most enquirers seem to suppose, but probably by association with abstracts or collections ending in *a*, and these became feminine because of the common use of such abstracts or collections in *a* as epithets for females. How they came to be so used, is plain, I think, from the Homeric use of neuter plurals in *a*, ex. gr., in Iliad XI., 124:

χρυσὸν Ἀλεξάνδροιο δεδεγμένος, ἀγλαὰ δῶρα,

or Iliad XIV., 238:

δῶρα δέ τοι δώσω καλὸν θρόνον,

where δῶρα is used as the epithet of a single object, with the meaning of an excellent gift. When a father wished to call his daughter "a good" or "a gift of God" he chose in preference to ἀγαθὸν or θεόδωρον the augmentative plural Agatha or Theodora. This augmentative form becoming the usual one for female epithets, was soon regarded as a feminine singular. Older female epithets, such as μήτηρ and θυγάτηρ have no mark to distinguish gender and probably belong to the oldest stage of language, when genders were not distinguished, being formed after the analogy of πατήρ. But with the adoption of *a* as an ending for female epithets, the feminine gender was established on an equality with the masculine and neuter, and while in other languages we have a new distinction of genders according to sex, coming in to supersede the older, founded on civic status, in the Indo-European languages, the new distinction is naturally developed from the old, without obliterating it, though it gradually changes its character, till it seems as though distinction of sex were the idea on which distinction of gender was primarily based.

ON THE CLASSIFICATIONS OF THE DÉNÉ TRIBES.

BY THE REV. FATHER A. G. MORICE, O.M.I.

(Read December 17th, 1898.)

THE fifth volume of the "Transactions of the Canadian Institute" contained a paper by the Rev. John Campbell, LL.D., which could not fail to interest me.* To say that, after a careful perusal of its pages, all doubt and uncertainty as to the origin of my Déné Indians have vanished from my mind would certainly be going beyond the truth. It may be that I am too exacting; but, as I went on reading, I could not but mentally formulate the strongest objections against, especially, the philological portion of the reverend author's effort. My intention to-day is not to expatiate on what I consider the shortcomings of that most important part of his essay, nor do I even wish to take exception to his conclusions. I intend to confine my attention to answering a few questions, correcting some misinformation and supplying omissions, and that in so far only as I am directly or indirectly concerned. In other words, I would beg to hazard a few remarks on the classifications of the Northern Dénés, such as reviewed by Prof. Campbell.

I hold that the reverend gentleman needlessly impugns the accuracy or appositeness of my information on the subject, such as embodied in my previous communications to the Institute, and, were his queries and hints left unanswered, ethnology would retrograde, on that particular point, to what it was ten years ago. Nor should it be forgotten that other well-meaning ethnographers have lately re-edited the errors against which I have several times protested. Hence the necessity of the following remarks.

Before going any further, and the better to define once for all our respective positions, may I, at the risk of appearing egotistical, be pardoned a remark of a somewhat personal character? † Ethnographers

* "The Dénés of America identified with the Tungus of Asia." My interest in that essay will appear so much the more natural as, some years ago, I published myself a short paper "Déné Roots," the main object of which was to ask for the collaboration of philologists towards the discovery of the Dénés' origin.

† The fact that the opening pages of my first paper contributed to the Institute were devoted to a criticism of an inaccurate classification of the Dénés, a criticism which Prof. Campbell now implicitly rejects, must be my excuse for offering remarks of such a personal character. People should know the grounds of my assurance, so that they may gauge the degree of accuracy of my information. A good point in favour of Prof. Campbell's essay is that, in common with a few other ethnographers, he has adopted the name Déné, which is the only appropriate word to represent that great aboriginal family which in other quarters continues to be called Athapaskan or Tinneh.

might be divided into two classes: there are the cabinet and the field investigators. On the other hand, ethnological classifications, especially of the American races, are based on language. Now, of the five different Déné tribes whose habitat lies entirely or partially within the northern part of British Columbia, I understand the dialects of three and speak that of the fourth with more facility than English. Within the last three months, my travels have brought me in contact with all or numerous members of the five tribes; so that should I have the faintest doubt about the ethnic status of any division of the Déné family, established in the extreme northwest of this continent, nothing would be more easy for me than to satisfy my curiosity. This by way of explaining my assurance in dealing with such questions.

Nor is this all. I belong to a religious Order which, for the last forty years or more, has had in hand the evangelization of all the Northern Déné tribes, and, through the numerous letters and essays contained in the pages of a private review published by said Order, I was enabled to study the various divisions of our aborigines long before I came here to become, as it were, one of them. One of the ablest and most regular contributors to that periodical which, I repeat, does not circulate among outsiders, was at one time the Rev. E. Petitot, who passed well nigh twenty years of his life in studying the Dénés critically. Now, most of what I ever wrote on the Eastern Dénés was based on his investigations, and in every case due credit was given him. It must be admitted that the opinion of such a scholar who personally knows the different tribes, should outweigh that even of travelers like Hearne and MacKenzie, who, for all their information, were entirely at the mercy of their interpreters and who were doomed occasionally to misunderstand and be misunderstood.* The linguistic data, names of tribes, etc., emanating from such a source are especially subject to caution in connection with languages of so delicate sounds as the Déné. For even such a dull-eared explorer as Sir John Richardson—who seriously derived the word *Esquimaux* from the would-be French "ceux qui *miaux*" (*lege*: "miaulent)—has confessed that "the sounds of the Tinné language can hardly be expressed by the English alphabet, and a great many of them are of a pronunciation *absolutely impossible* to an Englishman."†

Prof. Campbell quotes three different classifications of the Déné tribes, the first of which is Major G. W. Powell's. Of this he merely

* It is, therefore, a little surprising that, while noting obscure authors in his synonomy of the "Athapaskan" or Déné family, Major Powell should have omitted, in 1888, the name Déné-Dindjié, which had been publicly given to that aboriginal group by Petitot ever since 1875.

† Quoted in French by Petitot in his *Monographie des Déné-Dindjié*, p. xx.

states that some of the names are not tribal. He has no other fault to find with it. Now, I am almost certain that the very first tribe he mentions, the Ahtena, is not Déné.* Again I will ask: Where are in that list my Tsi|Koh'tin and my Sékanais (or Tsé'kéhné) and the Beavers and the Hares and the Dog-Ribs, etc.? Perhaps they are not really distinct tribes? will venture our reviewer. Let a single circumstance be my answer. When I was stationed among the Tsi|Koh'tin I used to preach without an interpreter. On my coming to Stuart's Lake, my residence since the last fourteen years, I could not understand or formulate a single sentence in Carrier. Moreover, who, with even a slight tincture of Déné phonology, could recognize as Déné the foreign looking Nagailer of Powell's list? Lastly, Tahltan — which should read Thahlthan †—is not the name of a tribe; it is a local name denominative of a body of water frequented by Indians within my sphere of action.

Commenting on that list, Mr. Campbell remarks: "The Montagnais are the Chippewyans or typical Athapaskans and their true name is Déné-Dindjié, . . . while the Slaves or Dogribs are the Thing-e-ha-dtinne."‡ The pre-occupation to find aboriginal names has evidently betrayed our reviewer into error and loose writing. The true name of the Montagnais or Chippewayans is *not* Déné-Dindjié, but simply Déné. As I have plainly noted in a monograph much quoted by Prof. Campbell, § the compound word is a name invented by Father Petitot to designate the whole of the Déné family, not any single tribe thereof. On the other hand, the Slaves or Dog-Ribs are not a single tribe, as one would seem warranted to infer from the above quoted sentence. They are two distinct tribes, though their territory is contiguous. The Dog-Ribs are well known as such in ethnographical literature, while the Slaves are called Strong-Bow or Thick-Wood Indians in Franklin's journal.

On Mr. W. Dall's classification Dr. Campbell has no criticism to offer. Indeed he almost seems to approve of it, since he therewith compares mine disparagingly. In his eyes what I wrote of the former, ten years ago, must be so much useless scribbling. To make out for his silence, I will refer the unprejudiced reader to my remarks which I deem as apposite to-day as they were then.||

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* See "Notes . . . on the Western Dénés," p. 15, foot-note, and p. 17, text.

† *Tha*, water (in composition), *hlthan*, lies (is stagnant, non-running). The population of that place is Nah'ane.

‡ P. 172.

§ "The Western Dénés," Proc. Can. Inst., Vol. vii., p. 110.

|| *Ibid. ibid.*

"The classifications of Mr. Dall and Father Morice for the northern group are somewhat different, and that of the latter, who finds fault with Mr. Dall's, is obscured by English names that are confusing and of very little scientific value." This is from Mr. Campbell. With all due respect for my opponent's opinion, how can English names in an English paper obscure a classification of races and confuse the mind of the English reader? Should they not, on the contrary, rather enlighten to a greater extent than so many would-be aboriginal words differently reproduced according to the linguistic ability of the traveller or the fancy of the transcriber? And how in the world are they of so "very little scientific value?" To be scientific, ought an Englishman to call the French *les Français*, the Italians *gli Italiani*, the Spaniards *los Españols*, the Greeks *οἱ Ἕλληνες*, etc.? Everywhere words representing ethnic divisions follow the particular genius of the idiom of the speaker, and it seems to me that this should more particularly be the case with the names of American tribes which are generally so difficult, when not altogether impossible, to spell without diacritical marks or other accessories found only in a few printing offices. When I write in English, the Indians nearest to me are the Carriers; should my essay be in French they become the Porteurs, but, of course, in all my native publications they remain the TaKeɪne. So it goes with the Montagnais; they are Chippewayans to the English and Déné to themselves; with the Beavers, who are Castors to the French, Tsa'tenne to the Carriers, and Dané to themselves, etc.

According to Prof. Campbell, I maintain that "the Kutchin tribes of Mr. Dall are, all but one, imaginary." This is hardly the case. Of course I would not, even indirectly, accuse my opponent of misrepresentation; yet his remark is somewhat misleading. It would seem to imply that, to the exclusion of all the others, one of Dall's Kutchin tribes—which one?—is real. I did say, and must repeat, that those of his tribes noted under the title of Western Tinneh "have no existence but on paper." But my remarks about the Kutchin are not so sweeping. I simply "strongly suspect that the seven Kut-chin tribes which he gives as specifically different, are only so many subdivisions of the same tribe, all of whom speak the same dialect, probably with local idiomatic peculiarities."* Which remark does not exclude the possibility of Dall's divisions of the Kutchin being real, though of a secondary importance. Father Petitot is quite proficient in the language of the Loucheux or Kutchin whom he has visited both east and west of the Rocky Mountains. Now he never mentioned but one tribe, and while in

* The Western Dénés, Vol. vii., p. 11.

his dictionary he gives even slight idiomatic or local peculiarities affecting the Chippewayan or Hare languages, he never quotes more than one Loucheux dialect. Major Powell himself gives but one Kutchin or Loucheux tribe, though he writes some years after Mr. Dall.

"Father Morice objects to this (Mr. Dall's) list," says Dr. Campbell, who adds, "But what shall we say of his own list followed by the form in each case of the word for man?" * Thus the main burden of his criticism in my case is not that my classification of the northern tribes is inaccurate or incomplete—indeed he seems almost to find it too complete, since he objects to the presence therein of one tribe—but that it does not supply him with those "tribal names" which he seeks for the purpose of his attempts at identification. For he speaks further on of my "deliberate avoidance of personal names," and regrets that "being able to enlighten our darkness in this matter," I "should decline to lift the veil." I confess that, through the dozen or more pages I devoted in the most important of my essays † to the classing of the Déné tribes, I thought I had left very little unsaid on the subject. I am told I was mistaken, and must therefore hasten to make out for my omission.

The reason I did not give any name the different tribes call themselves by is that, as a rule, *there is none*. They have, of course, some kind of vocable by which they are differentiated by outsiders; but, as these names vary according to the dialect of the speaker, which one was I to choose? Thus the Carriers, who are Areqne to the Tsé'Ke'hne, are 'Kutœne to the Babines; the Tsi|Koh'tin would become Tse|Kwah'tinni for the Babines, Tse|Kaht'qenne for the Tsé'Kéhne, etc., unless those various tribes chose to give them an altogether different name.

As I stated in my first communication to the Canadian Institute, which Dr. Campbell has certainly seen, the different tribes simply call themselves "men," and that for two reasons. The mental vision of the Indian is proverbially limited; collectivity is generally beyond its grasp. It is also dim and blunt; hence its difficulty in taking in abstraction. But the tribe is an aggregate of septs, and septs a collection of clans. I do not speak of the family; among our natives it does not exist as a unit. The father belongs to one clan or gens, the mother and the offspring to another. You ask an Indian to what tribe he belongs and he answers at once by the name of his clan. If you force him into giving a more comprehensive division, he may furnish you with the

* The Dénés of America identified with the Tungus of Asia, p. 173.

† Notes . . on the Western Dénés. Trans. Can. Inst., Vol. iv., pp. 10-17 and pp. 22-32.

name of his particular sept though this would be unusual—he would rather give you the name of the locality, lake or river shore he inhabits. In no case will he go any further, unless his intercourse with the whites has taught him their mode of thinking and the name outsiders give to his tribe. This is so true that no Déné dialect, to my knowledge, has any synonymous term for tribe as distinct from clan. Even that large tribe in the midst of which I live, a tribe territorially so important that its members are found all the way within four degrees of latitude, may be said to have no personal name. TaKepne is a term of extraneous origin which is intrinsically meaningless, though usage has conferred upon it the signification of "Indians." In that sense it is applied by the Carriers to any body of aborigines by contradistinction from the terms white man, Chinese or negro.

The second reason of the absence of any tribal name among the Déné is that vanity innate in the heart of the Indian which prompts him to ignore other tribes or nations. In his opinion, fellow-tribesmen are "the people." "the men," *Déné*. This foible is not proper to the Déné; many other American tribes know it. For, as remarks Major Powell,* "the name by which the tribes distinguish themselves from other tribes indicates the further conviction that, as the Indian is above all other created beings, so in like manner each particular tribe is exalted above all others. "Men of men" is the literal translation of one name, "the only men" of another, and so on through the whole category." Even the various tribes of Esquimaux are no exception to this rule; their collective name *Innuit* means also "men." Nay more, according to Klaproth quoted by Prof. Campbell himself, "the Tungus have no common or national name; yet most who dwell in Siberia call themselves Boye, Boya or Bye, that is 'men'" †—another trait of resemblance with our Déné which may well console our essayist for the absence of any truly Déné tribal name.

Commenting further on my list of Northern Dénés, Mr. Campbell says that "the Yellow-Knives or Copper Indians are the Ahtena." This statement is erroneous. I have already asserted that the Ahtena or Atna are not Déné. Prof. Campbell here follows Major Powell, who has been misled by Mr. Dall, who in his turn misunderstood Hearne. The latter discovered in 1769 to the *east* of the great northern lakes a river called *Satson-Die* (metal river) by the Dog-Ribs, and Coppermine by its white discoverer. Now W. Dall, confounding this river with the Copper River which flows into the Pacific Ocean, placed on its banks the habitat

* Indian Linguistic Families, p. 36.

† The Dénés of America identified with the Tungus of Asia. Trans. C. I., Vol. v, p. 167.

of the Indians whom Franklin had found in the steppes watered by Hearne's Coppermine River. The Yellow-Knives, who, according to Petitot, are related to the Cariboo-Eaters, live to the northeast of Great Slave Lake. They are the Copper Indians of Franklin.

"But who are the Cariboo-Eaters?" asks Prof. Campbell. They are, according to Petitot, an important tribe which "hunts on the steppes lying to the east of lakes Cariboo, Wollaston and Athabaska. Fort Fond du Lac is their rendezvous on the latter lake."* The same information is to be found in the essay prefixed to his polyglot dictionary which Prof. Campbell has seen.

As an instance of hasty writing, I must quote another of the latter's statements. "The Loucheux," he says, "are the Kutchins, Father Morice's Tudukh,"—he means Tukudh, but the printer is probably responsible for the deformation of the name. Now I invariably called that tribe Loucheux, and the only time I mentioned at all the word Tukudh I did so by way of indirectly protesting against it. I said: "The Nah'ane hunt over a territory the northern limits of which are the southern frontiers of the Loucheux," and in a foot-note I explained under the word Loucheux, "the *so-called* 'Tukudh' or 'Kut-chin.'"† Small matter to be sure, but important enough in that it shows the degree of carefulness observed by a writer. The Anglican Bishop Bompas and the Rev. R. McDonald are the parties responsible for that nickname, and, after them, Pilling who wrongly thought it represented a tribe different from the Loucheux.‡

Another proof of the Rev. Mr. Campbell's hasty writing I find in his reproduction of my list of the septs of three Western Déné tribes. Not only does he mix up the extraneous names of those tribes with those of their subdivisions, but he omits one of the latter which is to be found in the *addenda* to the paper from which he derives the whole list. I must further add that the omission of the apostrophe denoting the all important exploding or clicking sound renders all these words meaningless in Indian.

"Father Morice has questioned the native origin of Déné government by tœnaz-as (*lege* tœnezas), notables or chiefs." Loose writing again. I never questioned the native origin of any such government since I asserted that the Dénés had no form of government whatever. In a paper published by the Royal Society of Canada, I did state that the

* *Mémoire abrégé sur la Géographie de l'Athabaskaw-MacKenzie*, p. 224.

† The Western Dénés, Proc. Can. Inst., Vol. vii., p. 112.

‡ His "Bibliography of the Athapaskan Languages" is full of similar errors.

rank of chief or first magistrate of a village was of modern origin,* but we must not confound the notable or *tenesa*, of whom there are several in one locality, and the chief or single leader or head man of a place. I was quite emphatic on that point.

I have stated that among the reasons that prompted the present communication was the fact that old misstatements about the ethnological status of our Indians have but lately been reprinted. No later than 1893, in such an otherwise accurate and complete work as the "Standard Dictionary," † there appeared under the word American, the following list of all the Déné tribes, which is, I think, from the pen of Prof. O. T. Mason.

Athabascan.
Apache.
Chepewyan.
Hupa.
Jicarilla.
Kutchin.
Lipan.
Loucheux.
Mescalero.
Montagnais.
Navajo.
Slave.
Tinné.

Here, indeed, we have a list compared with which Dall's and Powell's are completeness itself. For it must be remarked that, brief as it appears, it is in reality even much shorter, since several tribes are therein twice mentioned under different names. To begin with, the first and the last terms, Athapascan and Tinné are synonymous. So are Chepewyan and Montagnais, Kutchin and Loucheux. In fact, of the twenty well authenticated Déné tribes, the author of the list gives but nine. Yet, while he omits such important tribes as the Carriers, the Tsi[Koh'tin, the Tsé'Kéhne, the Nah'ane, the Hares, etc., he mentions that remnant of a tribe, the Lipans, who, according to Powell, may number fifteen individuals in the United States, while they are not much more than twice as many in Mexico. Besides, if I mistake not, the Jicarilla are but one of the eight subdivisions of the Apache tribe that live north of Mexico. At least that is what one is led to infer from the Reports of the U. S. Commissioner for Indian affairs. If that official is correct, Major Powell is wrong on that and cognate points.

Finally, I must repeat that, in my opinion, the only accurate list of

* "Are the Carrier Sociology and Mythology Indigenous or Exotic?" Trans. R.S.C., 1892, p. 118.

† Funk & Wagnalls Co., New York.

all the Déné tribes so far published is to be found in my "Notes . . on the Western Dénés," p. 16. Should I have a doubt to formulate, it would be in connection with that tribal division known as the Bad People or Mauvais Monde—concerning the precise habitat of which Petitot appears misinformed. He is inclined to believe them an offshoot of the Carrier tribe, which could not be. He says that they are very little known, and formerly frequented the now abandoned Fort Halkett. That they really exist as a tribe, however, is clearly shown by the fact that they are called by the other Dénés, *Et'qa-o'tinc*, "those that act contrariwise," that is in a wrong way, from their former habit of going naked. Their proper name is Diné.

For the sake of extra completeness, we might add to my list the few natives of Déné extraction found some years ago in the Nicola Valley, and on Portland Canal, B.C. But as they have lost their tribal automony to such an extent that in a majority of cases, they have even forgotten their original tongue and are now mostly of mixed blood, I think they may well be ignored in a classification of Indian tribes.

THE USE AND ABUSE OF PHILOLOGY.

BY THE REV. FATHER A. G. MORICE, O.M.I.

(Read March 4th, 1899.)

WE frequently hear in scientific circles of craniometry and other anthropological measurements; our literature is full of descriptions of the manners and customs of different peoples; their social organization is detailed and their psychological attainments studied, while the archæologist never tires of submitting the claims of his favorite science to our consideration. Yet, when it is a question of determining with precision and without fear of error the ethnic differences upon which is based the distribution of mankind into distinct races, philology alone is entitled to unqualified confidence and respect. In other words, philology is the best, nay, the only safe criterion of ethnological certitude.

This proposition I have repeatedly formulated, and my first intention, on being asked to contribute my mite towards the fund of information which is to become the Memorial Volume, was to try and put it beyond the possibility of cavil. Proofs of the fallibility of the other branches of ethnological science are many and weighty. They could readily be presented for the appreciation of the indulgent reader. Circumstances however, have arisen whereby I have been led to abandon, or at least postpone, such a course in favor of more timely considerations.

Let it suffice, just now, to state by way of an *a fortiori* argument that, not only is language the best criterion of racial differentiations, but it can even be represented as greatly subserving the ends of history through archæology and mythology. Had not Champollion and Sir Henry Rawlinson previously familiarized themselves with the dialects of ancient Egypt and Assyria, those hieroglyphic and cuneiform inscriptions which for ages had puzzled legions of savants would still wait for a philologist equal to the task of deciphering them. And why is it, I may ask, that the researches of the American, French and German scientists relative to the Maya and other aboriginal characters have not yielded more practical results? Let Dr. D. G. Brinton answer for me. In the case of the former, it is largely, he says, "because none of the interpreters have made themselves familiar with the Maya language." * Hence it becomes apparent that there are cases when archæology can see but through philology's eyes.

On the other hand, more than once the identity of two single words or names in the course of myths proves of the greatest moment in suggesting the relation or affinity of the two nations among whom the myths obtain. Such homonymy may become an incentive to further researches which may ultimately be crowned with the most satisfactory results. Sometimes an antiquated phrase, a few archaic words no more understood may prove a most valuable clue in tracing out unsuspected racial affinities. In such cases, therefore, philology is also a useful aid to mythology.

But if the importance of its services is hardly susceptible of exaggeration, it must be confessed that philology is a double-edged weapon, inasmuch as, in the hands of an injudicious inquirer, it may bring forth nothing but futile and imaginary results. More, perhaps, than any other cognate science, its degree of usefulness depends on the amount of discernment displayed by the scholar. Hence the necessity of strict and well-observed rules in establishing linguistic comparisons. Most of my readers possess facilities for reference which I am far from enjoying in my retreat among the natives of Northern British Columbia. Yet I fancy that it may not be suggestive of too great presumption on my part simply to note in a cursory way those self-evident principles the ignoring of which I have personally remarked as leading to false and unwarranted conclusions, especially with regard to the American aboriginal tongues. These may sound as so many truisms to scientists within reach of well-filled libraries; but it seems to me that the repetition of such truisms may be of use to readers liable to reproduce the errors I shall presently denounce.

In the first place, it is of the greatest moment to carefully distinguish in a language that which is essential from that which is merely accidental And here, at the outset, we are confronted by two antagonistic schools: the lexical and the grammatical; the one relying chiefly on words for proofs of racial affinities, while the other attaches more importance to grammatical forms. We will not undertake to scrutinize the merits or demerits of either; similarity of grammar can hardly be said to be the result of accident, nor could the identity of words in two different languages when these words are sufficiently numerous. The analogy

* "The American Race," p. 157, note. This was written before Dr. Le Plongeon's famous discoveries in Central America. But, unless I am mistaken, the latter's interpretations of the same are altogether too marvellous and fantastic to be of much scientific value.

of grammatic process is easily discerned and hardly requires any preventive from error; therefore, what we are presently concerned with is words; how can their identity be safely established?

Language is the expression of thought and, as such, it is an aggregate of significative articulations. Therefore, in attempting linguistic comparisons, the student should, in the first place, observe principally the sound of the words. In languages possessing an abundant literature, as the European and the Asiatic, the orthography is of no importance whatever, unless it be considered as a means of discovering the origin of the words. Thus the German *vater* and the English *father*, though possibly different to the uneducated reader, are nevertheless one and the same to the scholar, who knows the phonetic value of the German *v*. Likewise, in comparing terms from American idioms, it is of the utmost importance to penetrate oneself with the particular orthography of the writer, as a word which appears different to the eyes may sound identical to the ear. Thus the Navajo *tana*, "man," may have exactly the same sound as the *dènè* of the missionaries among the Northern Dènè tribes.

Hence, while noting down foreign words or attempting linguistic comparisons, philologists could not too carefully precise the value of the letters used or, when extra signs or diacritical marks are found necessary, they could not too minutely explain the peculiar characteristics of their alphabet.* Instead of this, we occasionally come across writers who not only ignore themselves such all-important phonetic peculiarities, but do not even scruple to do away with such of them as they meet in others' writings. The most glaring instance of this unscientific carelessness which I have noticed of late is that of Dr. J. Campbell. The absence in his Dènè vocabulary† of the apostrophe or other corresponding sign, inverted letters, capitals, accent or diacritical marks destroys the last vestige of genuineness in many words which were originally but dubiously Dènè. I am wedded to no particular graphic system, nor do I think my own alphabet any better than that of others; but I hold that you cannot, without additional signs or graphic peculiarities, render with twenty-five letters an aggregate of more than sixty very different sounds.

And this seems to be the place to recall a common-sense rule which imposes itself on the transcriber of a foreign tongue: always write in such a way that all the letters be pronounced and that they constantly have the same value. It is useless to insist on such a self-evident principle.

* The reader will find my alphabet explained in my paper, "Dènè Roots," Trans. C. I. vol. III. p. 153.

† Transactions Canadian Institute, vol. V., p. 214 *et seq.*

If we now pass from the articulations considered as sounds to the artificial means of expressing them, we notice two kinds of letters of very unequal linguistic importance, the consonants and the vowels. In some languages, as the Semitic, the former only are used* to express ideas, whilst, in the majority of even the other stocks, the importance of the vowels is also but secondary. Thus the English "*stone*," is derived from the Saxon *stan*, which is *steen* in Dutch, *stein* in German and *sten* in Swedish. "Bean" is a Saxon word the equivalent of which is *boon* in Dutch, *bohne* in German and *bōna* in Swedish. Likewise *tsa* is the Carrier synonym for "beaver," which becomes *tse* and *tsi* among the Loucheux, *tso* with the Rocky Mountain tribes and *tsu* in Alaska. T'*si* (with a lingual explosion) means "canoe" in the dialect of several tribes; *t'se* has the same signification in Tsi|Koh'tin, and so it is with the *t'su* and the *t'so* of the Hare and other Indians.

Now the following entry appears in Dr. Campbell's lately published Déné and Tungus vocabulary:

Grass—(Déné) klo, klos, kkloh. (Tungusic): orcho, orokto, orat.

Here evidently the basis of comparison lies entirely with the letter *o* which, being a vowel and, as such, very changeable in Déné, could not by any means afford a solid ground for assimilation. This vowel is so little immutable even in connection with the equivalents for "grass" (where it seems at first glance to be more persistent than in other words), that a portion of the Carrier tribe, while keeping the root *t'lo* as a synonym for grass, change it into *t'lə* in the compound noun *t'lə-'kwət* (grass-on, *i.e.*, prairie.)

Therefore a word of vocalic inflection totally different from that of a heterogeneous race may be identical therewith if its consonantal elements are analogous. As evidence of this proposition I need only adduce the native word for "hog," in the language of three very distinct American families, viz., the Iroquois, the Algonquin, and the Déné. The main body of the Iroquois call it by onomatopœia *kwiskwis*, and those of Sault Ste. Marie say *kweskwes*. The Algonquins of Eastern Canada have altered its name into *kokoc*, and those of the western plains, the Crees, call the animal *kukus*, while the peculiar law of the sequence of vowels proper to their language has prompted the Carriers to soften the word into *kəkus*. This example makes it plain that the trans-Rockies tribe has derived its name of the hog, through a successive linguistic filiation wherein the principal consonants have remained intact, from the original

* "Were used" would perhaps be more correct since the invention of the vowel points by the doctors of Tiberias, but these accessories to the consonants can hardly be considered as genuine letters.

kwiskwis, a word invented on the opposite side of the continent to imitate the grunt of the animal thereby designated.

Another legitimate deduction from this example which applies to many other cases is that the only permanent, and therefore the really important, consonants are those which commence a word or at least a syllable.* Non-initial consonants, though generally more immutable than the vowels, have but a relative importance.

The consonants are then the most important element in the formation of words. But even among them there are some which are convertible with others to such an extent relatively to the various dialects that they are practically one and the same. This convertibility may manifest itself in three different ways: first, within the same dialect, as is the case with *d* and *t*, *g* and *k*, etc., within each of the Déné idioms which cannot detect the slightest difference between, say, *ta* and *da*, "lip"; *ku* and *gu* "worm," etc. Secondly, between related dialects or dialects belonging to the same linguistic group so that, though not changing the sense of the word, it indicates the nature of the idiom; such are the aforesaid letters with regard to most Aryan languages compared with one another; for instance "dance" is *tanz* in German; the Latin *dens* is *tand* in several germanic tongues, etc. Consonants of this second class, besides those already mentioned, are many and varied. Thirdly, we might extend this convertibility to another category of consonants, a category wherein cognate consonants in words from heterogeneous stocks, as the Aryan and the Turanian, do service in connection with words originally the same. Such are the *p*, *b*, and *f* of the Sanskrit (Aryan) *pita*, "father," the Syriac (Semitic) *batara*, the Zend or old Persian (Aryan) *fedre* and the Déné (American) *pa*, *pip*, etc., all of which terms have the same signification. To be brief; some consonants are convertible with corresponding letters within the same dialect, others' commutability manifests itself from dialect to dialect, while others again are commutable from stock to stock, that is between unrelated languages.

The German philologist, Jakob L. Grimm, was the first to formulate the law which bears his name and which regulates the interchange of consonants in the corresponding words of the different Aryan languages. American phonetics are quite peculiar, as is well known, and in connection therewith Grimm's law not only does not cover the whole ground, but in several instances it is positively at fault. A prerequisite to safe comparisons between words from stocks of the old and of the new worlds would then seem to be the acquisition of some principle

* For an apparent exception, see my paper "Déné Roots," Trans. C. I. vol. III, p. 151.

determining the commutability of the consonants in the languages from which the compared words are extracted. As far as the Déné languages are concerned, the complete list of commutable consonants will be found, in a tabulated form, in the Grammar which is to precede my great Carrier dictionary. Pending the publication of either, even a conscientious philologist may be satisfied with the instances of such convertibility noted in a previous paper, "Déné Roots." *

While, as we have seen, some apparently different consonants are essentially the same, others, which seem co-affin and related, are so hopelessly distinct that they cannot possibly admit of commutation. Here I refer more particularly to the American languages which are celebrated for the delicacy of their phonetic elements. Perhaps none surpass the Déné in this respect. These have three *t*, seven *k* or guttural consonants, etc., all so strictly distinct that their phonetic peculiarities are often the only means of differentiating the meaning of words which, to the careless observer, would otherwise appear identical. Thus in Carrier *ta* means "lip," *tha*, "three" (things), and *'ta* "feathers." Edge (of a cutting tool) is *Ka* in the same dialect, arrow is rendered by *'kra*,† *kra* is an interjection, etc. As it is with simple consonants, even so it is when the articulation to express is double or multiple. *Tsi* in Carrier is the equivalent for "head," while *t'si* means "intestines," and *t's̄i* is the word for "canoe." These examples might be multiplied almost *ad infinitum*.

We have in Déné two sets of words wherein the th sound (Petitot's t') is radical and characteristic in all the different dialects. They are synonyms for water and are proper to all words expressive of things even distantly related to water (*thû*, *thô*; *tha* in composition, *thèr*, bottom of the water, etc.) and the various equivalents of the adjective "three" (*tha*, *that*, *thane*, *thanh*, etc.) In the latter words the *th* ($=t+h$) is the means of distinguishing them from the number "four," all the Déné equivalents of which begin with a simple *t*. Dr. Campbell could have learned as much by a mere glance at my published Vocabulary of Déné roots; Petitot is no less explicit in his polyglot Dictionary. Therefore I am at a loss to understand why the former should have destroyed the identity of all those words by taking away the differentiating *h* and writing *to*, *toh*, etc.‡

It was with no smaller amount of astonishment that I came, some time ago, upon a comment on two American myths wherein the author

* Transactions of the Canadian Institute, Vol. III., p. 150.

† The *r* of this and the following word is so faintly pronounced that I regard *kr* as expressing a single articulation.

‡ See the Appendix.

—the Abbé Petitot—attempts to establish the identity of a fabulous nation called *Tsequil* with a prehistoric race surnamed "women" by the Northern Dénés on the ground that *tsequi*, he says, means women in Déné, while the original sense of Tsequil appears to be "petticoated men."* Now, the author must know just as well as I do that *tsequi* means women in no Déné dialect, and he ought to be aware that the difference between that pretended word and *t'sequi*,† the real equivalent of "women," is as great in Déné as that between, say, day and night. Hence his would-be identification falls to the ground through utter disregard for the value of consonantal articulation.

It would be harsh to call this philological bad faith; much more probably it is only blindness caused by an inordinate love of linguistic assimilations,‡ just as the sentence immediately following in his text seems to be due to misinformation. Speaking of the Déné language, he says that "il a été reconnu appartenir à la même famille que le toltèque."§ In the first place, many well-informed Americanists speak no longer of the Toltecs who, they declare, never existed as a nation, and therefore had no distinctive language; and then if by *toltèque* the author means, with some apparently mistaken ethnologists, the dialect of some ancestors of the Aztecs, he should certainly know that the idiom of the latter has no more affinity with the Déné than that of the Caribs or of the Fuegians.

In the same publication the author endeavours to identify the *tsaa*, *tsade* of some northern Dénés with the *tsau* of the Egyptians. *Omnis comparatio claudicat* is an axiom well known to the schoolmen, but which should never apply to linguistic comparisons. Yet I dare say that the above not only "hobbles," but even cannot stand at all, for two reasons. First, *tsaa* or *tsade* should be written as it is pronounced, not as may be convenient in the interest of the thesis. Now the author knows so well that this should be *t'saa* or *ttsaa* (the apostrophe or the double t denoting the lingual explosion), that he spells it himself according to the second orthography in his published dictionary. This exploding sound is so important from a philological standpoint that, while even consonants are liable to occasionally disappear altogether through the gradual alterations customary with all living languages, this American character-

* *Six Légendes Américaines identifiées à l'histoire de Moïse, etc.*, Paris, A. Hennuyer, p. 720

† The apostrophe indicates the lingual explosion proper to many American idioms.

‡ It could not be construed as due to any typographic error, as identical appreciations of similarly altered words are to be found elsewhere in the course of the work referred to.

§ *Six Legendes*, etc., p. 720.

See "The American Race," by Dr. D. G. Brinton, p. 129.

istic is inevitably retained.* Secondly, this attempt at linguistic identification must also be qualified a failure because *tsaa*, even if supposed to signify "headgear" as in the case in question, cannot be compared to *tsau*, which is the Egyptian for "crocodile."

From this last remark we may deduce this corollary: in all philological comparisons, both words, while homonymous, should also be synonymous. This is so evident that we need not insist. There is no lack of homonymous terms in all languages, and if the philologist's business was merely to discover consonances, his task would certainly not be a very arduous one. It must be admitted, however, that there are some cases when this synonymy of homonymous words needs be but relative. As illustrative of the appropriateness of this qualification, I may point to the etymology of the English word "loafer," which is said to come from the German *laufer*, a runner, which is itself derived from *laufen*, to run.

Passing from the letters to the words themselves, we cannot help noticing that some of the latter are more ancient, more immutable, and simpler than others; they reappear under a similar—though not necessarily identical—form in divers cognate dialects; in a word, they are the roots of the language. These are the essence of a dialect and, as far as practical, with them only should comparisons be attempted. But in this case care should be taken to choose only equally radical words for the purpose of identification. A living language is subject to inexorable laws of growth and mutations, and any resemblance between a modern accidental term and an old root of a different tongue must be the result of purely fortuitous coincidence.

A rule of analogous import demands that test words be compared, as far as possible, only with synonyms from one of the oldest forms of the language, not from one of its modern derivative idioms. To render this principle clearer by contrast, I shall give an instance of an evident violation of the same. Rev. C. Petitot, in an essay on the Déné languages,† gives the consonance between the Déné word *adi*, "he has said," and the French *a dit*, as in some way confirmatory of the unity of race between the American and the European nations from whose vocabulary the two words are extracted, Now, it seems to me that the

* In another paper, "Déné Roots," published in the Transactions of the Canadian Institute (Vol. II.), I have called attention to the absence of diacritical marks denotive of this explosion in the texts of the "Mountain Chant" by Dr. W. Matthews, hinting at the same time that, as the words which lack it are otherwise quite identical with their northern Déné equivalents, this most important peculiarity had possibly escaped the transcriber, and giving my reasons for this surmise. A copy of the paper sent to Dr. Matthews and accompanied by a note pointing to that passage failed to elicit a declaration that his rendering of the Navajo texts was faultless. Shall we apply in this case the maxim: *Qui tacet consentire videtur?*

† Paris, 1876, p. xvi.

comparison, to be of any ethnologic value, should be between the Déné word—supposing it to be a root—and the synonymous term in the original language from which modern French is derived. The French of to-day say *a dit* when their ancestors said *ha dict*; but between the formation of the dialect of the latter and the abandonment of its parent, Latin, an important change had taken place whereby two distinct verbs, *habere* and *dicere*, had been combined in one, so that the Déné *adi* should be compared, not with the modern French phrase, but either with its original two verbs, HA*bet* DICT*um*, or with the exact Latin synonym, *dixit*, which then lacks the equivalent for the first syllable of the American term.

We may classify root-words under two heads: There are those which are roots by reason of their standing from a grammatical point of view, and those which owe their position as immutable words to their signification, or rather to the importance in all languages of the objects they represent. By the first class I mean especially the numerals and the pronouns, which, it is well-known, generally have a kind of family air in cognate dialects. As to the pronouns, I think that hardly any qualificative reservation is necessary; but it is not so with all the numerals. By "all" I should be understood as referring only to the first ten numbers where the system is decimal. Thus in the Northern Déné dialects the words for seven, nine and even ten have no linguistic importance; but the first four numbers especially are of the greatest moment as a means of detecting philological affinities.

All the other roots are comprised within my second class as defined above. These are either monosyllabic or polysyllabic. In the first case their degree of immutability is generally greater, while with the second, except in the Semitic languages, which are remarkable for the triliterality of their radicals, there is very often allied to the original root, a sort of increment, accretion, or accidental alteration of a primitive element, which it is, of course, very important to discern. This remark applies not only to really ancient roots of simple import, but also, especially in the Aryan languages, to such words as were originally one throughout the whole stock, but which have grown distinctive of the particular nation by which they are used. In other words, in all such terms there is the radical and what may be considered a mere accident, whatever may be its place in the structure of the word. Of course in such cases the radical only has any weight in the balance of the comparative philologist; the accidental part of the word has no other value than that which may result from its being the means of identifying the particular dialect to which it belongs.

As I have said, the place of these varying and relatively unimportant forms may change with the linguistic group of which the radical may be characteristic. They constitute the desinence of the words in the Aryan languages. A few examples will, I think, be of use as a means of illustrating the above propositions. Here are a few words with an identical radical followed by different desinences.

Latin.	*Spanish.*	*Italian.*	*English.*	*French.*
Lacon-icus	-ico	-ico	-ic	-ique
Confl-ictus	-icto	-itto	-ict	-it
Prodig-iosus	-ioso	-ioso	-ious	-ieux
Declamat-orius	-orio	-orio	-ory	-oire
Ard-or	-or	-ore	-our	-eur
Barbar-ismus	-ismo	-ismo	-ism	-isme
Confus-io	-ion	-ione	-ion	-ion
Atten-tio	-cion	-zione	-tion	-tion
Paral-ysis	-isis	-isia	-ysis	-ysie
Leg-alis	-al	-ale	-al	-al
Sensib-ilis	-le	-ile	-le	-le
Principal-iter	-mente	-mente	-ly	-ement

This list could, of course, be almost indefinitely extended, especially if we were to make it comprise some words the real root part of which is slightly altered in a few dialects as, for instance, CONS*tans*: Italian, COS*tante*; VIR*tus*: French, VER*tu*, etc. Here then we have words the initial part of which is identical in all the languages represented, while the desinence varies with the dialect. It is unnecessary to observe that the essence of the word is contained in the former, the *rôle* of the latter being simply to differentiate the dialect. My reason for associating the English forms with the above will become more apparent when it is remembered that that idiom, though more generally ranked within the germanic subdivision of the Aryan linguistic group, nevertheless contains an almost complete vocabulary of Italic or Romance words, from among which all the above are selected. Practically, there are as many Latin words with unchanged radical and desinential forms digested, as it were, and assimilated according to the requirements of the peculiar organism of each dialect.

But the radical part of a word is not always so easily discernible. Its place and characteristics may vary according to the linguistic family—not the particular dialect—to which the word belongs. It is the task of the philologist to discover and locate this radical and, in such cases mere superficial studies would naturally prove inadequate to ensure success, inasmuch as it happens that this immutable element has no fixed place in the structure of words of even the same dialect. Thus in

Carrier the root of *təne*, "man," is the second syllable, while in *t'sèKè*, "woman," it is the first*.

Therefore, in trying to assimilate, for instance, the latter word to synonyms from a heterogeneous linguistic stock, its desinence would not be of any more value than the prefix of the former.

It is, no doubt, to Dr. Campbell's inability to discern those radicals in the Déné terms that we must ascribe some of his failures in word identifications. Thus, to reproduce but a few, he compares the Déné

*tat*si,	wind,	with the	Tungusic	*tit*
*hong*zil,	summer,	"	"	*anganal*
*kon*tlan,	all,	"	"	*gandzi*
*ted*hay,	salt,	"	"	*tak*
kl*in*,	dog,	"	"	ninak*in*

If those parts of the words I have italicized are not Dr. Campbell's ground for his attempts at assimilation, I would ask, where is the resemblance? But I must state with regret that those are precisely the unimportant portions of the words in Déné, leaving as the real root the other half which lacks all points of similarity with the Tungusic equivalents. Thus the root for wind in *all* the truly Déné dialects is *t'si* (not *tsi*, which means head). Examples: *nìṭt'si*, wind; *thìzt'si*, the wind commenced to blow; *hwcṭt'si*, taken away by the wind; *hwosaṭt'si*, brought in by the wind; *'kən nìṭt'si*, cut by the wind; *yaìṭt'si*, scattered by the wind; *iṭənaóst'si*, heaped up by the wind, etc., etc. In the word *hongzil*, which is not a noun meaning summer, but a verb corresponding to the phrase: it is warm, the ultimate root is *sil*, *səl*, heat, inflected by the prefix *hon* into *zil*. *Hon* is merely the sign of the impersonal verb am, as such it is common to *all* the adjective verbs, instead of being the radical part of the word for "summer." Equally disparaging remarks could be presented relatively to the other words. But enough of this. Had Dr. Campbell consulted with any degree of care my vocabulary of the Déné roots,† he would have been told in each particular case where the real, immutable part of the word lies.

It were hardly necessary to add to the preceding rules of comparative philology that all lexical comparisons should be made directly between actual words of different languages, not mediately through a possible translation of one of the two words, especially if that translation be into a dialect of another family. In the French work already referred to as containing unwarranted linguistic identifications,‡ the author thus assimi-

* As is evident from the words *ṭi-t'sè*, dog-female and *ya-t'sè*, progeniture-female (daughter).

† Transactions Canadian Institute, vol. III.

‡ *Six Légendes Américaines*, etc., p. 620.

lates to the Moses of the Bible the hero of a Déné legend called *Ni-ottsintani*. The Arabic name of Moses is *Moussa*; now *Ni ottsintani* means "l'enfant *Mousse*" in French; hence the identity of the two personages! Such deplorable play with the words needs only to be quoted to be condemned. It is certainly calculated to bring more discredit than honour on comparative philology, and, at the same time, it is not a flattering evidence of man's potentialities as a "reasoning animal."

This leads me to ask whether Dr. Campbell is serious when, in answer to hi.. own question: Are the names of the Déné tribes Tungusic? he compares such evidently non-Déné terms as Navajo, Llanero, Coyotero, Mescalero, Jicarilla, etc., with Tungus words of supposedly similar sound and declares that those "fifty-seven resemblances"—including, of course, the consonances between Tungusic and Mexico-Spanish names—"clear the way for more definite evidence."*

I have had more than one occasion, in the course of the present essay, to refer to Dr. J. Campbell's paper on "the Dénés of America identified with the Tungus of Asia."† This is certainly a most remarkable production. Indeed the boldness of its conclusions is more than wonderful. I will not venture to scrutinize one by one the appositeness of its several propositions. I must even confess my inability to follow the erudite author into the flights of imagination which he gravely gives as so many uncontroverted points of history. As we go on reading his last pages, we seem to be whirled about amidst a bevy of strange looking names, and, before we have had time to wonder at the audacity of an assertion, we have a still bolder one flung in the face, until our breath is fairly taken away. All I have been able to gather from the author's asseverations is that the ancestors of my Dénés, after having assisted at the defence of Troy, followed, to the number of 5,000, Alexander the Great in his triumphal march through the East, and then, reverting to the West, made, under the name of Huns, the remnants of the Roman Empire tremble at the sight of their valour and inhuman atrocities. They were not then, it seems, the poor, hare-like timid Indians who are now afraid of their own shadow. No wonder that Dr. Campbell finds my inoffensive Carriers a degenerate race!

But, if Dr. Campbell is satisfied with his conclusions, I am not to grudge him that meed of contentment. All I must remark here is that they surely do not flow from his premises, as far at least, as the philological part of his essay is concerned. Nobody would be more ready than myself to welcome the solution of a problem in which I have long

* "The Dénés of America," etc., p. 175.

† Trans. C. I., Vol. v., part 2.

taken such a keen interest. But my inmost convictions bid me declare, at the risk of appearing too self-confident, that the doctor's verbal identifications are, with a very few and unimportant exceptions, absolutely groundless. The reader will please remember his several failures, which I have already pointed out as resulting from the violation of fundamental laws of comparative philology. I may well pass over those assimilations which are attempted with words that are not roots. Let me add that a very large number of the terms he gives as Déné seem utterly extraneous to that linguistic family. Think, for instance, of such vocables as *telamachkur* for fish, *payyamay* for man, *alcorn* for rain, *ktekchuly* for cold, *ttshukulak* for eagle, *slku-tsukaisla* for girl, etc. Verily, any Russian or Bantu word taken at random would probably look more Déné.

Among such words of Dr. Campbell's Vocabulary as are undoubtedly Déné, many merely approximate in meaning the English term given as synonymous. Thus *tayuz* is the equivalent, not of the English "boy," but of the Latin *vir*; *siskay* means "my child" instead of "daughter" in general; *gunzun* should be translated "good," not "strong"; *teshintlan* corresponds, not to the word wood. but to the phrase "many sticks," and probably proceeds from some writer who had recourse to an interpreter during his intercourse with the natives. From such writers deliver the comparative philologist! Their mistakes are legion. Other words, as *beye*, *bitsi*, *paput*, etc., mean respectively *his* son (not cl ild in general), *his* heart (or rather his head), *his* belly, etc. They are deceitful in that, their pronominal prefix being taken as an integral part of the word, it concurs in suggesting identities that do not exist. In the Vocabulary in question the pronouns of the first and of the second persons are interverted. *Shi* means *I*, not *thou*, and I would be curious to learn where Dr. Campbell picked the word *hwe*, which he quotes as an equivalent for either of the two aforesaid pronouns.

And yet with all those and many other inaccuracies for which I am far from holding him responsible, how many real identifications do we find through the whole list? Three, perhaps four, apart from the synonymous terms for father and for mother, which are about homonymous in well nigh all languages. I know of more numerous genuine analogies between Chinese and Déné words. Yet it is in the face of such pitiful results that our author triumphantly proclaims that "the argument for the original unity of the Dénés and the Tungus is as convincing as that which joins the Indo-Europeans or Aryans in one family"!* With all due respect to such a veteran as Dr. Campbell, I, for one, must be allowed

* "The Dénés of America Identified," etc., p. 206.

to totally dissent from such a conclusion, for, in the Aryan languages, all the principal roots are practically identical, while in the present case, I fail to see how they could well be more dissimilar. For the benefit of such of my readers as have not made special studies in that branch of science, let me quote just only one word, the numeral "three" in the dialect of the seven principal groups into which the Aryan family is usually divided. The reader may then revert to the would-be analogies suggested by my opponent in his Déné-Tungus Vocabulary, defective as it is, and then judge between us.

English.	Slavic.	Lithuanic.	Celtic.	Latin.	Greek.	Iranian.	Sanskrit.
three	*tri*	*tri*	*tri*	*tres*	*treis*	*thri*	*tri*

Other Aryan roots exhibit generally quite as marked family traits, and Dr. Campbell should be the last not to know it.

Coming nearer home in search of genuine linguistic assimilations, I may instance, as a contrast with Dr. Campbell's identifications, the case of the Navajo Indians. Physically those aborigines have little in common with our Dénés; their psychological characteristics are quite distinct; their mythology has not, to my knowledge, a single point of similarity with the Déné folk-lore, and sociologically they are still more different. Yet philologists have not been long in detecting their perfect identity with the Northern Dénés. And no wonder; for their language abounds in clear and real, not nebulous or uncertain, analogies with the dialects of my Indians For the benefit of some too easily satisfied ethnologists, let me remark that in the "Mountain Chant" which contains the only continuous Navajo texts I have ever seen, you find, side by side with some terms proper to that tribe, or borrowed from adjacent stocks, no less than 72 words which, in spite of what may be defective rendering, are easily recognizable here, Stuart's Lake Mission, B.C., at a distance of perhaps 2000 miles from the nearest Navajo. To form a just idea of the proportion of really genuine Déné with local or loaned words, it should be borne in mind that those texts are composed of only a few words very often repeated. In fact, the proportion of truly Déné words in that "Chant" cannot be less than 75 per cent. Of course, such a large percentage is not necessary for the legitimate identification of two ethnographical divisions of mankind; a third or a fourth of that amount is more than sufficient. But where is the philologist who is ready to risk his reputation by asserting his willingness to be satisfied with two or three per cent. of related terms to determine the original identity of two separated branches of the human family?

Of Dr. Campbell's assimilation of the Othomi with the Déné, I shall only say that, in my opinion, his own Vocabulary makes it evident that there is absolutely no connection between the two stocks. As I am here confronted with the opposite declaration, viz., that in the doctor's second Vocabulary "the Othomi is placed opposite Tungus and Déné equivalents *to the complete identification* with these tongues,"* I must be excused for respectfully asking to be shown one single Othomi word related, however distantly, to our Déné idioms other than the monosyllable *da*, which is probably a chance synonym for "eye." All the other words are hopelessly non-Déné. On the other hand, a majority of Campbell's Othomi verbs are monosyllabic, a condition quite impossible in Déné, where a verb must be at least dissyllabic, being composed, in its simplest form, of a radical desinence preceded by a pronominal crement expressive of tense and person.

A parting word, and I close this already too long essay. *In medio stat virtus*; enthusiasm should never betray the comparative philologist into exaggerations or rash assertions which, sooner or later, he will have to withdraw. I have before me a printed statement to the effect that "of the Déné tongue it is no exaggeration to say that 50 per cent. of its radicals are pure archaic Chinese." Having noticed that bold assertion reiterated in a standard publication, I ventured to call the author's attention to its manifest exaggeration, with the result that it was privately withdrawn, though it remains unchallenged to this day in the Transactions of the Royal Society of Canada.†

APPENDIX.

The phonetics of the Déné languages are not easy, and many of their most important sounds will frequently escape the attention of even a professional linguist. Such an experienced analyzer of American idioms as Dr. Franz Boas is a witness to the truth of this assertion when he states in his Report on the Ts'Ets'a'ut tribe that "the Tinneh phonetics are difficult." (*Tenth Rep. on the N. W. Tribes of Canada*, p. 66). Of the Déné verb he asserts that it "is exceedingly difficult to understand" (*Ibid*). Under these conditions errors in transcribing words heard for the first time are to be expected as a matter of course, even from clever philologists, since their vocabularies and texts are more the work of their interpreter than the result of their own acquired science. Hence animadverting thereupon, instead of giving offense, should almost, it seems to

* "The Dénés of America Identified," etc., p. 206. The italics are mine.

† Trans. R. S. C., Sec. II., 1897, p. 89.

me, be expected as a natural occurrence. Dr. G. M. Dawson was so much of this opinion that he spontaneously sent me for corrections his Vocabularies of the Thaḷthan and the Ti-tco'-tina dialects (*Annual Report Geol. Survey, Canada, 1887*). Unhappily my work in that connection having been of a private nature, Dr. Dawson's every error has been faithfully reproduced in the reprint by Dr. Boas of the first named Vocabulary. To these circumstances are undoubtedly attributable several of Dr. Campbell's mistakes, though a careful perusal of my own Vocabulary and accompanying notes, published at a later date, would have prevented most of them. Such being the case, and to avoid the recurrence of similar errors, I have thought it of use to note the principal faults to be found in Dr. Dawson's Vocabularies. I do not vouch for the perfect accuracy of the words not mentioned, nor indeed for those parts of the corrected words left unaltered. I merely correct evident and *essential* errors. Apart from such corrections, Dr. Dawson's spelling remains intact. For the sake of briefness I give the faulty words under their corrected form only.

English.	*Thaḷthan.*	*Titco'tina.*	*Remarks.*
Father	ethe'-uh	atha'-a	Not *my* father, but father (vocative). Same remark applies to synonyms of mother.
My head	estsi		
My neck	es'kōs		
My foot	esκuh'	esκia'	
My bone	est'seⁿ'	est'sun'-uh	
Village	κē-yē'	κon'-a	This last word means "house," not "village."
My husband	esκuh-lē'-na	sκe-lē-nā	The *sine* which in Dawson's Vocabulary precedes this word, and the three that follow immediately, means *ego*, *I*, *me*, and recalls to mind the Chinook *naika*, probably used by the enquirer towards his interpreter. It is altogether foreign to the words wherein it is incorporated in Dawson's Vocabulary.
Daylight	ye-κa'		
Wind	it'si'	i't'si'	
Fire	κoñ	κun	
Water	thoo	thoo	
Ice	thenₙ	thun	
River	thoo-dēsā	thoo-za-za	This last word means literally: little water.
Leaf	e'tāne'	a'tona	
Grass	'klōāh	'klō-ye	
Feathers	t'sosh	me-t'sosa	The proper spelling of these words is probably 'qosh; me-t'qosa. The clicking sound is essential. These words mean 'down,' not feathers; me-t'sosa means "its down."
Mosquito	t'sih	t'si-a	
Three	thā-tē	tha-di-da	
Thirty	that-t'sosnan		

Further inaccuracies.

skel-e'-na (or rather sKe-lena) means :	my husband, not	man
ya-za	cloudless sky	sky (in general)
kos (or rather 'kōs)	cloud	sky
tih	grouse	bird
tsoo (or rather t'soo)	spruce (*abies nigra*)	tree
ges (probably)	white salmon	salmon
nin'-e	thou	I
sin'-e	I	thou
a-neh, a-ni are interjections which mean	come here! not verbs meaning	to come
ta is an interjection which means	give it to me! not	to give
sintuh', sinta' mean	be seated (and quiet) not	to sit

Of the verbs some are at the first person, others at the second, a few at the third, and others at the impersonal. Dawson's Vocabularies hint at no difference in Indian between fly and bird, he and that, tongue and mouth, house and village, man and husband.

The above remark concerning the verbs holds good relatively to those recorded by Dr. Boas, a majority of which are at the second person. Others, which, in the latter's Vocabulary, are monosyllabic, cannot be correct for the reason presented in the course of my paper.

As to G. Gibbs' Vocabulary, the admission by its compiler that it "is not always altogether correct" (Tenth Rep., B.A.A.S., p. 68) renders any criticism on the same unnecessary.

NOTE.—When the above was written, I was not yet acquainted with Dr. Boas's short "Vocabulary of the Chilcotin Language" (Twelfth Report on the North-West tribes of Canada, B.A.A.S.), which teems with errors. But that gentleman, being a conscientious scholar, takes care to preface it with the remark that since he is "not familiar with the grammatical structure of the language, the vocabulary must be held subject to revision," a precaution some writers are not loyal enough to take. In this connection, I would take the liberty to observe that the double consonant *tl*, pronounced exactly as in English, is of very common occurrence in all the Déné dialects. Now, since Dr. Boas, and quite a few others, render by *tl* the sibilant *l* which I usually represent by an inverted *l*, I would ask: How do those authors transcribe the common *tl* sound (= t + l) which we find, for instance, in the Chilcotin negative particle *tla* (pronounced tlah), and in such words as *tlun* (pronounced tloon), "mouse," *antlé* (prohibitive particle, *kaetlen*, "he was born," *tlaasa*," very good," *tlaaja*, "very many," (not "many," as Dr. Boas has it), etc. Dr. Boas spells this last word *tlaa'tla*, that is, with two identical *tl*'s, though the sound represented by the first is very different indeed from that of the last, wherein there is absolutely no *t* sound.

SKETCH MAP LOCATING INSCRIPTIONS.

DECIPHERMENT OF THE HIEROGLYPHIC INSCRIPTIONS OF CENTRAL AMERICA.

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(Read March 18th, 1899).

CHAPTER I.

PALENQUE AND ITS RUINS.

Near the point where the three republics of Mexico, Yucatan and Guatemala touch, lie the ruins of the ancient city of Palenque. These are really on Mexican ground, being situated in the northern part of Chiapas, the most southerly province of Mexico. The region in which they lie, and the adjoining parts of Yucatan and Guatemala, are covered with a dense tropical forest, extending over an area of between forty and fifty thousand square miles. Apart from the monument to be considered, there is no testimony as to the time when a great native civilization in this wide region came to an end, and its deserted cities and fertile fields were converted into jungles and the home of wild beasts. The aboriginal chronicles and the records of the Spanish conquerors, so full of the history of Mexico, and not altogether deficient regarding northern Yucatan and western Guatemala, have little or nothing to say concerning the southern Atlantic coast of Central America. Yet the birthplace of American continental civilization seems to have been there. According to Lizana and other writers, the first colonists of Yucatan came thither from Haiti by way of Cuba, but no conjecture is made as to the point whence their ancestors set out to reach the former island.[1]

It is probable that the bloodthirsty and avaricious Alvarado traversed this site of ancient civilization in 1524, and turned it into a waste howling wilderness by his barbarities. For two hundred and twenty-two years subsequent, no human beings visited the ruins, save wandering natives, who, amid the relics of their former greatness, cursed the Spanish name and swore undying hatred to those who bore it. In 1746, however, a body of Spaniards traversed the country of northern Chiapas, and stumbled upon the ruins of Palenque; but it was not till 1787 that

Captain Antonio del Rio visited them for the purpose of scientific description, and made the world acquainted with their nature. He examined fourteen buildings of hewn stone, together with a subterranean aqueduct, and estimated the extent of buildings along the river at from seven to eight leagues in length, and half a league in breadth. The next explorers were Du Paix and Castineda in 1807, who made drawings and plans of the monuments, which were used by Waldeck and Lord Kingsborough. Waldeck himself visited Palenque in 1832, and Stephens and Catherwood in 1840. The ruins were inspected by Morelet in 1846, and in 1858 by Charnay. In the accounts of these explorers, and in the works of Brasseur de Bourbourg, Bancroft, Baldwin, Short, etc., ample material is provided for enabling the reader to picture to himself the deserted city.[2] The following description is largely from Brasseur de Bourbourg.[3]

The ruins receive their name from the village of Palenque, within a few miles of which they are situated. The ancient city had been built on the hill slopes at the entrance to the steep mountain range of Tumbala, which in unforeseen circumstances might serve as a safer refuge for its inhabitants. But at that time the adjacent plains, intersected by so many rivers and natural canals, formed a great lake, similar to the lagoon of Terminos, such as it now appears at the time of the height of water between June and October. A distance of from nine to twelve miles separates the ruins of this metropolis from the river Catasaha. This is the space to which the name of Las Playas, or the Flats, is given, because of the inundation to which they are subject.

The plain of Palenque, undulating slightly, descends gently towards the sea, intersected by a multitude of streams, which have their sources in the mountains. Nature, always prodigal of her gifts in this enchanting climate, assured to it in profusion, with perennial fertility and healthfulness, tested by a long succession of years, all that a fertile soil under a delightful sky could furnish spontaneously in productions necessary to the support and comfort of life. The little river Otolum flows at the foot of the ruins, before going to join the Rio Michol, which further on swells the Catasaha, itself a tributary of the magnificent Uzumacinta. The limpid tide of the Michol winds at the foot of the mountains, rolling its waters among the flowers and shrubs of the meadows that spread abroad the sweetest perfumes. A site so favoured by nature could not fail to attract living beings. It is, in fact, the retreat of a multitude of quadrupeds and of birds of every hue. They delight to multiply in these smiling solitudes, whence man drove them and held them at a distance for ages, and whither they only returned when revolutions, banishing man in his turn, gave them back their rural abodes, he abandoning on their behalf his palaces and his temples as a souvenir of his sojourn and his power.

If Votan was the founder of Palenque and its first buildings were his, his successors apparently completed what he had begun in adding to the splendour of this capital. The city extended along the foot of the mountains from east to west, a distance between twenty-one and twenty-four miles. It came down to the bank of the Michol, which laved its front, thus giving it a breadth of only two or two and a half miles. In the midst of the plain which stretches between the mountains and the river, there rises majestically upon a vast artificial mound the building which it has been agreed to call the palace of the kings. The periodical inundation which, from the month of June, begins to cover the low ground where the Michol flows, then swollen by the superabundant waters of the Cordilleras, had doubtless compelled the Votanites to the necessity of heaping up by great labour the low-lying land on which the founder of the monarchy had desired to erect his royal abode. Afterwards, this plan having become sacred in the eyes of his people, the wish to protect his palace against the waters must have inspired the design of this gigantic edifice. Other monuments destined for different uses were afterwards built on the same plan, and that which could at first have been only a necessity of circumstances, became a consecrated custom for all the great buildings of American civilization.

The city proper was arranged in the form of an amphitheatre on the slope of the mountain all around the plain, the palaces of which must have presented a singular appearance at the time of inundation. Built upon so many artificial mounds, they resemble the rocks of lake Maggiore, transformed by the Borromeos into as many enchanted castles. The streets followed irregularly the course of the streams, which in their descent furnished abundance of water to every dwelling. On one of the summits, constituting the rear terrace of the amphitheatre, there rose, directly in front of the palace of the kings, another monument which would seem to have served as temple and citadel, and whose lofty walls commanded a view of the country as far as the shores of the Atlantic.

The numerous monuments of Palenque which time has respected give a sufficiently complete idea of its architecture; its general characteristics are simplicity, soberness and solidity. This last quality pertains not only to the nature and use of the materials; but also to the slope that has been observed in the bases of most of the palaces and temples. In addition to this peculiarity, which they share with the majority of buildings in Yucatan, Guatemala and Mexico, they have that of being perfectly oriented, that is to say, their four faces are opposite the cardinal points. Their plan is that of long parallelograms, and they are generally placed on natural or artificial eminences.

The great palace of the kings presents the most complete idea of a royal habitation. The pyramidal construction which forms its base is a parallelogram of 1,080 feet in circumference by 60 in height; it is built of stone and mortar. It is ascended by a colossal staircase situated below the eastern facade, and its steps of a foot high seem made for the strides of a race of giants. Thus the summit of the terrace in front of the palace is reached, and entrance is gained by five doors; of the two chief ones, that on the right leads to the great court of honour, the other, on the left, to the inner apartments. The extent of the building is 240 feet in length, and 145 in diameter. Its height is 36 feet. This gives 96 to the whole mass from base to summit. Within and without runs a double corridor, which, inside the palace, constitutes in many places separate apartments. The openings between the pillars are hardly more than six feet high in the outside corridor, but those of the interior buildings are generally higher. The vaulted ceilings, resting upon walls of prodigious thickness more than twenty feet above the floor, form at the top a truncated angle, bounded by large and very thick slabs. The building is crowned on the outside by a large frieze framed in two double cornices square in shape. Finally, between all the doors, upon the face of each of the pillars of the corridor which runs round this monument, full reliefs in stucco are incrusted, representing figures of more than ordinary stature, and cartouches of sculptured writing.

The interior of the palace does not present the same regularity, but it seems to correspond better to the magnificence of the princes who inhabited it. There may be seen several immense courts surrounded by great porticos with granite columns, covered with figures in relief double the size of those without. Magnificent peristyles lead to various dwelling quarters intelligently distributed. Succeeding the two courts of honour, there rises a tower of eight stories, the staircase of which in many places is upheld by vaulted arches, and from the top of which the eye can gaze far over the city, the country and the sea.

But even the irregularity which reigns in these arrangements, and above all, the vast difference between the proportions of the inside buildings and the principal corridor which surrounds the palace, without dwelling on the peculiar elegance that is observable in the form of the gates opening upon the courts, appear to prove that the owners of the palace, while seeking to preserve the outside portico, built perhaps by the sons of Votan, found themselves nevertheless compelled to embellish their habitation, and to introduce into it changes exacted by the development of civilization. For the same reason, they adorned with stucco reliefs the columns of the periphery, which had remained apparently under the early reigns without any other ornament than that of their severe and majestic nakedness. In fact, when the kings of Palenque had begun to be accustomed to luxury and magnificence, after they had adorned the new edifices built in the middle of the palace with sculptures in relief, they experienced the necessity of putting the old residence of their predecessors in harmony with their own. It was then without doubt that the external columns were stuccoed with models patterned otherwise exactly after the granite sculptures of the great court of honour. Hence the astonishment of travellers who attributed to a caprice of the architect what was only the natural consequence of the advance of art.

The other buildings discovered at Palenque are analogous in point of construction to the palace. They are majestically situated on pyramidal masses of great height, with a peristyle at the entrance. At the bottom is what may be called the chapel, having on each side one or two other pieces of architecture opening upon the corridor, and which seem to have served as dwellings for the guardians of the divinity who was there worshipped. Although its dimensions are much smaller, the system of the chapel is the same as that of the palace, and the reliefs, either in plaster or engraved on stone, have the same character. The only difference to remark is that two of these monuments are surmounted by a second story, the form of which and its multiplied adornments in stucco recall the strange and fantastic models of Indian pagodas. What becomes certain after examination is that they belong to a different epoch, and to an order of civilization other than that above which they are raised.

If a tradition preserved among the inhabitants of the modern little town of Palenque is to be believed, the artificial mound upon which the great palace is raised is divided up within into halls and galleries, the sepulchral abode of the kings and princes of the ancient city: but, up to this day, the Indians have religiously preserved the secret of these tombs and no traveller has been able to penetrate the catacombs of the Votanites. Those who have visited Yucatan have thoroughly satisfied themselves of the concavity of the pyramids which are so frequently met with in that peninsula. In spite of the comparatively modern period of the monuments of that country, remains have been recognized, especially in the ruins of Mayapan, the severe and unornamented style of which claims an antiquity contemporary with that of Palenque. There, as in the latter city, the walls are almost always covered with a plastering of stucco, to which oxide of iron has given a tinting, which would seem to denote that iron was formerly known in America, although no implement fashioned of this metal has ever been discovered.

Another interesting relic of ancient architecture preserved at Palenque is a fine bridge thrown over the river Michol, a short distance from the palace. It is built of square hewn stones, joined together without mortar by means of their shape only; it has no parapet. Sixty feet long by forty-five wide, it rises twelve feet above the ordinary level of the water. But a singular thing is that the opening which giyes passage to the river, square above, goes on enlarging convexly, contrary to the style of our bridge arches, the form of which is concave. This mode of construction is evidently opposed to solidity, but the stones are so well matched in the edifice in question that it has been preserved intact down the centuries.

Three miles east of the city appears another monument of the same character. It is a canal or subterranean aqueduct, a hundred and eighty feet long, six in width and twelve in height, through which runs a strong stream of exceedingly limpid water, coming from the wooded mountains and flowing from south to north. The dimensions of this monument vary in some places It is made of large stones laid without cement and fitting by their individual shapes, and the roof is formed of other flat stones which cover the entire breadth of the aqueduct. It is hard to say what purpose this great hydraulic construction served; perhaps it conducted the waters of the mountain to the public baths of this great metropolis, or it may have served to facilitate the passage of the water from one quarter to another.

It is to be observed that in the buildings of Palenque no brick is found, although so often employed in other parts of America; everywhere stone only appears. It is true that the quarries were so near the city and so easily worked that the inhabitants may never have dreamt of using other materials. Wood, if it were ever made use of, has entirely disappeared. It is hard to say whether the architects of Palenque made use of lintels of hardwood, such as those found at Tulha and in Yucatan. As for the openings serving for windows, they are small and generally capricious in form, surrounded within the buildings with arabesques and patterns in bas-relief, at times very pleasing It is thus that the Latin cross, so thin and delicate, which is the principal object in the temple of the cross, is formed by an opening piercing the wall from side to side to serve for a window. Many, however, have been noticed representing a Greek T. As for the pavement of their buildings, it is composed of a hard and fine stucco, similar to that made use of to cover the partition walls.

There is a curious fact connected with the art of painting among the Tzendals of Palenque. It refers to a bas-relief presenting writing in square cartouches, sculptured on a slab framed in the wall of a landing on a staircase which seemed to lead to the subterranean halls of the the palace. It projected about six inches. Du Paix, having had it torn away with much difficulty, so solidly was it inserted, found to his great astonishment, that the reverse of the slab presented the colored sketch of the subjects engraved in relief on the outside. Was this, said one of the commentators on the expedition, a precaution against the ravages of time or the instability of human things? Did the director of the palace desire that this law or legend, whatever it may have been, engraved upon the stone, should pass down to posterity in spite of the vicissitudes of time and circumstance? Layard, in his work on Nineveh and its remains, shows that the ancient Assyrians set the example of this double writing, long ages before America was discovered by man.

Mr. Baldwin, following Stephens and Catherwood, thus writes, "The largest known building at Palenque is called 'The Palace.' It stands near the river on a terraced pyramidal foundation, 40 feet high and 310 feet long, by 260 broad at the base. The edifice itself is 228 feet long, 180 wide, and 25 feet high. It faces the east, and has 14 doorways on each side, with 11 at the ends. It was built entirely of hewn stone, laid with admirable precision in mortar which seems to have been of the best quality. A corridor, nine feet wide, and roofed by a pointed arch, went round the building on the outside, and this was separated from another within of equal width. The palace has four interior courts, the largest being 70 by 80 feet in extent. These are surrounded by corridors, and the architectural work facing them is richly decorated. Within the building were many rooms. From the north side of one of the smaller courts rises a high tower or pagoda-like structure, thirty feet square at the base, which goes up far above the highest elevation of the building, and seems to have been still higher when the whole structure was in perfect condition. The great rectangular mound used for the foundation was cased with hewn stone, the workmanship here, and everywhere else throughout the structure, being very superior. The piers around the courts are covered with figures in stucco or plaster, which, when broken, reveals six or more coats or layers, each revealing traces of painting. This indicates that the building had been used so long before it was deserted that the plastering needed to be many times renewed. There is some evidence that painting was used as a means of decoration, but that which most engages attention is the artistic management of the stone work, and, above all, the beautifully executed sculptures for ornamentation.

"Two other buildings at Palenque, marked by Mr. Stephens, in his plan of the ruins, as 'Casa No. 1,' and 'Casa No. 2,' are smaller, but, in some respects, still more remarkable. The first of these, 75 feet long by 25 wide, stands on the summit of a high truncated pyramid, and has solid walls on all sides save the north, where there are five doorways. Within, are a corridor and three rooms. Between the doorways leading from the corridor to these rooms are great tablets, each 13 feet long and 8 feet high, and all covered with elegantly carved inscriptions. A similar but smaller tablet, covered with an inscription, appears on the wall of the central room. 'Casa No. 2' consists of a steep and lofty truncated pyramid, which stands on a terraced foundation, and has its level summit crowned with a building 50 feet long by 31 wide, which has three door-ways at the south, and within, a corridor and three rooms. The edifice, sometimes called 'La Cruz' has, above the height required for the rooms, what is described as 'two stories of interlaced stucco work, resembling a high fanciful lattice.' Here, too, inscribed tablets appear on the walls; but the inscriptions, which are abundant at Palenque, are by no means confined to tablets. As to the ornamentation, the walls, piers, and cornices are covered with it. Everywhere, the masterly workmanship and artistic skill of the old constructors compel admiration; Mr. Stephens going so far as to say of sculptured human figures found in fragments, 'In justness of proportion and symmetry they must have approached the Greek models.'

"'Casa No. 2' of Mr. Stephens is usually called 'La Cruz,' because the most prominent object within the building is a great bas-relief, on which are sculptured a cross and several human figures. This building stands on the high pyramid, and is approached by a flight of steps. Dr. Paix says, 'It is impossible to describe adequately the interior decorations of this sumptuous temple.' The cross is supposed to have been the central object of interest. It was wonderfully sculptured and decorated; human figures stand near it, and some grave ceremony seems to be represented. The infant held toward the cross by one of the figures suggests a christening ceremony. The cross is one of the most common emblems present in all the ruins. This led the

Catholic missionaries to assume that knowledge of Christianity had been brought to that part of America long before their arrival; and they adopted the belief that the gospel was preached there by St. Thomas. This furnished excellent material for the hagiologists of that age; but, like everything else peculiar to these monkish romancers, it betrayed great lack of knowledge. * * * What more will be found at Palenque, when the whole field of its ruins has been explored, can not now be reported. The chief difficulty by which explorers are embarrassed is manifest in this statement of Mr. Stephens. 'Without a guide, we might have gone within a hundred feet of the buildings without discovering one of them.' More has been discovered there than I have mentioned, my purpose being to give an accurate view of the style, finish, decoration, and general character of the architecture and artistic work found in the ruins, rather than a complete account of everything connected with them. The ruins of Palenque are deemed important by archæologists, partly on account of the great abundance of inscriptions found there, which, it is believed, will at length be deciphered, the written characters being similar to those of the Mayas, which are now understood."[4]

Dr. Short says: "Nothing of a definite nature is known of the style of roof with which the palace was covered, since every vestige of it has disappeared. Castaneda represents it as sloping and plastered, while Du Paix refers to it as consisting of large stone flags, carefully joined together. The neighboring buildings, such as the Temple of the Three Tablets, the Temple of the Cross, and the Temple of the Sun, each have well preserved roofs of masonry, which are quite remarkable. The first of these stands upon its lofty pyramidal base, measuring one hundred and ten feet on the slope, with continuous steps on all sides. The temple, which is thirty-five feet high, is crowned with a sloping ornamental roof of great beauty. The roof is divided into three parts; the lower section recedes from the cornice with a gentle slope, and resembles the corresponding section of a French or Mansard roof. The stucco decorations of this lower section, which is also painted, add considerably to the general effect. Five solid square projections with perpendicular faces, suggestive of the attic windows of a modern French roof, are found in this section, corresponding to the several doors of the temple immediately below. The second section, which slopes back at a more acute angle, is of solid masonry. The crowning section seems to have been purely ornamental, consisting of a line of pillars of stone and mortar, eighteen inches high and twelve inches apart, surmounted by a layer of flat stones with projecting sides. The Temple of the Cross and the Temple of the Sun both have roof structures, which may be described as resembling a lattice work of stone."

"The most interesting feature of Palenque architecture is the arch, of which there are two styles, if one of them may be classed as an arch at all; of this we have doubts. The style to which we allude is that which has been designated as the Yucatan arch. This so-called arch is nothing more than the approach of two walls towards each other in straight lines, nearly forming an acute angle at the top. These inclining walls are constructed of overlapping stones, with a small surface of exposed ceiling produced by a lintel like covering. The principal doorway, which is eighteen feet high, is constructed in the form of a trefoil arch, while niches or depressions of the same trefoil form are ranged along the inclined face of the gallery on each side of the entrance. This arch is suggestive of the Moorish pattern, though the latter, probably, is the more modern."[5]

Lewis Morgan will not allow that the buildings of Palenque were palaces and temples. Referring to Palenque as a pueblo, he says: "There are four or five pyramidal elevations at this pueblo quite similar in plan and general situation with those at Uxmal. One is much the largest, and the structures upon it are called 'The Palace.' It has generally been regarded as the paragon of American Indian architecture. As a palace implies a potentate for its occupation, a character who never existed and could not exist under their institutions, it has been a means of self-deception with respect to the condition of the aborigines which ought to be permanently discarded. Several distinct buildings are here grouped upon one elevated terrace, and are more or less connected. Altogether they are two hundred and twenty-eight feet long, front and rear, and one hundred and eighty feet deep, occupying not only the four sides of a quadrangle, but the greater part of what originally was, in all probability, an open court. The use of the interior court for additional structures shows a decadence of architecture and of ethnic life in the people, because it implies an unwillingness to raise a new pyramidal site to gain accommodations for an increased number of people. Thus, to appropriate the original court, so essential for light and air, as well as room, and which is such a striking feature in the general plan of the architecture of the Village Indians, was a departure from the principles of this architecture. Nearly all the edifices in Yucatan and Central America agree in one particular, namely, in being constructed with three parallel walls at intervals, giving two rows of apartments under one roof, usually, if not invariably, flat. Where several are grouped together in the same platform, as at Palenque, they are severally under independent roofs, and the spaces between, called courts, are simply open lanes or passage ways between the structures. An inspection of the ground plan of the Palenque ruins in the folio volume of Du Paix, or in the work of Mr. Stephens, will be apt to mislead, unless this feature of the architecture is kept in mind. There are in reality seven or eight distinct edifices crowded together upon the summit level of the platform. Mr. Stephens speaks of it as one structure. 'The building,' he remarks, 'was constructed of stone, and the whole front was covered with stucco and painted. . . . . The doorways have no doors, nor are there the remains of any. . . . . The tops of the doorways were all broken. They had evidently been square, and over every one were large niches in the wall on each side, in which the lintels had been laid. These lintels had all fallen, and the stones above formed broken natural arches.' The interior walls in two rooms shown by engravings were plastered over.

"Architecturally, Palenque is inferior to the House of the Nuns; but it is more ornamental. It has one peculiar feature not generally found in the Yucatan structures, namely, a corridor about nine feet wide, supposed to have run about the greater part of the exterior on the four sides. The exterior walls of these corridors rest on a series of piers, and the central or next parallel wall is unbroken, except by one doorway on each of three sides, and two in the fourth, thus forming a narrow promenade. One of the interior buildings consists of two arch corridors, but wider, on opposite sides of a central longitudinal wall. All the rooms in the several edifices are large. In one of the open spaces is a tower about thirty feet square, rising three stories. The Palenque structures are quite remarkable, standing upon an artificial eminence about forty feet high, and large enough to accommodate three thousand people living in the fashion of Village Indians.

"An impression has been propagated that Palenque and other pueblos in these regions were surrounded by dense populations, living in cheaply constructed tenements. Having assigned the structures found, and which undoubtedly were all that ever existed, to Indian kings or potentates, the question might well be asked, if such palaces were provided for the rulers of the land, what has become of the residences of the people? Mr. Stephens has given direct countenance to this preposterous suggestion. In his valuable work he has shown a disposition to feed the flames of fancy with respect to these ruins. After describing the 'palace,' so called, at Palenque, and remarking that 'the whole extent of ground covered by these (ruins) as yet known, as appears by the plan, is not larger than our Park or Battery' (in New

York), he proceeds: 'It is proper to add, however, that, considering the space now occupied by the ruins as the site of palaces, temples and public buildings, and supposing the houses of the inhabitants to have been, like those of the Egyptians and the present race of Indians, of frail and perishable materials, as at Memphis and Thebes, and to have disappeared altogether, the city may have covered an immense extent.' This is a clear case of *suggestio falsi* by Mr. Stephens, who is usually so careful and reliable, and, even here, so guarded in his language. He had fallen into the mistake of regarding these remains as a city in ruins instead of a small Indian pueblo in ruins. But he had furnished a general ground plan of all the ruins found of the Palenque pueblo, which made it plain that four or five structures upon pyramidal platforms at some distance from each other, with the whole space over which they were scattered about equal to the Battery, made a poor show for a city. The most credulous reader would readily perceive that it was a misnomer to call them the ruins of a city; wherefore the suggestions of Mr. Stephens, that, considering the space now occupied by the ruins as the site of palaces, temples, and public buildings, and *supposing* the houses of the inhabitants . . . of frail and perishable materials to have disappeared . . . the city *may have* covered an immense extent. That Mr. Stephens himself considered or supposed either to be true may have been the case, but it seems hardly supposable, and in either event he is responsible for the false colouring thus put upon these ruins, and the deceptive inferences drawn from them."

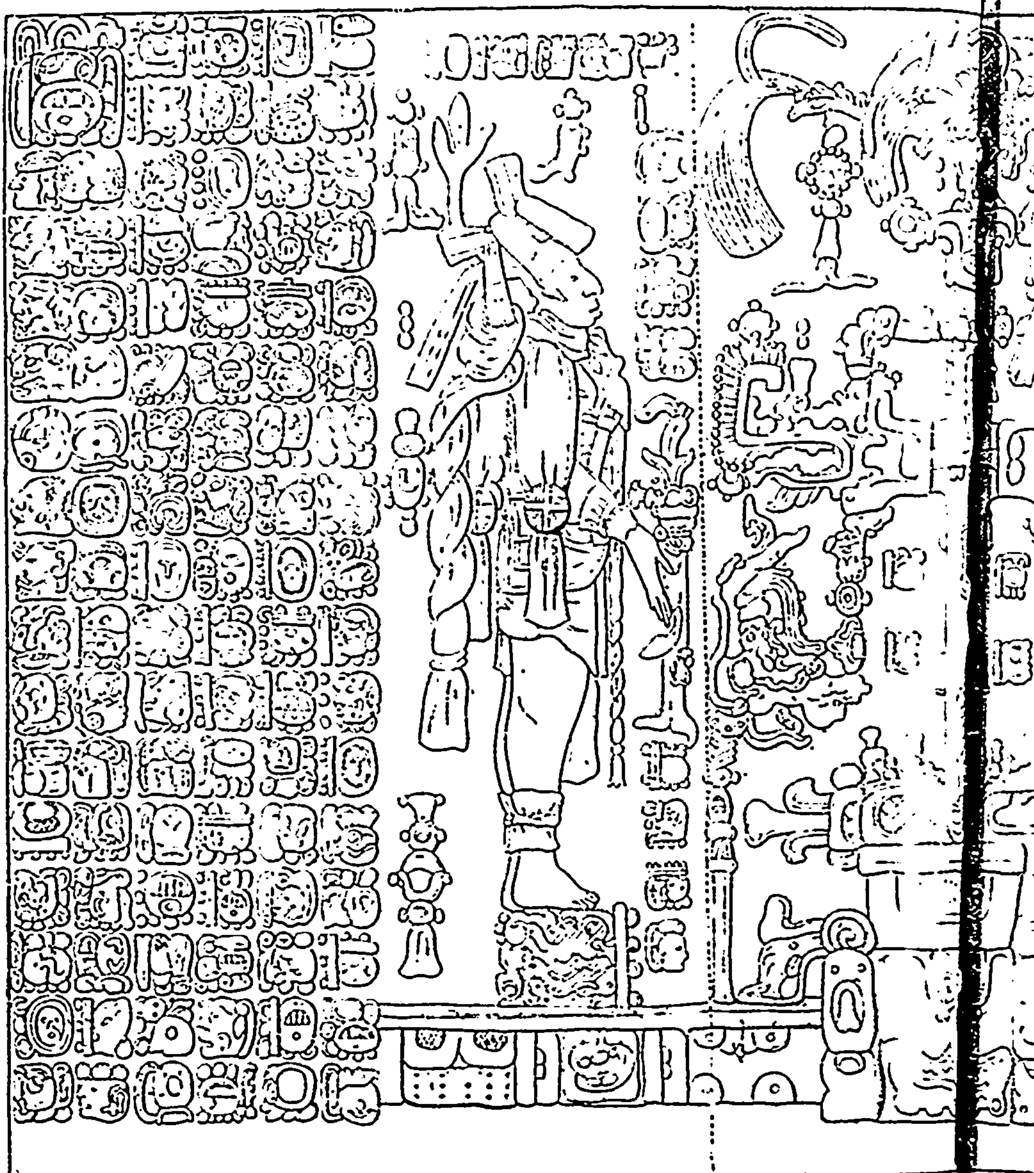
In quoting these words of a late highly esteemed correspondent, the writer regrets, in one sense, that he cannot homologate them. Mr. Morgan sought to unify American Indian architecture, which is an impossible task, inasmuch as tribes of very different origin constitute the aboriginal population of the continent, and their modes of building, like their languages, physical features, customs, and traditions, exhibit marked and irreconcilable differences. The Mayas of Yucatan and the Quiches and Cachiquels of Guatemala had no connection of any kind with the Pueblo Indians. Their histories assert that they were governed by great monarchs, almost absolute in their sway, a rule that continued down to the appearance of the Spanish invaders. Elaborate ornamentation and elegantly carved hieroglyphics are no part of a common dwelling house; nor, with all his invective against Mr. Stephens, has Mr. Morgan succeeded in proving that, even in rough outline, the palaces and temples of Palenque were not such. Credible history attests that the Mayas, Quiches, and Cachiquels possessed palaces and temples as well as kings and priests. No village life could have developed or even continued the high art of these ancient buildings; such art could only flourish in a large and wealthy community under enlightened patronage. There is nothing at all absurd in the supposition of Mr. Stephens, which he shared with all the other explorers, that the houses of the people were what the present dwellings of the natives are, common and perishable structures. It is, however, likely that Du Paix and De Bourbourg have exaggerated the size of the city of Palenque, and that a good many miles should be deducted from its twenty-one to twenty-four in length. Making every allowance for such exaggeration, the ruins indicate a very large city in a high state of aboriginal civilization, and its written records cannot fail to excite the intelligent curiosity of all who seek to learn more than we yet know of ancient life in the cradle of American history.

CHAPTER II.

THE TABLET OF THE CROSS.

In the preceding chapter reference has been made more than once to the temple or house of the Cross. The Rev. Stephen D. Peet, in a *resumé* of the late Dr. Charles Rau's monograph upon the tablet, thus describes the building in which it was found. "The temple which contained it was situated on a pyramid, which was 134 feet high on the slope. The pyramid itself was on a broken stone terrace sixty feet high, with a level esplanade around its base, 160 feet in breadth. The dimensions of the temple are as follows: Fifty-one feet front, thirty-one feet deep, height about forty feet. This would make the total height of the pyramid, terrace, and temple, two hundred and thirty-four feet. The temple had three entrances at the front; and was covered with stucco ornaments. The piers between the entrances contained hieroglyphics and figures in bas-relief. The interior was divided into three parts: an outer corridor, an inner corridor, which might be called the sanctuary, and a chamber called the adoratorio, at the rear of the sanctuary. There was a door or opening from the outer corridor to the inner, and another door or opening into the chamber. These three doors, that in the front, that between the corridors, and that into the chamber or adoratorio, were all in a line and so arranged that the light from the outside could penetrate into the adoratorio and strike the tablet. The tablet was on the wall back of the chamber or adoratorio, and covered nearly the entire wall. Stephens gives the dimensions of the entire room containing the tablet as follows: 'Thirteen feet in length, seven feet in depth,' and represents the tablet as covering the entire wall. Galindo states: 'it was covered with a flat roof.' Charnay says that "the altar, which recalls by its form the ark of the Hebrews, is a sort of covered box, having for an ornament a small frieze or moulding. High above both extremities of this frieze are two wings, reminding one of the same kind of ornamentation often seen in connection with Egyptian monuments.' It is a question whether Charnay did not confound the wing ornaments on the temple of the sun with what he saw on the temple of the cross, and attribute them to this frieze, as no one else has ascribed the wing ornament to the temple of the cross. He says in reference to the tablet: 'In the background of the altar are seen three immense slabs, close by, joined, and covered by precious sculptures.' According to all accounts, we judge that the tablet itself was six feet four inches high, and thirteen feet long, as it covers the entire wall of the adoratorio."[1]

The tablet was originally composed of three distinct slabs, as represented in the illustration. Those on the right and left contained groups of hieroglyphics, of which 102 belonged to the right and ninety-nine to the left. There are also thirty-nine cartouches of hieroglyphics scattered over the central slab, which, so far has been the chief object of interest. Down to the time of Du Paix's visit in 1808 the tablet was complete. When Waldeck visited Palenque in 1832, the middle slab was gone. The robber was William Brown, an American sea captain who had married a wealthy Spanish lady, the owner of a house near Palenque. The Indians, whom he employed to remove it and carry it to his house, had brought it some distance, when according to one account, the priests, according to Waldeck, the governor of Chiapas, compelled them to drop their burden. Torn from its original place by a fanatic, who saw in it a reproduction of the Christian emblem miraculously employed by the ancient inhabitants of these palaces, it was designed to ornament the house of a rich widow in the village of Palenque; but the authorities were aroused by this devastation, and prohibited the removal of the stone. It was consequently left in the woods, where I unconsciously trod on it, until my guide directed my attention to this precious stone. It was covered with moss, and the sculptures had become totally invisible. When I afterwards concluded to reproduce it, it had to be rubbed with branches, and set against a tree. In 1842 the right slab was almost all gone, according to Stephens, but, in that same year, Mr. Charles Russell, United States consul at Laguna, shipped to Washington a number of fragments, which, when pieced together, were found to constitute the missing right slab. There has been some controversy



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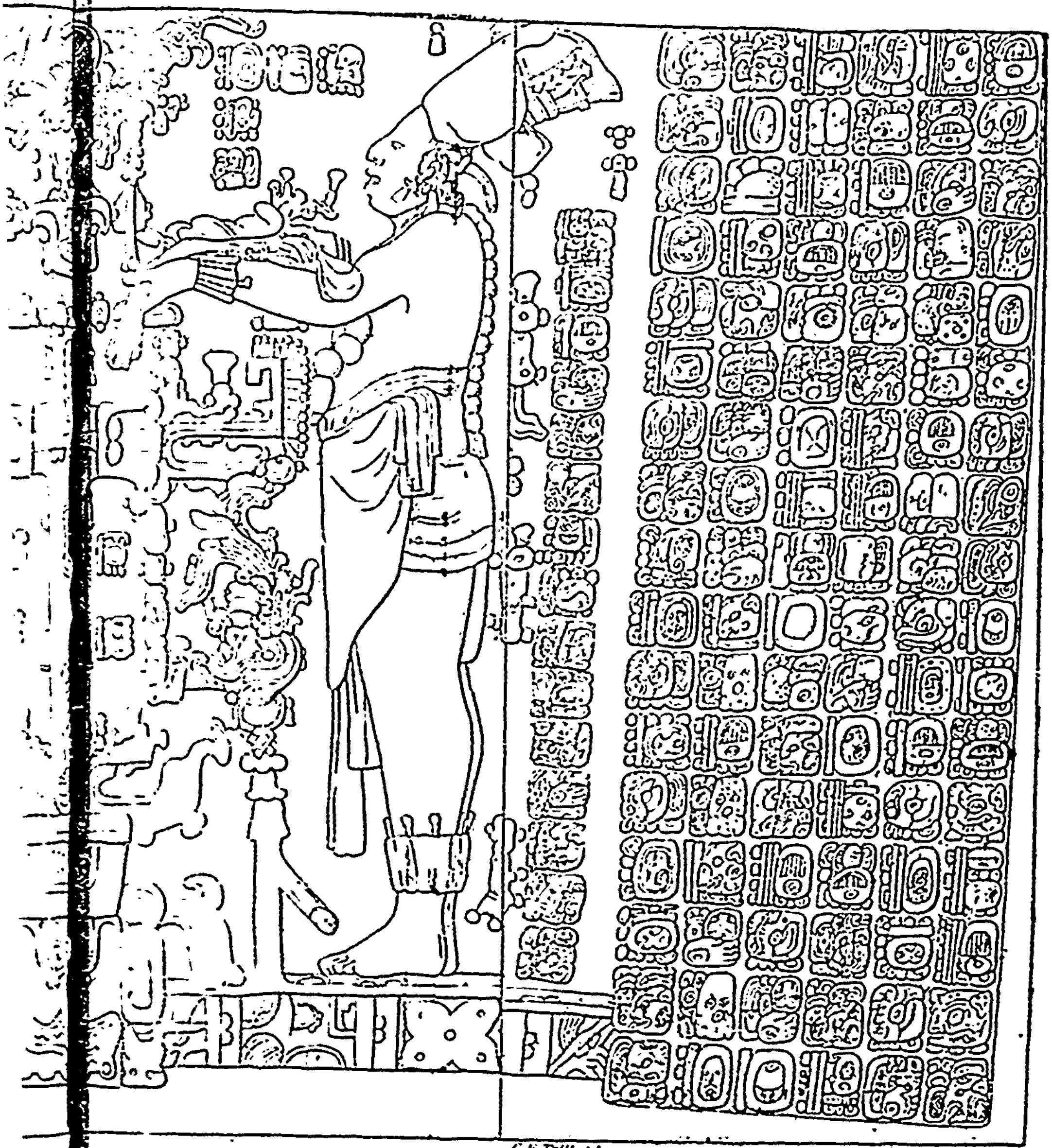

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over this, however."[2] The left slab is supposed to be still *in situ*, and the centre one where Captain Brown's bearers were compelled to drop their precious burden in the forest.

Although the trustworthy illustration might speak for itself, Mr. Stephens' description may not be superfluous. He says: "The principal subject is the cross. It is surmounted by a strange bird. The two figures are evidently important personages. They are well drawn, and in symmetry of proportion are perhaps equal to many that are carved on the ruined walls of Egypt. Their dresses are in a style different from any heretofore given, and the folds would seem to indicate that they were of a soft and pliable texture, like cotton. Both are looking toward the cross, and one seems in the act of making an offering, perhaps a child. All speculations on the subject are of course entitled to little regard, but perhaps it would not be wrong to ascribe to these personages a sacerdotal character. This tablet of the cross has given rise to more learned speculations than any others found at Palenque. Du Paix and his commentators, assuming for the building a very remote antiquity, antecedent to the Christian era, account for the appearance of the cross by the argument that it was known and had a symbolic meaning long before it was established as the emblem of the Christian faith. There is no doubt that the symbol of the cross is contained upon the tablet. The symbol in this case has a complicated character. These are the features of the cross, namely, the upright pieces, and the cross-pieces or arms, but the arms terminate with figures which resemble maces or battle axes, such as are used among the native races. The centre of the standard has the figure of a winged arrow. The top of the standard is ornamented by various expressive symbols, somewhat resembling the horns on the Assyrian columns, and on the top stands the thunder bird. The bird is ornamented with tassels, and pendants, and symbols of various kinds. The base of the cross also has various ornaments, which we will not undertake to explain. The whole cross rests on a masked face, which somewhat resembles the human countenance, but is distinguished by a peculiar mouth and eye, the eye somewhat resembling that in the rain-god, a figure which may be seen in the temple of the sun at Palenque. Pendant from the arms of the cross are ornaments which reach to the floor on either side, containing various symbols, and among them, heads with protruding tongues, and various symbolic figures emanating from their eyes. There is also, on the ornamentation of the standing figure at the left, another cross, and among the hieroglyphics on either side, the Greek tau can be recognized."[3]

The figure of the cross in general is so simple that it is as old as the art of writing, of drawing, even of making a mark more complicated than a straight line. It is found in all lands and in all ages, sometimes with religious significance, but oftener without. It is an old symbol in Egypt and in Assyria, in India and in China, in Asia Minor and in Etruria, as well as throughout America. The simplest mode of construction is an upright pole fixed in the ground, and the next to that is a cross piece from which articles of any kind may depend. That so much attention has been paid to the Palenque cross is not to be wondered at, but, as Mr. Baldwin has said, the attention is more a sign of ignorance and credulity than of scientific curiosity. The fantastic bird idol is the true object of interest. In it, perhaps, may be recognized the Voc of the Quiches, mentioned in their sacred book, the Popol Vuh. Among the Cachiquels this bird god was called Vaku, and Dr. Brinton thinks that Savacon of the Caribs, which they represent as a huge bird that makes the winds, and as the companion of Iroucan, is this same Voc, inasmuch as the Quiches call it the messenger of the god Hurakan.[4] The Voc is a bird described by Coto "as having green plumage, and a very large and curved bill, apparently a kind of parrot." It is a well-known fact that all the Maya-Quiche peoples were in the habit of immolating captives taken in war to their gods, and that, in default of these, they did not scruple, in cases of supposed necessity, to sacrifice their slaves, their children or their poor. The high priest was always a member of the royal family.[5] The object presented to the idol is not necessarily an infant. It is a trait of almost all ancient representations of human figures, such, for instance, as the Egyptian and Assyrian, to give prominence to kings and other distinguished personages by magnifying their portraits inordinately, at the expense of their victims, opponents, or inferiors.

The chief merit of the pictorial part of the tablet is that it furnishes what is doubtless a faithful representation of two distinct, though allied, types of feature and dress, illustrating the period to which the tablet belongs. The headdress of the larger of the two figures, on the right, is curiously like that of the Tokari, as represented on the Egyptian monuments. Kenrick thus describes it: "A high cap or helmet, wider at the top than at the base, divided into coloured stripes, with disks of metal attached to it, descending on the back of the neck and fastened beneath the chin."[6] By the name of their god Tohil, Tockill, the Maya-Quiches claim some sort of connection with the ancient Tokari, intermediate links being found in the Tagalas of the Philippines, and in the almost universal Polynesian god Tagaloa or Tangaloa. The ancient art of Java closely resembles that of Yucatan and Guatemala, so that the chief building at Palenque has been likened to the temple of Boro Bodo in that island.[7] Old Javanese representations of native features and dress are very similar to those on the monument in question, which sets forth people who had kept up the traditional customs of a warm climate.[8] On Easter Island, the most easterly in Polynesia, and thus the nearest to America, groups of hieroglyphics resembling, at least in general outline, those of the Tablet, have been found, together with colossal statues, beyond the power of its present inhabitants to fashion.[9] These may yet be found to stand in some definite relation to Central American art, and to this end the accurate portraiture of the living figures may be our aid; but this is to anticipate.

Professor Cyrus Thomas, referring to his study of the Maya Manuscript Troano, says regarding the hieroglyphics of the Palenque Tablet: "If the reader will examine carefully the character V 14 (that is, the fourteenth in the fourth line of the right hand inscription, reading from top to bottom and from left to right), especially on Dr. Rau's photograph, he will see that it is almost identical with that in the Manuscript I have rendered *pecuah*, 'tortilla of maize.' Comparing this with the large initial, we find but a slight difference between the two; in the latter, the comb-like figures are drawn down to the sides, and the loops are placed above. In this, the form of the central oval is not to be relied upon as strictly correct, as the lines are too freely rounded; still we presume it is slightly different from the little upper circle in V 14. Supposing the Maya language to have been used, and the characters on the Tablet to have the same signification as similar characters in the Manuscript, we should find, in this initial, sounds closely resembling those in *pecuah*; as the bars are interlaced, I presume the first syllable should be *pech* or *pach*. Turning to Landa's Relacion (264), we find that 'In the month Pax, they (the Mayas) celebrated a festival named Pacumchac, on which occasion the chiefs and priests of the inferior villages, assembling with those of the more important towns, having joined together, they passed into the temple of Citchaccoh.' If we interpret the character Pacumchac, we at once find a satisfactory explanation of the repeated occurrence of the symbol for *Pax* in this inscription. From Landa's description, which is somewhat confused, I judge this was one of their chief festivals, but nothing appears in his statement that accords with the scene on the middle slab. This, however, cannot be properly urged as an objection to my rendering; first, because there were doubtless many formalities which he does not mention; second, because the ceremonies of this festival, as practised at Palenque may have been quite different from those observed by Landa; third, there are some reasons for believing, even from Landa's words, that during the festival petitions for rain and abundant crops were offered. I presume also that, during this festival, took place the rejoicing over the first fruits of the maize harvest. I may as well state here as elsewhere that I do not think the offering made by the priest on the right is an infant; the probability is that it is a dough image. Although we see what appears to be the body and limbs, we have to assume that the head wears a mask to believe it to be the body of a child. If it is the figure of a child, then the scene represents a special occasion, when the sacrifice was made to avert some impending danger. The difference in the height of the two priests favors the idea that the artist referred by his figures to particular persons, if not to a special occasion. Finally, it is possible that, although the inscription relates chiefly to this festival, others are also alluded to. But, be this as it may, I have reached my conclusion as to the rendering by legitimate steps."[10]

With all due respect for Professor Cyrus Thomas, whose patient labours in many fields of archæological research entitle him to honour, the writer fails to see that he has made his point in this case. It is true that guess work has contributed to discovery since the days of Sir Isaac Newton, and there are legitimate hypotheses which it is allowable to employ for a time as working theories, but between blind submission to doubtful authority and a preconception of the mind as to what an unread description should contain, there lies a wide field of induction and tentative inference, which it is well in the interest of science to exhaust. The testimony of one credible eye-witness is sufficient to overturn the most formidable arguments based upon circumstantial evidence. In the case of the Tablet, the witness is the engraver of the hieroglyphics, and when his tale is told, we shall know what is the true story contained in the central slab.

CHAPTER III.

MAYA-QUICHE DOCUMENTS AND THE MATERIAL FOR THEIR DECIPHERMENT.

The Maya-Quiche family of languages consists of three divisions. The first is the Huastec, spoken in the northern part of the Mexican province of Vera Cruz. It stands alone in its class. The second is the Maya. Maya proper is the language of Yucatan and the island of Carmen, and of the villages of Monte Cristo and Palenque, situated respectively in the Mexican provinces of Tobasco and Chiapas. Allied to the Maya are the Lacandon and the Peten, pertaining to the tribes so named dwelling in Guatemala. The third division is the Guiche of Guatemala, which is also spoken in part of Chiapas. Other dialects in Chiapas are the Chiapanec, the Chanabal, the Tzendal, the Chol and the Tzotzil. Another, the Zoque, extends over parts of Chiapas, Tobasco and Oaxaca. Besides the Quiche proper, Guatemala owns the Cachiquel, the Zutuhil, the Mame, the Pocoman and the Poconchi. The last of the Quiche dialects is the Totonac, which pertains to the Central part of Vera Cruz, south of the Huastecs, and to the neighboring part of the province of Puebla. Although the continuity of their area has been broken by the advent of intrusive tribes of a different origin, all of the above mentioned tribes and dialects have a common character, and are quite distinct in physical features, in grammar and vocabulary, in writing, in history and mythology, from the peoples generally known as Mexicans, Nahuatlac, or Aztec.[1]

Of the Maya-Quiche tribes, those which have left anything in the shape of literature are the Mayas and Quiches, the Cachiquels, the Tzendals, and the Pocomans, the first three being in this respect the most important.[2] Most of these writings are extant in European characters, accompanied with Spanish translations. They are, therefore, transcripts from original manuscripts in hieroglyphic character, which, with few exceptions, have perished. The destruction of the original documents was due to the religious vandalism of Bishop Landa and other Churchmen, who regarded them as tending to perpetuate native superstition. Only three are known to have survived this unhappy exercise of zeal, although Dr. Brinton supposes that there may be two in Europe and two or three in Mexico which have not been published. Those which have seen the light are the Dresden Codex, set forth in Lord Kingsborough's Mexican Antiquities and elsewhere; the Codex Peresianus discovered by Professor Léon de Rosny in the National Library at Paris, and now in course of publication by him; and the Codex Troano of Madrid, published by the Abbé Brasseur de Bourbourg. These codices consist respectively of seventy-four, twenty-two and seventy pages, between seven and nine inches long, and from four to five and a quarter inches wide. Their material is paper made from the leaves of the maguey, and the hieroglyphics are executed in black and in colours, being accompanied with illustrative paintings in a rude kind of art. Attempts have been made to decipher the codices by Brasseur de Bourbourg, Léon de Rosny, Hyacinthe de Charencey, William Bollaert, Cyrus Thomas, and some other students, but so far absolutely without success. What is true of the codices is also true of the stone inscriptions found at Palenque, in Chiapas, at Copan, on the borders of Honduras and Guatemala, and at Chichen Itza and other parts of Yucatan. They have so far defied the art of the epigrapher.

The materials with which these students of the hieroglyphics have attacked the codices and inscriptions are those provided by Bishop Landa. They are a so-called alphabet, and figures denoting the Maya months and days. There are thirty-three characters in his alphabet, twenty signs for the days, and eighteen for the months as represented in the plate. The phonetic values of no fewer than seventy-one characters being given, and the Maya language being known, it might be supposed a simple task to read a Maya document. All that investigators have succeeded in accomplishing, however, has been to point out a character here and there, and suggest a probable signification for it. The most careful and laborious comparison and analysis of the signs for months and days has failed to connect them in any way with the supposed alphabet, which Dr. Felipe Valentini characterized as a Spanish fabrication. Dr. Brinton comes to Landa's defence, stating that the Bishop did not affirm the possession by the Mayas of an alphabet, but merely wrote that, if they had occasion to express in their writing the sounds of the Spanish alphabet, they would do so by these characters.[4] The alphabet then must be given up. Turning to the signs for days and months, no principle can be found to govern their phonetics. The day character Cauac enters into the composition of the month hieroglyphics Yax, Zac and Ceh; the day character Ymix is nearest in form to the month sign Mol; and the day figure Chuen forms part of the month symbol Tzec. The first day is Kan, and the fourteenth month is Kankin, but the sign of the former has no part in that for the latter.

Were the meanings of the words for days and months certainly known, the student might proceed to analyze the hieroglyphics by this aid, but the significations suggested are more than doubtful in almost all cases. Of the days, Chicchan, Lamat, Cauac, and Ymix have defied all interpretation, as have Tzec and Yaxkin among the months. Those acknowledged to be exceedingly doubtful are the day signs Manik, a wind passing; Muluc, reunion; Chuen, a board; and Ben, economical distribution. The remaining are Kan, yellow, or a string of twisted hemp; Cimi, dead; Oc, the contents of the palm of the hand; Eb, a ladder; Ix, fish skin or roughness; Men, a builder; Cib, gum copal; Caban, heaped up; Ezanab, flint; Ahau, a king or period of twenty-four years; Ik, wind, spirit; and Akbal, the approach of night. The other month names are

Pop, a cane mat; Uo, a frog; Zip, a tree; Tzoz, a bat; Xul, end; Mol, to reunite; Chen, a well; Yax, first or blue; Zac, white; Ceh, a deer; Mac, a cover; Kankin, yellow sun; Muan, cloudy weather; Pax, a musical instrument; Kayab, singing; and Cumhu, a thunderclap. There is no resemblance between these alleged significations and the forms of the hieroglyphics. Thus, the month signs, Xul, an end; Yaxkin, signification unknown; Yax, first or blue; and Ceh, a deer, are winged, and a wing in Maya is Xik. But it is useless to dwell upon these disappointing discrepancies, which are the despair of the interpreter.[5]

Mr. Baldwin has been quoted as saying that the inscriptions at Palenque "will at length be deciphered, the written characters being similar to those of the Mayas, which are now understood." Elsewhere he quotes Brasseur de Bourbourg as saying, "The alphabet and signs explained by Landa have been to me a Rosetta stone." Had Mr. Baldwin looked into the work of the learned Abbé, he would have found the truth of Dr. Brinton's statement, "When the Abbé Brasseur edited the Codex Troano, he also attempted an explanation of its contents. He went so far as to give an interlinear version of some pages, and wonderful work he made of it! But I am relieved of expressing an opinion as to his success by his own statement in a later work, that he had, by mistake, commenced at the end of the Codex instead of its beginning; that he had read the lines from right to left, when he should have read them from left to right, and that his translations were not intended for more than experiments." A glance at the work of those diligent labourers in this field, M. Léon de Rosny and Professor Cyrus Thomas, will speedily undeceive anyone who thinks that the key to Maya writing has been discovered.

Is the value of any one sign certainly known? The answer is, Yes; the day sign Ahau, meaning king, and a period of twenty or twenty-four years, is known without doubt. The numerals also are familiar to scholars, balls denoting units up to four, and occasionally beyond, and short strokes or bars, about the length of five balls placed in line, standing for fives. It will also appear in the sequel that one or two of the other characters mentioned may be made use of to elucidate Maya texts. This is a very meagre stock in trade to start with, although Messrs. De Rosny and Thomas profess to have greatly extended it. The more their additions are examined, the more doubtful they appear. The writer's experience in translating inscriptions has told him this, that the key which can only unlock the meaning of part of such a document is no key at all, the whole document, of course, being legible or undefaced. No complete hieroglyphic Maya writing, however brief, has yet been deciphered. All is conjecture, imagination, attempt to connect pictographs and hieroglyphics, preconceived ideas of calendars, deities, sacrifices, and other rites that ought to be set forth in these records, but that are not.

These gentlemen follow what is called the method of science, which is to proceed to interpret the unknown from the known. This is very natural and is the course that has often brought about great results. The known Greek in the Rosetta stone led to the interpretation of the unknown Egyptian; but the Greek alphabet has not interpreted the Etruscan, nor the Devanagari the Lat Indian, in spite of Prinsep and Cunningham. When clever men have been working for many years, and some of them for centuries, along the line of the so-called method of science without results, it is time for a change, a reformation, a revolution, time to drop the traditions of the past, and inaugurate a new method of arriving at truth. Had the so-called method of science been such, the Etruscan inscriptions would have been read long ago; had Landa's key been a real key, such men as De Bourbourg, Bollaert, De Charencey, De Rosny and Thomas, would have ere this given the world complete translations of the texts. The method of science may have been a very noble lion, but it is dead; a living dog is better. Landa might have saved the world a great deal of trouble had he been a wise man; but he was not. He saw that the Mayas had writing, and burned twenty-seven rolls of it in 1562, to the great distress of the natives. He at once concluded that, as Spanish writing was by letters, so was that of the Mayas. He might have known better, for Father Alonzo Ponce in 1588 said: "The natives of Yucatan are, among all the inhabitants of New Spain, especially deserving of praise for three things: First, that, before the Spaniards came, they made use of characters and letters, with which they wrote out their histories, their ceremonies, the order of sacrifices to their idols, and their calendars, in books made of the bark of a certain tree. These were on very long strips, a quarter or a third of a yard in width, doubled and folded, so that they resembled a bound book in quarto, a little larger or smaller. These letters and characters were understood only by the priests of the idols (who in that language was called Ahkins) and a few principal natives. Afterwards some of our friars learned to understand and read them, and even wrote them." Why did Landa not apply to these industrious friars?

Thanks to the kind attention of several eminent scholars, the Maya hieroglyphic problem has been for some time under the writer's eye. Judging that it lay out of his sphere, he acknowledged the kindness of these scholars, and their eminent qualifications as interpreters of the unknown, and gladly read what they had written on the subject. Recently, however, having no special work of decipherment on hand, he took up the Maya problem, after a course of Brasseur de Bourbourg's History of the Civilized Nations of Mexico and Central America, and Dr. Brinton's Maya Chronicles, when light dawned upon him, but not through the unsuccessful method of science. He found that the hieroglyphics were not alphabetic nor syllabic, but purely ideographic like the original Chinese symbols, and that numbers, not employed always as such, but in the rebus form, played a large part in this peculiar writing. All the world is familiar with

y y u r
y y u b
i c u r
y y 4 me

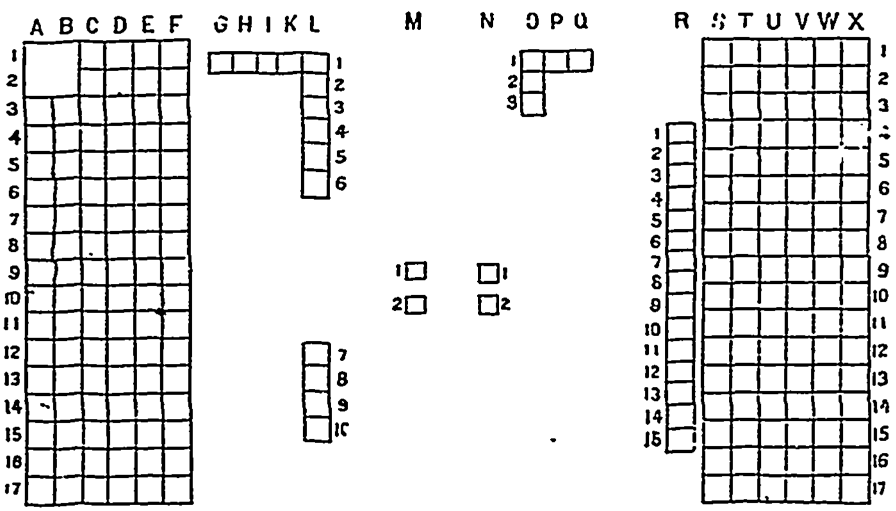
This, being interpreted, reads: "Too wise you are, too wise you be; I see you are too wise for me." This is pretty nearly the way in which the Maya-Quiches wrote, as the sequel will show.

Chapter IV.

THE NEW SYSTEM OF READING THE HIEROGLYPHICS; THE GROUPS ON THE LEFT.

Entirely discarding the material provided by Landa, the writer sought a solution of the Maya problem in Old World systems of writing which are hieroglyphic or have been deduced from hieroglyphic originals, and in this was utterly unsuccessful. His knowledge of the Hittite and its descendants clearly indicated that the Maya system was not related to them, but as the Maya-Quiche languages are preposing, that is, languages making use of prepositions, he expected to find links in Egyptian, Assyrian and Chinese. Nothing definite, however, could be obtained from any of these sources, although the old Chinese symbols, which constitute the bases of the 214 keys or radicals, exhibit some affinity to the Maya system. Discarding external aids, he found that the symbol Ahau occurs several times in the Palenque tablet, and that, in the fourth character from the left in the ninth line on the left side of the inscription, there are two Ahaus, the first being placed under one ball, standing for *hun*, one, and the second resting upon three balls, which as three, should be rendered by *ox*, or should be regarded as the sign of plurality, *ob*. Taking the latter tentatively, the group would read *hun ahau ahauob*, "one king of kings." As *ob* probably comes from *yaab*, meaning "much, abundant," any subscribed number might denote plurality. Now, hieroglyphics may be syllabic, like the Hittite and Aztec, the syllables being the first in the name of the object they indicate, or alphabetic, syllabic, and ideographic, like the Egyptian, or purely ideographic like the Chinese. The presumption established by *hun ahau ahauob* was that the Maya system, like the Chinese, is purely ideographic; and that, if the student can tell what the symbols stand for, and has a knowledge of the Maya phonetic equivalents, he is in a position to read any Maya document. Of course there arises the awkward question, Is this Maya? May it not have been the work of those who spoke Chiapanec, Tzendal, Quiche, or Cachiquel? Palenque is close to Yucatan, and the people who dwell there now speak Maya, so that the method of science says, Begin with Maya; but common sense adds, Do not necessarily end there, if it furnishes defective results.

With a very slight change, Dr. Rau's index diagram of the tablet of Palenque may be found useful for reference.



The "one king of kings," or *hun ahau ahauob*, is D 9. His name should be near at hand, either before or after. To the left at C 9, are the symbols for 13, and a Tau in an oval. To the right at E 9, are those for 9, and the same a little varied. Thirteen in Maya is *oxlahun*, and 9 is *bolon*. The *bolon* hieroglyphic reappears in E 1, in F 12, in G, and, with a different adjunct, *bolon* is in U 2, S 12, and on the pedestal of the smaller human figure on the left. Also, nineteen, or *bolon-lahun*, is in U 14, and *bolon*, in a secondary position, occurs in D 5. This prominence of *bolon* at Palenque suggests the name of the city, especially as there is a place called Bolonchen, or the nine wells, in Yucatan, phraseology similar to the Beersheba or seven wells in Southern Palestine. Can the Tau in the oval be *chen*, a well? If it is, then C 9 is *oxlahun chen*. But *oxlahun* is found in F 15, with 7 or *uuc*, and another cartouche, on the top of R 2, over a similar cartouche, and after six or *uac*, in U 1, in V 7 before an animal's head, in S 10, in T 12 before *ahau*, in W 14 before a woman's back, in the following X 14 before a symbol not unlike that which follows it in U 1, and in V 17 before a circular figure like that in S 10. Now if all of these denote one thing, place, or person, what is the value of the symbols immediately following the *oxlahun*. If the animal be a dog, as is most likely, the value is *pek*, a dog. To this agrees the woman's back, for *pach* is the back of the shoulders. Also *bak* means "to tie with cords," and *pak* denotes "a stone wall, and to found, build, plant or sow." The character after *oxlahun* in U 1 is a corded bundle, and the inscribed oval in S 10 and V 17 may, from the analogy of the Chinese, denote cultivated ground. The group thus selected may be read *oxlahun pek*, or "thirteen dogs," than which nothing could seem more ridiculous.

A knowledge of history comes to the relief of the epigrapher, and saves his work from scorn. There was an *ahau*, or king, and a very powerful one too, whose name was Thirteen Dogs. He was not a Maya king nor a Tzendal, nor even a Quiche; he was king of the Cachiquels of Guatemala, but seems to have held the Quiches and Mayas also in subjection. His name in Cachiquel is Oxlahuh-Tzy, which, being translated into Maya, gives Oxlahun-Pek. He and Cablahuh-Tihax, or Twelve Flint Knives, were colleagues in royalty over the Cachiquels, having succeeded to the dignity of Huntoh and Wukubatz. Cablahuh was the grandson of Huntoh, and Oxlahuh, the son of Wukubatz.[2] In Maya cablahuh is Lahca, and *tihax* is *tok*. In E 10, Lahca is over a very commonly recurring oval, which might at first sight be taken to represent the night sky, but which may possibly be explained by *tox*, to pour out, distribute, divide. In L 7, Lahca precedes *uaxac* or 8; but in D 13, it is once more over the same figure as in E 10. It is somewhat obscure in V 5. Immediately above *Oxlahun-Pek*, *hun ahau ahauob* of C and D 9, are C and D 8. The first, C 8, consists of *ox*, 3, *ca*, 2, and a covering, which in Maya is *buc*, thus making Oxcabuc, which is the nearest thing the Maya can come to Wukubatz. In D 8, appear *hun*, one, and *co*, a tooth, giving Hunco instead of the Cachiquel Huntoh, the name of Wukubatz' colleague. These two groups never appear again.

A commonly recurring group is that in T 1, X 3, W 4, V 6, S 8, U 12, S and V 16, and X 17. It consists of a rolled up mat on the left, and a human face displaying a tongue on the right. A mat in Maya is *pop*, and the tongue is *ak*. Read as *pop-ak*, the word means nothing; but as *ak-pop*, it represents the title of the Quiche kings of Cawek, which was *ahpop*, or the chief of the mat.[1] In S 1, W 3, U 6, 16, and W 17, appears a group regularly preceding this *ahpop*, which consists of a bundle, a hand and a turtle shell. A hand is *kab*, and a turtle shell *ac*, and the bundle may denote *kaxah*, to tie together. The whole word read *kax kabac*, which in the form *Kah Cawek*, "the town of Cawek," would fitly unite with the Quiche title *ahpop*, inasmuch as the house of Cawek alone had the right to that title. Thus V, W, X 17 read as follows: *Oxlahunpekob Kah Cawek ahpop* or "Oxlahun-Pek, the ahpop of the House of Cawek." Oxlahun-Pek, or in the Cachiquel, Oxlahuh-Tzy, was evidently the king who had this tablet erected. He gives to another monarch, out of courtesy doubtless, the title of *ahpop* in S and T 16, where *ahpop* is followed by the bundle *kah*, and the symbol for rain *kaaxha* or *chak*. His name, *Kahkaxha*, reappears in T 11, 13, and with disguise, in W 1. The latter reads Uuclahun Cankaaxha. Now, in Quiche, four is *cah*, not *can* as in Maya, so that, in this case, the Quiche pronunciation seems to have been adopted. Before deciding about kahkaaxha, the two groups preceding *Oxlahun-Pek kah Cawek ahpop* may be read. They are in the index diagram T U 17. In T we have 8 or *uaxac*, followed by a human face, *ich*, and in U, 5 or *ho*, before an oval representing the sun and his rays, *kin*. Now *Uaxac ich hokin* means "I set out into Uaxac," which can but mean Oaxaca, the province which is only separated from Chiapas by Tehuantepec.

Oaxaca had its powerful monarch like Guatemala, and he was Oxlahuh Tzy's contemporary. His predecessors on the throne had been named Zaachilla I., II., and III., but he bore in addition, according to the Mexican annals, the title Cocyoëza. The Maya-Quiche expedient for Zaachilla was Uuclahuh, and Kahkaaxa replaced the Mexican Cocyoëza. The Mexican annals have nothing to say of the combination of these two great powers of Guatemala and Oaxaca. The form Uuclahuh occurs again in W 11, followed by *Ahau*, king. It does not follow that wherever 8 or uaxac appears, it denotes Oaxaca; but it does, apparently, in C 2, where it is followed by *hun*, one, and *ich*, a face. The same title *hunich*, quite differently formed, is in L 6. What it means is hard to say; it may be *hun cdz*, the one established, a governor, resident or ambassador. "Uaxac hunich" denotes some officer of Oaxaca. In D 10 occurs *Uaxac ca ahau*, either "the king of Oaxaca" or "the two kings of Oaxaca." In V 3, *Uaxca ahau* sets forth Kahkaaxha. In T 2, *uaxac pek* doubtless stands for "the city of Oaxaca, *pak*, meaning a building or walled city. In E 16, is another *uaxac ahau*, and another in W 12. In W 15 appears *uaxac tok ob*, preceded by *can*, 4, the whole probably being *can uaxac tox ob*, "the four dividers of Oaxaca." The name appears in the same numerical form in many parts of the inscription.

There is one curious hieroglyphic to which the writer was first led to assign a value through the Chinese symbol for a cloud, in Maya, *muyal*. This is confirmed by its likeness to the hieroglyphic for the month Mol. It occurs in E 2, in D 6, and less distinctly in other places. In D 6, it is preceded by a comb-like figure that seems to have the phonetic value *ca*, which Landa's eleventh letter confirms, and by the representation of a foot *oc*. The reading is *ca Ocmuyal*, "when Uxmal." The *ca* appears in another form in the character occupying A, B, 1, 2, in which it is preceded by *ox* or 3, between which and *ahauob* comes a difficult sign that may mean two ends, and be translated by *xul*, an end. If so, the first hieroglyphic group is *ox kaxal ahauob*, which can only be *ox kuxil ahauob*, "three inimical chiefs." The next characters, constituting C1, are a central aperture, and a single ball, representing one or *hun*. The former probably is intended to represent the navel, and stands for *nak*, the abdomen. It has many forms, as in A 14 and X 2, where its *n* power seems confirmed by its combination with a nose, *nu*. It is also combined with a figure denoting an ornamented ear, as in V 4, S 5, 7, X 7, and S 11, 13. The ear is *xicin*, but *xic* means to split and divide, and *nak*, "to put an end to."

Returning to the beginning of the inscription, D1 is easily read as 6 or *uac* and *tokob*. This plural word must qualify the rebel *ahau* Nakhun, and may be read *Uaxtokob*, "of the Huastecs," who are known to have been very troublesome in the time of Oxlahuh-Tzy and Cocyoëza. "Bolonpak," or the city of Palenque, is E 1, and F 1 commences with *holhun*, 15, which is followed by *bak*, corded, and a common Aztec and Maya hieroglyphic, *tun*, a stone. Holhun appears to denote a place generally called Holom, on the borders of Guatemala and Honduras, in which case *baktun* would stand for the Maya *puchtun*, fighting, quarreling." A different group is F 2. It begins with *ox*, and that which is below may represent the breast, *tsem*, while the upright at the end probably stands for *xul*, the end. If this be correct, the reading is *ox tsem xulob*, which makes no sense, but with necessary latitude, *yok dzau xulob*, they make an end, *xulob*, of devastating, *dzau*, over, or in front of, *yok*. The first nine characters, or groups of characters, may thus be read:

Ox kuxil ahauob, Nakhun Huaxtokob. Bolon pak, Holhun puchtunob Uaxac Hunich nakxicinob ca Uxmal yok dzan xulob: "The three inimical (literally disgusted) chiefs, Nakhun of the Huastecs, the town of Palenque, and Holhun fought and put to death the Hunich of Oaxaca, when they finished devastating before Uxmal."

The third line is brief, but not free from difficulties. Two spaces are united probably as a mark of respect, to join *hol*, the head, and *pop*, the mat. No other reason can be given for two mats instead of one which would have sufficed. The Holpop, or head of the mat, was the chief of a city or town.[6] The group C 3 is familiar in part, the tongue taking the place of the turtle shell, and a circle or wheel, *pet*, surmounting the whole. It thus reads *cah Cawek pet*, but *pet* must stand for *bet-ah*, to make. The symbol D 3 is *can*, 4, and *ich*, a face, while E 3 is two noses and two wheels, the nose being *nu* and the wheel *pet*, to set forth the name of Nohpat, the last king of Uxmal.[7] F 3 consists of *ca*, 2, and a parrot's head. There is a parrot called *xkan dzulop*; and *yaxchun* denotes a beginning, while *tolob* means "lines." The *ca*, therefore, may be the Maya verb substantive or auxiliary, *cah*. The sentence may thus be read: "*Holpop cah Cawek bet Canich, Nohpat cah yaxchun tsolob:*" "The house of Cawek made Canich holpop, who is the beginning of the line of Nohpat." Conache is represented as one of the early Quiche kings and the head of the house of Cawek, but nothing is said of his going to Yucatan or of Nohpat's descent from him.[8]

A and B 4 give, the first, *chi*, the mouth and the second *tsol*, a string, together probably setting forth *tzicil*, obedient, loyal, as *ahauob* follows. In C 4, *Uaxac* is succeeded by *ppoc*, a hat, and *ppul*, an earthen jar, to denote *popol*, the people. D 4 consists of *kab*, the hand, *bak*, which does not need translation, and *dzib*, to write. The day character *cib* may be compared with this, and the word *chibal*, lineage. These make up *kabbak cib*, to which the modern *keban cib*, evil desire, must answer. E 4 gives *ox*, 3, and the symbol for fire, *kak*; and F 4 is composed of *ka*, the trefoil, a mere supposition, and *chilek*, the forehead. Instead of *ox kak kachilek*, we must read *yok coch* or *koch kuxilek*, literally "before carry (or spread) the disloyal." The entire sentence is: *tzicil ahauob Uaxac popolob kebac cib yok coch kuxilek:*" "The disloyal spread their evil desire before the loyal chiefs of the people of Oaxaca."

A and B 5 repeat *kachilek ahauob*, the disloyal chiefs. C 5 is Uaxac, followed by two separated slabs denoting division, *xic*, and marked with the cloud symbol *mol* or *muyal*. The latter means "together, in common." D 5 is *can Bolon tokob*, four dividers of Palenque; and E 5 is *ox*

Buluc tokob, three dividers of Buluc, which perhaps denotes Paraxtunya or Parraxquin, ruled over by Belehe-Gih, whom Oxlahuh-Tzy vanquished and killed.[9] F 5 is *uuc ahauob*, seven chiefs. Taken together, we read: "*Kuxilek ahauob Uaxac xicmol can Bolon tokob ox Boluc tokob uuc ahauob:*" "The disloyal chiefs together dividing Oaxaca (are) four monarchs of Palenque, (and) three monarchs of Buluc, seven chiefs."

A 6 is *kachilek* again; B 6 should be *caan tok*, from *caan*, the sky, which in Quiche is *cah*; the word meant is probably *catac*, and. The cross slabs representing division give *xic*, so that C 6 is *ox xic ahauob*. three dividing chiefs; and D 6 has already been read *Uxmal ahauob*. In E 6, a new character appears, *uinic*, a man, together with *ox* and *ahauob*, making up *Ox Winik ahauob*. Brasseur mentions a great enemy of Oklahuh Tzy, called the Atzih-Winak-Cawek, Cay Hanahpu, more briefly named the Atzih Winak. He ruled over the Tukuches, a branch of the Cachiquels.[10] The last group in the line, F 6, reads *canob xic mol*, they talk, *canob*, of dividing together. The whole line is: "*Kuxilek catac ox xic ahauob Uxmal ahauob Ox Winik ahauob canob xic mol;*" "The disloyal and the three separating chiefs talk division together (with) the chiefs of Uxmal (and) the chiefs of Ox Winik."

Another disjointed sentence is in line 7. A 7 consists of *ox*, 3, *cib*, as in D 4, and *kab*, the hand, making *ox*, or rather *yok cib keb* for *keban*, over the evil desire. Taking B 7 to be the sky and the moon, for the sun is quite different, it may be read *cah u*, is theirs, meaning, which is theirs. C 7 is Uxmal, but probably *pak*, a stone wall, should be added; and D 7 is *Nohpat ahau*. The following E 7 was hard to explain, but seems composed of a drop of water or other liquid on the first slab, the drop being *thun*, but standing for *than*, a word, speech; and an ornamented ear on the other. The latter is *xicin*, so that *than xicinob* is really *than ci cenob*, word pleasant they said. F 7 belongs to the next sentence, so that the whole of this one is: "*yok cib keb cah u Uxmal pak Nohpat ahau than ci cenob:*" "They talked pleasant words to King Nohpat, (or to the chiefs of Nohpat) of the city of Uxmal over their wicked desire." The value of the shield under *ahau* is doubtful; it may possibly denote plurality, in which case it must refer to the chiefs under Nohpat.

F 7 is the well known Cah Cawek, and A 8 is *ak*, the tongue, pronounced *ah* in *ahpop*. But what is B 8? The writer proposed *kulel*, the whole being the well-known word *ahkulel*, a lieutenant or deputy. As *kulel* means to act for another, the idea of a breast or teat furnishing milk to one's offspring may be connected with it. However, it may denote something very different, for which the reader is referred to the researches of Dr. Brinton." The following C and D 8 have already been read as Oxcabuc and Hunco or Huntoh. E 8 consists of *pop*, as in *ahpop*, pol or hol, the head, and the circle or wheel, *pet*, giving *popol bet*, the people make; and F 8 contains *nak*, the abdomen, and *kab*, the hand. This last is evidently a form of *nah*, to desire, which assumes the form *nahuba*, to suit. The sentence runs forward into the next line, in which A 9 is *chi*, the month, followed by *pet*, the wheel, and the well known *tok*. Then come *Oxlahun Pek* and *hun ahau ahauob*. This sentence is: "*Cah Cawek ahkulel Oxcabuc Huntoh popol bet nakab cib betokob Oxlahun Pek hun ahau ahauob*"; "The people make the request of the regents, Oxcabuc and Huntoh, they make the desire (that) Oxlahun-Pet (be) one king of kings."

The next sentence is short. E 9 is *Bolon pak*, the city of Palenque. F 9 apparently consists of *ka*, *pet*, and *tan*, the breast, which make up *kapettan*, and this must be an expedient for *kebanthan*, to plot, commit treason. A 10, if Huntah be better than Hunco, is *toh*, which means "right, just." B 10 is very difficult. It begins with *ho*, 5, followed by what might be *hun*, but which may answer to the trefoil *ka*, and which two dots on the upper part of the head would appear to confirm, as 2 is *ca*. Then comes *chi*, the mouth, and the sign of plurality *ob*. In Maya, *hokzahuba* means "to take oneself away from": the word that is here is *hakachiob*. The sentence may read: "*Bolon pak kebathanob toh hokachiob*"; "The city of Palenque rebel, withdrawing themselves from righteousness."

C 10 is a combination of *kachilek* and *xicin*, the ear, and D 10 consists of *uaxac*, 8, *ca*, 2, and *ahauob*, it thus appearing that the shield subscribed does denote plurality. In E 10 appears *can*, 4, but here uniting with *ob* to signify *canob*, they tell. Then follows Lahca, in Cachiquel Cablahuh, and after it the well known symbol *tok*. F 10 is *lahun*, 10, and *kachilekob*. This may be read: "*Kuxilek xicin Uaxac ca ahauob canob Cablahun-Tox lahun kuxilekob*": "Hearing of the defection, the two kings of Oaxaca tell Cablahun-Tox of the ten rebels." A 11 seems to consist of *hun*, one, *xicin*, the ear, and *ox*, 3. B 11 contains ox, 3, *kab*, the hand, and *xchup* or *chup*, a woman; but former groups, such as D 4 and A 7, indicate that the whole should be read *yok keb cib*, over the evil desire. C 11 reproduces F 10, *lahun kachilekob*; and D 11 is *uaxac*, 8, *ppocc*, a hat, and *chi*, the mouth, but *ppocchi* is an expedient for *paxi*, to abandon, forsake. Hence we read: "*hun xicin ez yok keb cib lahun kuxilekob Uaxac paxi*": "One, hearing of the discovery over the evil desire, the ten revolters left Oaxaca." In A 11 ox is doubtful, and a poor equivalent for *cz*, which *ich*, the eye or face, would better represent.

E 11 is *Uaxac kax*, that is, united, rather than *ox*, 3, *ahauob*; and F 11 is *ox kuxilekob*. The analysis of A 12 probably furnishes *ca*, 2, *bak*, the bundle, and *tun*, the stone, the whole standing for the verb *kebanthan*, to rebel, commit treason. B 12 is pet, the wheel, and *tun*, a stone. Plurality is probably denoted by *yub*, a coat or cloak, as it is sometimes by *yib*, a bean. C 12 is the same with the prefixed *ca*, which means, when; and D 12 contains the *ku* of *kuxilek*, and *tun*, a stone, with plurality. E 12 begins with a kettle, *mazcabcun*, and also contains *kab*, the hand, and *ox*, 3. The latter may represent *kubuc* to deliver; and *mazcabcun* seems to contain the negative *ma*, with edzcab, to do promptly, and *can* to say, hence "promptly refuse." Thus the sentence will be: "*Uaxac kax ahauob ox kuxilekob kebakthan pqtanob ca patanob katunob ma edzcab can kubuc*": "The three revolters rebel (against) the united kings of Oaxaca, refusing to deliver the tributes, when tributes they ask." The word for ask is *kat*.

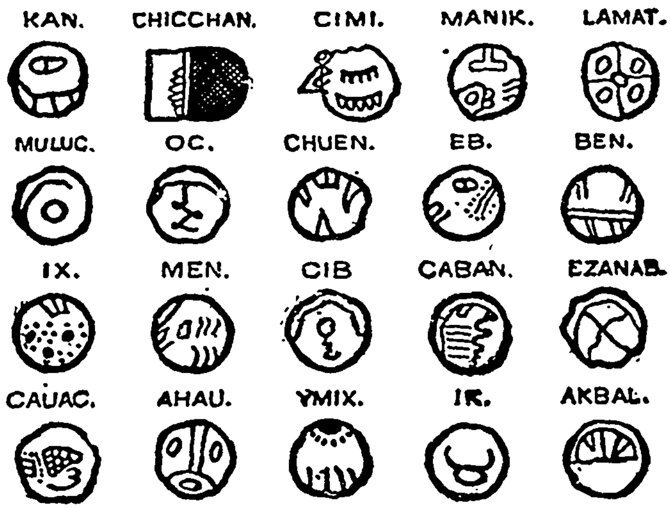
F. 12, *Bolon pak*, begins a new sentence. A 13 is compounded of the mat, *pop*, the jar *ppul*, and Bolon, designating the people of Palenque. The next group, B 13, prefixes *nak*, the end, and *hun*, one, to *popol*. In C 13, the first character is vouched for as *ca* by its two strokes, for 2 is *ca*, and the stone, *tun*, follows, making *katunob*, soldiers or armies. D 13 prefixes *nak*, the end, in the plural, to Cablahun-Tox; and E 13 is another *katunob*. This makes the brief sentence: "*Bolon pak popol Bolon Nakhun popol katunob nakob Cablahun-Tox katunob*": The soldiers of Cablahun-Tox finish the soldiers of the city of Palenque, of the people of Palenque, and of the people of Nakhun."

F 3 is a *ca* sign, followed by a vase or cup, *cul*, and seems to be a proper name, Cacul. A 14 is recognizable as a form of Nakhun; and B 14 combines the figure of a man, *uinic*, with that of *yub*, a cloak. The latter may be part of his name, Hun Ahpu. There is no difficulty in determining C 14 as *ox ahauob*; and D 14 is 18 or *uaxaclahun*, followed by *ox ahauob*. Uaxaclahun must consist of Uaxac or Oaxaca and *lukun*, departing from. The Quiche form *lahuh* would be nearer than the Maya *lahun*. Then follows E 14, *ca*, with *pet*, the wheel, and *chi*, the mouth, denoting an officer of some kind. As the Quiche *cha*, answers to the Maya *can*, to speak, and as this officer is elsewhere denoted by *can*, the number 4, it is probable that the *capetchi* is the *canbezah*, instructor, or the *chunbezah*, leader. F. 14 separates *hun*, by its form, from the following *ca*, 2, and unites it with the subscribed *tun*, a stone. Then *ca* combines with *ich*, the face. These make *hunten* at one time, and *chaac* or *chuuc*, to take. Hence we may read: "*Cacul Nakhun, Winik Yub ox ahauob Uaxac lukuh ox ahauob Chunbezah hunten chaac*:" "The Chunbezah took at one time Cacul, Nakhun, and Winik Yub, three chiefs, three chiefs deserting Oaxaca."

A 15 consists of *ca*, 2, and a symbol for *can*, conversation, with plurality, making *cacanob*, which is the verb *caxan*, to seek, hunt for. B 15 contains *ahauob*, and the sign of division, *xic*, in the plural; and C 15 appears to be *ka-tun-ob*. This short sentence is "*caxanob ahauob, xicob katunob*": "The warriors search for the separating chiefs." In D 15, may be recognized *kab*, the arm or hand, *chup*, the woman standing for *cib*, desire, *ppoc*, the hat, to represent *pach*, taking possession of, and *ahauob*. E 15 consists of *ox*, 3, the conventional *ca*, and *meex*, the beard, making up *yok kamah*, on receiving or taking possession of. F 15 gives Oxlahun, *uuc*, 7, and *tok*; and A 16, with *ox*, and *hulel* (see B 8), makes the postposition yoklal, by means of. Hence the whole is: "*Keb cib pach ahauob yok kamah Oxlahun hayac toc yoklal*": "On capturing the chiefs cherishing evil desire, Oxlahun destroyed (them) by means of burning." To destroy is *hayal*, past *hayac*, and *toc* is the verb, to burn.

B 16 is *uaxaclahun*, with *ich*, the face, but meaning in, and the first divides into *uaxac*, Oaxaca, and *lai*, these *u*, their. In C 16, *ox* stands for *yok*; then comes *hun*, followed by a bird's head, *xul* (see the month so named). The whole is *yok hunkul*, forever. The next, D 16, is *kuxilek*, followed by E 16, *uaxac ahauob*. F 16 gives *ox*, 3, *kax*, united, and *ahauob*; and A 17 is *nak xicin-ob*. These may give: "*Uaxac lai u ich yok hunkul kuxilek Uaxac ahauob ox kax ahauob nakxicinob*": these are they in Oaxaca revolting from the lords of Oaxaca; (whom) the three united kings forever destroyed. B 17 seems made up of *ox*, 3, and *hol*, the head. The only Maya word known to the writer with which *oxhol* at all agrees is *uacchahal*, to emerge forcibly. In C 17, *capetchi* seems to reappear, *chi* denoting border, edge, as well as mouth. The next group, D 17 is unusual, but appears to be *ox tokob Nakhun*, in which case *oxtok* will consist of *yok*, over against, in front of, and *toch*, to contend, hence, an opponent. E 17 must be the same as C 17, *capetchi*, although more like *capethun*; and F 17 combines *ca* with the wing, *xik*, and the face, *ich*, to make the proper name *Caxikich*. Hence: "*uacchal Chunbezah yoktokob Nakhun Chunbezah Caxikich*": "fled precipitately the leader of the rebels, Nakhun, and the leader, Caxikich."

Landa's Maya Alphabet.



Day Characters.

Month Characters.

CHAPTER V.

THE NEW SYSTEM OF READING THE HIEROGLYPHICS: THE GROUPS ON THE RIGHT.

Beginning with S 1, *Cah Cawek* appears, followed by *ahpop*, T 1, and that by Oxlahun Pek; but the bundle does double duty by standing for part of the Cachiquel king's name, and for *puch* in *puchtun*, fighting. V 1 unites the conventional *ca* with *tun*, a stone, to make *katunob*; and W 1 is already known as Uuclahun Cankaaxha, or, according to the Mexican, Zaachilla Cocyoëza. X 1 is easily read as *can ahauob*. In S 2, appears a peculiar group, consisting of the conventional *ca*, and the head of a wild beast of savage aspect; its name ought to be *xikic* or *ichxik*, and that of the tiger-cat is *ckxuk*, which is not very discordant from the latter. It will, therefore, be necessary to correct F 17 by this and read Cakxikich as Caichxik. T 2 gives *buluc*, 11, and the oval inscribed dimly, which may be taken as *pak* rather than as *pet*, a circle. U 2 contains *bolon*, the division, *xic*, and the inscribed *muyal* or *mol*; and V 2 consists of *ax*, with *muyal* again, and *pak*, building. W 2 gives *can*, 4, *kax*, united, and *ahauob*: and X 2 is *nak*, the abdomen, with *ob*.

This larger than usual sentence is: "*Cah Cawek ahpop Oxlahun-Pek puchtunob katunob Uuclahun Cakaaxha can ahauob Caichxik Buluc pak Bolon xicmol Uxmal pak can kax ahauob nakob:*" "The warriors of the armies of Oxlahun-Pek, Ahpop of the House of Cawek, demolished the four chiefs of the Zaachilla Cocyoëza, namely Caichxik, the town of Buluc, the united dividers of Palenque, and the town of Uxmal, four (or closely) united chiefs."

S 3 is *katunob*, they fought, and T 3 is *pak*, building, perhaps *pakmol*, and *lahun* for *lukun*, deserting. In V 3 we have *uaxac lahun* for *uaxac lai u*, Oaxaca these their, and *oxtokob* for *yoktockob*. V 3 is *uaxac ahauob*. Thus: "*katunob pakmol lukun Uaxac lai u yoktockob uaxac ahauob*," They fought the united separating towns, those rebelling against *Oaxaca's* eight chiefs." W 3 is quite familiar, *Cah Cawek*, and X 3 is *ahpop*. S 4 consists of *ho*, 5, and *caban*, recognized from the day so called, an expedient probably for *yok chab*, to take over. T 4 gives *canlahun*, 14, with *kaaxob* for *chuucob*, prisoners. The reading is: "*Cah Cawek ahpop yok chab-en canlahun chuucob:*" "I, the Ahpop of the House of Cawek, took fourteen prisoners." U 4 is *ox kox ahauob*, and V 4 *nak xicinob*, followed by W. 4, *ahpop*, and X 4, *katun*. S 5 is *nak xicinob* again, and T 5 combines *ppoc*, a hat, with *ppul*, a jar, to make *popol*, people. Then V 5 is the conventional *ca*, with *uaxac*, and a circle suspended which may stand for the sun *kin*, and, as *ahkin*, for a priest. This sentence reads: "*Ox kax ahauob nak xicinob ahpop katun nak xicinob popol ca Uaxac ahkin:*" "The army of the Ahpop destroyed the three united chiefs, when the priesthood of Oaxaca destroyed the people."

The succeeding groups present some difficulty. V 5 begins with Cablahun or Cablahuh, adopting the Cachiquel form of 12; below it seems to be *ich*, the face or eye, but with the meaning of, in; and alongside are *ca tun*, or two stones. W 5 has *can*, 4, meaning to tell; *dzib*, writing, but an expedient for *cib*, wish; the symbol of cultivation, *pak*, and *tun*, a stone, with plurality, denoting *puchtunob*, they fight. X 5 seems to be *ox muyal*, the fourth particle differing from the other three. It may be the border *chi*. S 6 is *canlahun*, 14, and *hotokob* for *hotochob*, houses; and T 6 is *ox ahauob pet ahauob* for *yok ahauob bet ahauob*, on account of chiefs making chiefs. The whole is "*Cablahun ich katun can cib puchtunob Uxmal chi canlahun hotochob yok ahauob bet ahauob:*" "He tells the desire to the army with Cablahun, (that) they fight against the fourteen houses of the borders of Uxmal, because of chiefs making chiefs." U and V 6 are *cah Cawek ahpop*. W 6 is *can*, 4, and *baktun* for *puchtun*; but *can* is rather the adverb intensifying what it agrees with, for X 6 is *ox oxtokob*. With these words is connected S 7, *nak xicinob*, which gives plurality to the subject. "*Cah Cawek ahpop canpuchtun ox yoktockob nakxicinob:*" "The Ahpop of the House of Cawek destroys three very quarrelsome rebels." T 7 is Cah Cawek, and the following U 7, made up of *ox*, and an inscribed oval. must surely be a new expedient for *akpop* or *ahpop*, as it is succeeded in V 7 by the full name Oxlahun-Pek. Then in W 7 we have *ox ahauob*, and in X 7, *nak xicinob*. This short sentence is: "*Cah Cawek ahpop Oxlahun Pek ox ahauob nakxicinob:*" "Oxlahun-Pek, the Ahpop of Cawek, destroys three chiefs."

S 8 is the *ahpop*, T 8, *ox*, with the figure for *kin*, the sun; as this is the only verb, it must be the same as *okin*, I entered, or *hokin*, I set out for. U 8 is *uaxaclahun lahun pakmolob* for *Uaxac lai u lukun pakmolob*, those united towns separating from Oaxaca. V 8 is *uaxaclahun ahauob* for *Uaxac lukun ahauob*, the chiefs separating from Oaxaca. Thus the whole is: "*ahpop hokin Uaxac lai u lukun pakmolob Uaxac lukun ahauob:*" "I, the Ahpop, set out for those united towns separating from Oaxaca, of the chiefs separating from Oaxaca." The next sentence presents peculiar difficulties. W 8 sets forth two stones divided, hence *tun*, a stone, and *xic*, division, *tunxicob*. In X 8, the first hieroglyphic is *ca*, and the second *xul*; hence it affords the name of the chief Cacul in F 13. S 9 is *can* with *pak*, but seems to denote the Chunbezah, as T 9 is Oxmuyal or Uxmal. U 9 has *kalkab*, the finger, and *kax*, united, and *ahauob*, chiefs, but *kal* is to imprison, and *chab*, to take. V 9 is *tun*, the stone, and *xicinob*, the ears; and W 9 is *pak*, a stone wall or town. X 9 has the now well known conventional *ca*, and the abdomen, *nak*. The whole reads: "*Tunxicob Cacul Chunbezah Uxmal kal chab kax ahauob Tunxicinob pak ca nakob:*" "The Chunbezah of Uxmal took prisoner Cacul of Tunxicob, when the united kings destroyed the town of Tunxicob."

S 10 is Oxlahun-Pek, and T 10 is Uaxac pak. Then comes U 10, *hopet*, which seems to be an expedient for *ubah*, to hear, understand. V 10 is *ox*, 3, and *ho*, 5, with *tokob*, representing *ox hotochob*, three houses. But W 10 is the abdomen, with *hun*, one, to the right, and the sign of plurality below, hence Nakhunob; while X 10 is *uuc*, 7, and *kin*, the sun. This is *hayac*, destroy, but the final *kin* looks like a mark of the first person singular. S 11 is the well known *nak xicinob*; T 11 is *Cakaaxha*; and U 11 is evidently *pak*, a stone wall, with *tun*, a stone and plurality for *puchtunob*. Hence the reading: "*Oxlahun-Pek Uaxac pak ubat ox hotochob Nakhunob hayackin nakxicinob Cakaaxh* *puchtunob:*" "Oxlahun-Pek (at) the town of Oaxaca hears (that) the warriors of Cakaaxha utterly destroyed three houses of the Nakhuns." V 11 is not Cah Cawek, but *Cah kab*, and, as W 11 is *uuclahun ahau* (see W 1), it must denote the son of Cocyoëza, whom the Mexicans called Cocyopi. X 11 is *uuc* 7, *can*, 4, and a very indistinct *muyal* or *mol*. S 12 contains *bolon* and *oxtokob*. This may be rendered: "*Cahcab Uuclahun ahau hauac canmolob Bolon yoktockob:*" "Cocyopi, the Zaachilla King, ceased parleying (with) the rebels of Palenque."

T 12 is *Oxlahun ahauob*, and U 12 is *ahpop*. V 12 is difficult; *ho* is there, and *pop*, the mat, and *pet*, the wheel; perhaps it is *hopoppet*, or *ubah bet*, makes to hear or understand. W 12 is *uaxac ahauob*, and X 12 is *can kax ahauob*, while S 13 is *nak xicinob*. Together the words are: "*Oxlahun ahauob ahpop ubah bet Uaxac ahauob can cax ahauob nak xicinob:*" "The Ahpop makes the chiefs of Oxlahun to understand (that) the Kings of Oaxaca destroy the very united chiefs." T 13 is the name of the King of Oaxaca, Cakaaxa; and U 13 consists of *ca*, 2, and *pach*, the back, doubtless making *chab pach*, take prisoner. V 13 reads *uaxaclahun*, 18, and *uactokob*, which, in D 1, has been read Huastecs. This brief sentence gives: "*Cakaaxha chab pach uaxaclahun Uactokob:*" "Cakaaxha takes prisoners eighteen Huastecs." W 13 is *nakob*, and X 13, which adds the ear, *nak xicinob*. S 14 gives *can*, 4, and a wavy line descending from the top of an oval, which comparison shews to denote *pak*; the circle in the right hand corner is probably the border *chi*; so that the hole is *canpakchi* or Chunbezah. T 14 is *lahun-pek*, ten dogs, but Brasseur calls the son of Cablahuh-Tihax by the name of Lahuh-Noh? Noh is the seventeenth day of the Guatemalan month, and means a temple; the Maya word for temple is *kuna*, but *na* simply means a house, so that *pak*, a building might answer to it. V 14 reads, *bolonlahun ahauob*, but should be *Bolon lukun ahauob*, the separating chiefs of Palenque. V 14 is *ox kax ahauob*; and W 14 *oxlahun pach* or *pek*. This completes the sentence: "*nakob nakxicinob Chunbezah Lahun-Pek Bolon lukun ahauob ox kax ahauob Oxlahun-Pek:*" "The Chunbezah and Lahun-Pek meet and entirely destroy the chiefs separating Palenque, the three united chiefs of Oxlahun-Pek."

X 14 contains Oxlahun-Pek and Oxmuyalob. S 15 is ox *uuctokob*, which should probably be read *ox hauac tockob*, the three, *hauac*, ceasing, *tock*, to oppose. Cah Cawek is T 15, U 15 is *nakob*, a form of *nakal*, to approach. These words are: "*Oxlahun-Pek Uxmalob ox hauac tokob Cah Cawek nakob:*" "The three ceasing to oppose those of Uxmal join Oxlahun-Pek at the house of Cawek." V 15 is an extraordinary compound of the symbol of cultivation *pak*, the bundle *ca*, and the dog *pek*, with his head tied up, *bak*. The whole may be rendered *pach chabacob*, they took prisoners. W 15 is *can uaxac tockob*, the four opposers, or fighters, of Oaxaca; and X 15 is *hunkal ahauob*, twenty chiefs, "*pach chabacob can Uaxac tockob hunkal ahauob:*" "The four opponents of Oaxaca took twenty chiefs prisoners." S, T, U, V, W 16 are all well known. "*Ahpop Cakaaxha Cah Cawek ahpop nakob:*" "The Ahpop Cakaaxha and the Ahpop of the House of Cawek meet." X 16 is *nakxicinob*; and S 17 is *Caichxik*, who seems to have been the most notorious enemy of the allied monarchs. This briefest of all sentences reads: "*nakxicinob Caichxik:*" "They utterly destroyed Caichxik." The last sentence reveals Oxlahun-Pek as the author of the inscription. T 17 is *uaxac*, 8, and *ich*, the face, denoting *Oaxaca ich*, into Oaxaca. U 17 consists of *ho*, 5, and *kin*, the sun, making *hokin*, I set out. V 17 is the familiar Oxlahun-Pek; and W, X 17 are equally well known as Cah Cawek and Ahpop. This historical statement is: "*Uaxac ich hokin Oxlahun-Pek, Cah Cawek Ahpop:*" "I, Oxlahun-Pek, Ahpop of the House of Cawek, set out for Oaxaca."

Such is the completion of the main inscription of the tablet. Though the explanation of the signs may appear sufficiently simple, it was not arrived at without much careful comparison and analysis. Scholars possessing a more complete and accurate knowledge of the Maya language and its related dialects, may be able to improve, in some respects, upon the reading of individual hieroglyphics, and upon the interpretation of their phonetic equivalents; otherwise the translation given is substantially the meaning of the document. It remains to test the main part of the story with the summary or the addenda contained in the central or pictorial part of the Tablet. These addenda form the subject of the following chapter.

CHAPTER VI.

THE NEW SYSTEM OF READING THE HIEROGLYPHICS: THE DETACHED CENTRAL GROUPS.

The group on the left consists of two divisions. The first contains G, H, I, K, and L 1 to 6; and the second, L 7 to 10. Taking them in order, G is at once recognized as *Bolon Pak*, the city of Palenque. H is *Uaxac kuxilek*. I begins with the conventional *ca*, followed by *ox*, 3, after which comes an entirely new hieroglyphic. This may be regarded as *mol*, a gathering, joining; so that the whole may be read as *ca Uxmal.* K is a fourfold hieroglyphic, consisting of *pet*, the wheel, and *tun*, a stone, followed by two stones or *ca tun*, making up *patan katun*, tribute asking. L 1 is *can*, 4, and *tun*, a stone, and unfortunately L 2 is erased, all except the initial *ho* or *ox.* In Short's North Americans of Antiquity, this L 2 is quite distinct, and is the same as B 8 and A 16, with the prefix mentioned. It will thus read *ahkulel* or *yoklal.* Taking the latter as the true rendering, the preceding *cantun* will be *chunthan*, the spokesman or presiding officer. L 3 is *ca* with *kuxilek*; and L 4 contains *kax*, united, with *ahauob*, and *petob* for *betob*, they make united chiefs. In L 5 may be detected *ox* for *yok*, and *kuxilek*, and *cabob*, for *chabob*, they killed. L 6 is known to be the same as the second part of C 2, namely Hunich. The reading of this troublesome paragraph is: "*Bolon pak Uaxac kuxilek ca Uxmal patan katun Chunthan yoklal ca kuxilek kax ahauob betob yok kuxilek chabob Hunich:*" "The haters of Oaxaca of the city of Palenque, when Uxmal asked tribute by means of the Chunthan, then the haters made united chiefs, and through hatred killed the Hunich."

The second part of this group begins at L 7, which unfortunately is defaced in all the copies so far as the cartouche is concerned. The numbers are clear, the first being *cablahun*, or in Maya *lahca*, 12, and the second, *uaxac*, 8, but here denoting Oaxaca. The defaced cartouche is probably *tokob*, opposers, but might be *ahauob*, chiefs. L 8 contains *ox* for *yok*, and *kuxilekob*; and L 9 has *uaclahun*, 16, over *hun*, 1, *tun*, a stone, and *tokob*. The verb *tok* means, to burn and *uaclahun* or *uaclahuh* must stand for *yoklal*, because of. An unnumbered hieroglyphic is that under the feet of the standing figure, consisting of *ox*, 3, *kak*, fire, and *bolon*, 9. Then comes L 10, in which *ca* is followed by the circle *pet*, and the face, *ich.* The footstool group and L 10 read together *ox kax Bolon chunbezah*, the three united leaders of Palenque. The whole of this short record of vengeance is: "*lahca Uaxac tockob yok kuxilekob yoklal hunten tocob ox kax Bolon chunbezah:*" "The three united leaders of Palenque burned at one time twelve opponents of Oaxaca in consequence of their enmity."

The next group consists of O 1, P, Q, and O 2 and 3. O 2 is *uaxac* followed by *hun*, 1, in a circle, *pet*, making *patan*, tribute or a tributary. P represents in a peculiar way Cablahun-Tok; and Q, with nine balls and a face, furnishes *Bolon ich.* In O 2 may be seen *ox*, 3, *ca*, 2, and *yub*, a cloak, the whole being *ox chaab*, killed three. O 3 consists of *ox*, 3, *pet*, circle, and *kab*, the hand; it is the formula *yok bet keb*, for doing evil. Thus the whole may be read: "*Uaxac patan Cablahun-Tox ox chaabob* *yok bet keb:*" "Of the tributaries of Oaxaca Cablahun-Tok killed three for doing evil."

The group R is a difficult one. R 1 is evidently *pak*, the stone wall, in the plural, *pakob*, towns. R 2 is uac, 6, qualifying the towns, followed by Oxlahun and *tokob*, burned; 3 is *uaxac ahauob*, eight chiefs; and 4 and 5 furnish *Cah Cawek ahau ahpop.* 6 seems to consist of *ca*, represented by the number under the first figure, and *xul*, the bird's head, as in C 16 and X 8; the whole word is probably *cuchul*, family or retainers, in the sense of subjects. 7 contains *ox* for *yok*, and *pet* for *bet*, and *kab* for keban, but to these it adds *ca* and *ox*, if the comb-like *ca* be not read as *nak* or *xul* at the end of a group. The form *caox* might stand for *chuuc*, to seize, or *chaah*, he killed. In 8 the first upright character can hardly be anything else than *ca;* it may stand for *che*, wood. It is followed by *ox* for *yok*, and by what looks like *tok* for *tock.* As obscure at first is 9, which examination shows to consist of *pet*, the wheel, and *tun*, a stone, alongside of the comb-like *ca* over another stone, the whole making *patan katun.* No. 10 suggests *pet*, *pop* and *pak*, but the latter must be regarded not as building but as stone, *tun*, to make *patan*, with *ca tun*, or two stones to precede *pop*, the mat. It will thus be *patan katun pop*, the tribute asker of the mat. In 11 the expedient for the trefoil is *ka*, and to be followed by a hat, *ppoc*, while the upright behind it is either *nak* or *xul*, the end. Perhaps it is *ca paxal*, and depopulate, seeing that it is followed by *cacab*, the commune, in 12, and that it is followed in 13 by the name of Caichxik, the rebel. No. 14 is *ca kuxilek;* and 15 appears to be *pak*, the town. This difficult line may then be read: "*pakob uac Oxlahun tocob uaxac ahauob Cah Cawek ahau Ahpop cuchul yak bet keb chaah ca yok tockob patan katun pop: ca paxal cacab Caichxik ca kuxilek pak:*" "Oxlahun burned six towns of eight chiefs of the subjects of the Ahau Ahpop of the House of Cawek, when they refused the tribute which the tribute-asking Pop demanded: then he depopulated the commune of Caichxik when the town rebelled."

M 1 is no doubt *ho*, 5, *ca*, 2, and *kulel.* This *ho* must evidently stand for *ku*, a god, and his name is Cakulel, identified with Tepeu, Tepac or Tepal, a chief divinity of the Maya-Quiches.[1] M 2 is *ho*, 5, *hun*, 1, *nak*, an end, and *pet*, a wheel, making *Ku Hunakpet*, the god Hunakpet, probably the same as Hunahpu of the Popul Vuh, or sacred book of the Quiches.[2] N 1 may be Ho Pakpetox or Paktunox, but sheds no light on the mythology of Palenque; and N 2 is so obscure that it is hard to make anything of it. Nevertheless, the writer, recognizing N as the deity of the so-called cross, that is Pak or Vaku, the bird messenger of Hurakan, also called Petox and Tunox, supposes N 2 to consist of *hol*, a hole, and *hun*, and thus to denote by Holhun the deity Hurakan, whose name has so far been unaccounted for.[3] Hurakan in Maya must be Holkan, the warrior, and is represented under the pedestal of the left hand standing figure of the group, by fifteen dots, which give the number *holhun*, preceded by 2 *pops*, and followed by *uuc*, 7. This may be read: "*ca popob Holkan hayac Buktanox hayac cankax kulel hun:*" "Two thrones Hurakan destroys, Puchtunox destroys, the very united ruler one." The phallus to the left of the centre pedestal, with a ball subscribed, stands for *kulel*. It is really a representation of syphilis, which as Brasseur and Dr. Brinton have shewn, came to be associated in the minds of the Maya-Quiches with the thought of royalty, and was even applied to the gods. Even now, *kulel* and kindred terms of disgusting origin are employed by the Maya-Quiches in address as honorable titles for ladies and gentlemen.[4] Commencing with a similar figure on the right of the pedestal, and placing *ca*, 2, first, we read: "*Cakulel yoktokob hayac Puchtunox nakob patan hayac Pak hayac:*" "Cakulel destroyed the rebels, Puchtunox destroyed the enders of tribute, Pak destroyed . . . . ."

The group of hieroglyphics to the left of the feathered shaft of the cross consists of a circle or wheel, *pet*, a comb-like *ca*, and a cartouche containing the symbol of division, *xic*. It should perhaps be read *capetxic* for *chunbezah*, the foundation or founder, or ruler. The rest of the inscription along the shaft is difficult. It begins with *ca*, 2, but meaning, when or then, to the left of the bird's legs. Below, a little to the left, are four balls round a circle, giving *can* and *pet*; and, just under the bird, is *chi*, a border. Here then is the Chunbezah again. On either side of the nest-like figure containing two eggs is the symbol for *uac*, 6; and the figure, with the subscribed *hun*, may be read *ca*, 2, *buc*, covering, and *hun*, 1, making *hayac chabuc on*, destroying, we killed, or *chabuc en*, I killed. Far to the left, over the spiked balls, is *tun*, a stone, with four balls about it, making up *cantun*, which may be read *can than*, saying a word, or *chunthan*, the president, spokesman. This is followed by *ca*, 2, and then comes a fancy cartouche that may be read *hun ahau*. Next appear a circle and 1, making *patan*, tribute, after which one would expect *katun*, asked, but a *tun*, or stone, alone appears, which may represent, *than*, speech, used as a verb. The next group is *hun bak-pet*, the latter of which unites with the following stone to make *patan*, so that *hun bak* is one four-hundred. After the *tun* comes a circle with two balls, making *kapet*, answering, as many examples have shewn, to the modern *kebanthan*, to rebel. Once more, *hun bak*, a four hundred, appears, and, below it, two stones, *ca tun*, denoting *katun*, a soldier. The last legible figure in the line is a second *kapet*. On either side of the shaft below is the double cartouche, giving, on the left, *pet*, and on the right, *pak*, and making together *bet pach*, made prisoner. The lower cross-piece answers to 5, making nine with the four balls, so that, with the cartouche *pak* below, it reads *Bolon pak*, the city of Palenque. The whole legend is: "*ca Chunbezah hayac chabuc en* (or *on*) *chunthan ca hun Ahau patan (ka) tun hun bak patan kebat hun bak katun kebat bet pach Bolon pak Chunbezah;*" "then the Chunbezah, destroying, killed, when the president asked the tribute of the one king, four hundred rebelling against tribute (and) four hundred rebellious warriors taken prisoners by the Chunbezah of the city of Palenque."

A group which appears at first sight more of a pictograph than ideographic writing, is that apparently suspended from the bird's tail. It consists of *thun*, a drop, standing for *than*, a word; fourteen balls round a human face, with two more outside of their circle, making up *cacanlahun ich;* and 3, *ox*, followed by 2, *ca*, and *yub*, a dress. The whole of this ingenious rebus is: "*than chacanla Hunich yok chaab:*" "A word making manifest over the murder of the Hunich." From the head of the standing figure on the left rises a three-branched tree. Tree is *che*, 3 is *ok*, and branch is *ak;* hence *cheoxak* may serve to denote that the personage is Cakaaxha. In this case he is the subject of the sentence written in different forms on both sides of the tree. That on the left is *ox*, 3 *tun*, a stone, *pak*, a town, *ca*, 2, and *yub*, a dress. On the right it consists of *ox*, *tun*, *pak*, *ca*, and a shoe, *ya* or *yab*. Thus we read: "*Cheoxak yok tan pak chaab:*" "Cakaaxha before the middle of the city killed." Lower down on the left appears *ox*, 3; and still lower are *thun*, a drop, *pet*, with *hun*, *can*, 4, round a cartouche containing a new hieroglyphic, which may be read as *buc*, covering, followed by, *ca*, 2. These give: "*yok than patan can puchtun ca:*" "Over a word refusing tribute when." Below the mantle folds occur *ca*, 2, *tun*, a stone, *ca*, 2, *pet*, circle, *tun*, stone, the tree figure holding a stone, *tun*, with another *ca*, another *pet*, a fourth *ca*, and a *yub*. Thus we have: "*katun kebatthan puchtun kebat chaab:*" "The army revolting, the quarrelsome revolters he kills."

From the back of the figure on the right hangs a line of beads or wampum, thirteen in number, at the end of which is something like a hand, but as it has an eye, it may represent a dog, *pek*. At the back of his hat is *ca*, 2, and to the right, a group, *ox tun* or *yok tan*, and another below it, *ca pet tun*, or *kapetthan*. Coming back to the space between R and the figure, one meets *thun*, a drop, *pet* and *hun*, followed by *ca* and *yub*. Then read: "*Oxlahun Pek ca yok tan kebatthan tan patan chaab:*" "Oxlahun Pek when before the centre (of the city) the revolters towards tribute he killed." Then comes *ca*, and below it *thun*, *ca*, *pet*, a long *tun*, and *can*. Thus: "*katun kebatthan can:*" "the army to rebel telling." Opposite the ankles of Oxlahun is something that may possibly read *katun ca tsuc* (part) *ca*, or two *katuns* of twenty years, and two *tsucs* or periods of four years, making the event occur in the forty-eighth year of the king.

The Tablet is not yet exhausted. Under the right hand limb of the cross, and between N 1 and 2, and the ornamentation in front of Oxlahun, is a line of characters. A little to the left appear *ca* and *tun*, and then, at the head of the line, *pet*. Below it come *hun* and *tun*, afterwards *ca*, *tun*, a peculiar form of *bak*, next *pet hun*, and finally *pak*. The whole is: "*katun bet hunten ca tun bak patan pach:*" "The army made at one time two to the four hundred tribute prisoners." The corresponding line on the left side of M 1 and 2 presents *xik*, the wing, *hun tun*, *che-ox-ak*, the three branched tree, *ca pet*, and a possible *nak*. These give: "*xic hunten Cheoxak kebat nak:*" "divides at one time Cheoxak the rebels' abdomen." The last obscure line is between the lower part of L and the base of the cross. It consists of *ox* 3, the symbol for division, *xic* and *lahun*, 10, followed by *ca pet*, after which seem to come *ahau*, *pet* and *tun*. The reading may be: "*yok xic lukun kebat ahau patan:*" "Over dividing secession they rebelled against the king's tribute." Other parts of the carving may be significant, but the explanations given may be fairly said to exhaust the text of this remarkable inscription.

CHAPTER VII.

THE TEXT AND TRANSLATION OF THE TABLET.

Taking the story of the Tablet in its order, a commencement is made with the left hand series of ninety-nine groups of characters, read in lines from left to right like European writing.

Ox kuxil ahauob Nakhun Uactokob Bolon pak Holhun
Three disaffected chiefs Nakhun, Huastecs Palenque city Holhun

puchtunob Uaxac Hunich nakxicinob ca Uxmal yok dzan xulob
fought Oaxaca Hunich destroyed when Uxmal before ruining they ended

Holpop Cah Cawek bet Canich Nohpat cah yaxchun tsolob
Holpop house Cawek made Canich Nohpat to be beginning lines.

Tsicil ahauob Uaxac popolob kebac cib yok coch kuxilek
Loyal chiefs Oaxaca peoples evil wish before spread disaffected
Kuxilek ahauob Uaxac xicmol can Bolon tokob ox Buluc tokob
disaffected chiefs Oaxaca dividing together 4 Palenque nomarchs, 3 Buluc nomarchs
uuc ahauob. Kuxilek catac ox xic ahauob Uxmal ahauob
7 chiefs. Disaffected and 3 separating chiefs, Uxmal chiefs
Ox Winic ahauob canob xic mol. Yok cib keb cah u Uxmal
Ox Winic chiefs they talk division together. Over wish evil is their Uxmal
pak Nohpat ahau than ci cenob. Cah Cawek ahkulel
city Nohpat king word pleasant talked. House Cawek lieutenant
Oxcabuc Huntoh popol bet nahub cib betahob Oxlahun
Oxcabuc Huntoh people make request desire they make Oxlahun
Pek hun ahau ahauob. Bolon pak kebathanob toh hokachiob
Pek 1 king of kings. Palenque city they rebel right withdraw.
Kuxilek xicin Uaxac ca ahauob canob Cablahun Tok lahun
Disaffection hearing Oaxaca 2 kings tell Cablahun Tok 10
kuxilekob. Hun xicin ez yok keb cib lahun kuxilekob
disaffected. One hearing discovery over evil wish 10 disaffected
Uaxac paxiob. Uaxac kax ahauob ox kuxilekob kebakthan
Oaxaca left. Oaxaca united kings 3 disaffected rebel
patanob ca patanob katunob ma edzcab can kubuc
tributes when tributes they ask no promptly saying to deliver
Bolon pak popol Bolon Nakhun popol katunob nakob
Palenque city people Palenque Nakhun people soldiers finished
Cablahun Tok katunob. Cacul Nakhun Winic Yub ox
Cablahun Tok soldiers. Cacul Nakhun Winic Yub 3
ahauob Uaxac lukun ox ahauob Chunbezah hunten chaac.
chiefs Oaxaca deserting 3 chiefs Chunbezah at one time took.
Caxanob ahauob xicob katunob. Keb cib pach ahauob
They search chiefs separating soldiers. Evil desire possessing chiefs
yok kamah Oxlahun hayac toc yoklal. Uaxac
on receiving Oxlahun destroyed burning by means of. Oaxaca
lai u ich yok hunkul kuxilek Uaxac ahauob ox
these their in over forever disaffected Oaxaca chiefs 3
kax ahauob nakxicinob. Uacchal Chunbezah yoktokob
united kings destroyed. Fled precipitately Chunbezah rebels
Nakhun Chunbezah Caichxik.[1]
Nakhun Chunbezah Caichxik.

The Right Hand Inscription.

Cah Cawek Oxlahun Pek puchtunob katunob Uuclahun
House Cawek Oxlahun Pek fighting soldiers Zaachilla

Cakaaxha can ahauob Caichxik Buluc pak Bolon xicmol
Cocyoëza 4 chiefs Caichxik Buluc city Palenque dividers united

Uxmal pak cankax ahauob nakob. Katunob pakmol
Uxmal city very united chiefs destroyed. They fought towns together

lukun Uaxac lai u yoktockob Uaxac ahauob. Cah
deserting Oaxaca these their rebels Oaxaca chiefs. House

Cawek Ahpop yok chab-en canlahun chuucob. Ox kax
Cawek Ahpop over took I 14 prisoners. 3 united

ahauob nakxicinob Ahpop katun nakxicinob popol
chiefs destroyed Ahpop army destroyed people

ca Uaxac ahkin. Cablahun ich katun can cib puchtunob
when Oaxaca priest. Cablahun in army tells desire fight

Uxmal chi canlahun hotochob yok ahauob bet ahauob,
Uxmal border 14 houses over chiefs making chiefs.

Cah Cawek Ahpop canpuchtun ox yoktockob nakxicinob.
House Cawek Ahpop very quarrelsome 3 rebels they destroyed.

Cah Cawek Ahpop Oxlahun Pek ox ahauob nakxicinob.
House Cawek Ahpop Oxlahun Pek 3 chiefs they destroyed.

Ahpop hokin Uaxac lai u lukun pakmolob Uaxac lukun
Ahpop I set out Oaxaca these their deserting towns-together Oaxaca deserting

ahauob. Tunxicob Cacul Chunbezah Uxmal kal chab
chiefs. Tunxicob Cacul Chunbezah Uxmal took prisoner

kax ahauob Tunxicinob pak ca nakob. Oxlahun Pek
united kings Tunxicob town when ended. Oxlahun Pek

Uaxac pak ubat ox hotochob Nakhunob hayac kin
Oaxaca city hears 3 houses Nakhuns destroying

Nakxicinob Cakaaxha puchtunob. Cahcab Uuclahun
destroyed Cocyoëza warriors. Coçyopi Zaachilla

ahau hauac canmolob Bolon yoktockob. Oxlahun
King ceased parleying Palenque rebels. Oxlahun

ahauob Ahpop ubah bet Uaxac ahauob can kax
Chiefs Ahpop hear makes Oaxaca kings very united

ahauob nakxicinob. Cakaaxha chab pach uaxaclahun
chiefs destroyed. Cocyoëza takes prisoners 18

Uactokob. Nakob nakxicinob Chunbezah Lahun Pek Bolon
Huastecs. They met utterly destroyed Chunbezah Lahun Pek Palenque.

lukun ahauob ox kax ahauob Oxlahun Pek. Oxlahun Pek
dividing chiefs 3 united chiefs Oxlahun Pek. Oxlahun Pek
Uxmaleb ox hauac tockob Cah Cawek nakob. Pach
those of Uxmal 3 cease oppose House Cawek joined. Prisoner
chabacob can Uaxac tockob hunkal ahauob. Ahpop
they took 4 Oaxaca opponents 20 chiefs. Ahpop
Cakaaxha Cah Cawek Ahpop nakob. Nakxicinob Caichxik,
Cocyoëza House Cawek Ahpop met. Utterly destroyed Caichxik
Uaxac ich hokin Oxlahun Pek Cah Cawek Ahpop.[2]
Oaxaca into I set out Oxlahun Pek House Cawek Ahpop.

THE DETACHED GROUPS OF HIEROGLYPHICS.

G to L 6.

Bolon pak Uaxac kuxilek ca Uxmal patan katun
Palenque city Oaxaca disaffected when Uxmal tribute asked
Chunthan yoklal ca kuxilek kax ahauob betob yok
Chunthan by means of then disaffected united chiefs made over
kuxileh chabob Hunich.[3]
Disaffection killed Hunich.

L 7 to 10.

Lahca Uaxac tockob yok kuxilekob yoklal hunten
12 Oaxaca opponents over disaffections because of at one time
tocob ox kax Bolon Chunbezah.[4]
burnt 3 united Palenque leaders.

O, P, Q.

Uaxac patan Cablahun Tok Bolon ich ox chaabob
Oaxaca tributaries Cablahun Tok Palenque in 3 killed
yok bet keb.[5]
over doing evil.

R.

Pakob uac Oxlahun tocob uaxac ahauob Cah Cawek
Towns 6 Oxlahun burnt 8 chiefs house Cawek
ahau Ahpop cuchul yok bet keb chaah ca
King Ahpop family over doing evil killed when
yok tockob patan katun patan katun Pop. Ca
opposite opposed tribute asked tribute asking Pop. Then
paxal cacab Caichxik ca kuxilek pak.[6]
depopulate commune Caichxik when rebelled city.

M.

Ho Cakulel	Ho Hunakpet
god Cakulel	god Hunahpu

N.

Ho Puch-tunox	Ho Holkun [7]
god Puch-tunox	god Hurakan.

BASAL INSCRIPTION IN PART.

On the Left.

Ca popob Holkan hayac Puchtunox hayac
2 thrones Hurakan destroyed Puchtunox destroyed
cankax kulel hun . . . . .
very united ruler one . . . . .

On the Right.

Cakulel yoktockob hayac Puchtunox nakob
Cakulel rebels destroys Puchtunox enders
patan hayac Pak hayac.[8]
tribute destroys Pak destroys.

INSCRIPTION ON THE CROSS.

Ca Chunbezah hayac chabuc-en chunthan ca hun ahau
Then Chunbezah destroyed killed I president when one king
patan katun hun bak patan kebat hun bak katun
tribute asked 1 400 tribute rebelling 1 400 warriors
kebat bet pach Bolon pak Chunbezah.[9]
rebelling made prisoner Palenque city Chunbezah.

Characters suspended from the Bird-Idol's Tail.

Than chacanla Hunich yok chaab.[10]
Word manifesting Hunich over murder.

Characters behind the Left-Hand Figure:

beginning with the Three Branched Tree.

Cheoxak yok tan pak chaab: yok than patan can
Cocyoëza before middle city kills: over word tribute saying
puchtun ca: katun kebatthan puchtun kebat chaab.[11]
oppose when: army revolting quarrelsome rebel kills

Characters behind the Right-Hand Figure:
beginning with his cue.

Oxlahun Pek ca yok tan kebatthan tan patan chaab:
Oxlahun Pek when before centre revolting towards tribute kills:

Katun kebatthan can : katun ca tsuc ca.[12]
army to revolt telling : katun 2 tsuc 2.

Characters in line to the right of the Ns.

Katun bet hunten ca tun bak patan pach.[13]
Army made at one time 2 to the 400 tribute prisoners.

Characters in line to the Left of the Ms.

Xic hunten Cheoxak kebat nak.[14]
Divided at one time Cocyoëza rebel abdomen.

Characters between lower part of L and base of Cross.

Yok xic iukun kebat ahau patan.[15]
Over dividing secession rebel king tribute.

THE TRANSLATION OF THE INSCRIPTION.

"Three disaffected chiefs, Nakhun of the Huastecs, of the city of Palenque, and of Holhun, fought against and put to death the Hunich of Oaxaca, when they ceased devastating before Uxmal. The House of Cawek made Canich the Holpop, who was the first of the line of Nohpat. The disaffected spread their wicked desire before the loyal chiefs of the people of Oaxaca. The disaffected chiefs, together dividing Oaxaca, are four nomarchs of Palenque, and three nomarchs of Buluc, seven chiefs. The disaffected and the three separating chiefs talk secession together with the chiefs of Uxmal and the chiefs of Ox Winic. They talk pleasant words to King Nohpat of the city of Uxmal over their wicked desire.

The people make the request of the regents, Oxcabuc and Huntoh: they make the request that Oxlahun-Pek be the sole king of kings. Those of the city of Palenque rebel, withdrawing themselves from righteousness. Hearing of the disaffection, the two kings of Oaxaca tell Cablahun-Tok about the rebels. One hearing of the discovery of their wicked desire, the ten disaffected ones leave Oaxaca. The three disaffected ones rebel against the united kings of Oaxaca, refusing to deliver tribute when they demand tribute. The warriors of Cablahun-Tok vanquish the warriors of the city of Palenque, of the people of Palenque, and of the people of Nakhun. The Chunbezah took at one time Cacul, Nakhun, and Winic Yub, three chiefs, three chiefs deserting Oaxaca. The warriors searched for the separating chiefs. On capturing the chiefs cherishing a wicked desire, Oxlahun destroyed them by burning. These are they in Oaxaca revolting from the Kings of Oaxaca, whom the three united kings forever destroyed. The

Chunbezah of the rebels, Nakhun, and the Chunbezah Caichxik fled precipitately.

"The warriors of the army of Oxlahun-Pek, Ahpop of the House of Cawek, demolished the four chiefs of the Zaachilla Cocyoëza, namely, Caichxik, the city of Buluc, the united dividers of Palenque, and the city of Uxmal, four united chiefs. They fought the united seceding cities, those rebelling against Oaxaca, eight chiefs. I, the Ahpop of the House of Cawek, took fourteen prisoners. The army of the Ahpop destroyed the three united chiefs, while the priesthood of Oaxaca destroyed the people. He tells his desire to the army under Cablahun that they should fight against the fourteen houses of the border of Uxmal, because of their chiefs making kings. The Ahpop of the House of Cawek destroys three very quarrelsome rebels. Oxlahun-Pek, the Ahpop of Cawek, destroys three chiefs. I, the Ahpop, set out for those united cities seceding from Oaxaca.

"The Chunbezah of Uxmal took prisoner Cacul of Tunxicob when the united kings destroyed the town of Tunxicob. Oxlahun-Pek, at the city of Oaxaca, hears that the warriors of Cocyoëza utterly destroyed three houses of the Nakhuns. Cocyopy, the Zaachilla king, ceased to parley with the rebels of Palenque. The Ahpop makes the chiefs of Oxlahun to understand that the kings of Oaxaca are destroying the leagued chiefs. Cocyoëza takes eighteen Huastecs prisoners. The Chunbezah and Lahun-Pek meet, and entirely destroy the chiefs dividing Palenque, the three leagued chiefs of Oxlahun-Pek. The three ceasing to oppose those of Uxmal join Oxlahun-Pek at the House of Cawek.

"The four opponents of Oaxaca took twenty chiefs prisoners. The Ahpop Cocyoëza, and the Ahpop of the House of Cawek meet. They utterly destroy Caichxik. I, Oxlahun-Pek, Ahpop of the House of Cawek, set out for Oaxaca.

"The disaffected of Oaxaca of the city of Palenque, when Uxmal asked tribute through the Chunthan, these disaffected ones made united chiefs, and through their disaffection killed the Hunich.

"The three united Chunbezahs of Palenque at one time burnt twelve opponents of Oaxaca, in consequence of their disaffection.

"Of the tributaries of Oaxaca, Cablahun-Tok killed three in the city of Palenque for working mischief.

"Oxlahun burnt six towns of eight chiefs whom he killed, of the subjects of the king, Ahpop of the House of Cawek, when they refused the tribute which the tribute demanding Pop asked. Then he depopulated the commune of Caichxik when the town rebelled.

"The god Cakukel; the god Hunahpu; the god Puch-tunox; the god Hurakan.

"Two thrones Hurakan destroys, Puch-tunox destroys, the very united, one ruler.

"Cakulel destroyed the rebels. Puch-tunox destroyed the refusers of tribute. Pak destroyed . . .

"Then the Chunbezah, destroying, killed, when the Chunthan demanded the tribute of the one king, four hundred rebelling against tribute, and four hundred rebellious warriors taken prisoners by the Chunbezah of the city of Palenque.

"A word, making manifest the murder of the Hunich.

"Cocyoëza, in front of the centre of the city, killed, for speech refusing tribute; when the army revolted, he killed the quarrelsome revolters.

"Oxlahun-Pek, when he killed the revolters against tribute in front of the centre of the city, telling the army to rebel, in the (his) forty-eighth year.

"The army at one time made four hundred and two (or, twice four hundred) prisoners on account of tribute.

"At one time Cocyoëza divided the abdomens of the rebels.

"They rebelled against the king's tribute, on account of dividing secession."

Such is the record of the Palenque Tablet, the story of eight hundred victims immolated at the shrines of the Bird-god Vuch, and his three companion deities, for rebelling against the exactions of two cruel tyrants, Cocyoëza, king of Oaxaca, and Oxlahun-Pek, king of the Cachiquels, and the boastful usurper of the Quiche royal dignity, Ahpop of the House of Cawek. The story is comparatively modern, but, nevertheless, full of interest.

CHAPTER VIII.

ANOTHER RECORD OF THE CACHIQUEL KINGS: THE ALTAR AT COPAN.

There may be many other records of the conquering Ahau Ahpops of the Cachiquels, but the only one known to the writer when he wrote this chapter, is one familiar by sight to students of American antiquities, the hieroglyphic tablet of the altar at Copan. Mr. Baldwin says:

Inscription on the Copan Altar.

"The ruins known as Copan are situated in the extreme western part of Honduras, where they are densely covered by the forest. As already stated, they were first discovered about forty years after the war of the conquest swept through that part of the country, and were at that time wholly mysterious to the natives. The monuments seem older than those at Palenque, but we have only scant descriptions of them.

They are situated in a wild and solitary part of the country where the natives 'see as little of strangers as the Arabs about Mount Sinai, and are more suspicious.' For this reason they have not been very carefully explored. It is known that these ruins extend two or three miles along the left bank of the river Copan. Not much has been done to discover how far they extend from the river into the forest." Mr. Stephens, however, has preserved the inscription of these ruins, which, historically, is more valuable than mere descriptions of buildings.

The inscription, as may be seen in the plate, consists of six lines, each containing six groups of hieroglyphics, which call for the same attention as those of Palenque. The first, that on the left in line 1, begins with the well-known *ho*, *5*, over a cartouche containing writing, *dzib*. It is doubtful whether the subscribed *ox*, 3, should be read as such, or at all. No. 2 is *holhun*, 15, followed by *ox*, 3, and *pet*, the circle; 3 is *ppoc*, a hat, and a cartouche which looks like another *dzib*, but which, in the meanwhile, may be regarded as *tun*, a stone. Then follows group 4, consisting of *buluc*, 11, *hun*, 1, *ich*, a face, and *ox*, 3. In the Palenque Tablet, Buluc is the name of a place, and the Hunich is an official of some kind, an intendant or ambassador. This sentence reads: "*Hodzib Holhun Oxpet puchtun Buluc Hunich:*" "The Ahtzib (writer) of Holhun, Oxpet, fought the Hunich of Buluc." This is the literal translation. Really, it was the Hunich who fought Oxpet. No. 5 is Oxlahun-Pek, again, although the dog, *pek*, is very different from that of Palenque, and more like a parrot, perhaps the bird Vaku. No. 6 is 12, in Cachiquel, *Cablahun*, followed by *ca*, 2, and *tun*, stone. Line 2, No. 1 begins with the comb-like *ca*, in this inscription standing for *can*, 4, followed by *mak*, to eat soft things, to eat without chewing, and by *kab*, the hand or arm, either qualified by *ox*, 3, or by *ob*, plurality. No. 2 consists of *hun*, 1, *xic*, division, *hun*, 1, *kab*, the hand (see line 5, No. 1), and a final comb, that may be *can*, *nak*, or *xul*. Regarding it provisionally as *can*, we may read: "*Oxlahun-Pek Cablahun katun can makkab Hunzichuncabcan:*" "Oxlahun-Pek Cablahun army tells to imprison Hunzichuncabcan." The last name may mean *hun*, the one, *xic*, dividing, *hun*, one, *cab*, country, *can*, powerful, or *nuc*, great. Thus he would be, the one dividing a great country.

The sentence is completed in the two following groups. No. 3 contains *ox* and *pet*, followed by *ca ca*, which must give *chuc* or *chaac*, to kill or the killer. No. 4 is *kalkab*, the finger, *holhun*, 15, *thun*, a drop, and *dzib*, writing. The whole may be rendered: "*Oxpet chuca kalkab Holhun* *tancab:*" "the murderer of Oxpet within the prison of Holhun." A prison is *mazcab*, but *cab* means, to imprison. A new sentence begins with No. 5, which contains *ca*, *uac*, 6, *tun*, stone, *ox*, 3, and, below these, *ca tun*. In 6, a fancy *kun*, 1, unites with the stone to make *huntun*, and four fancy units give *can*, followed by a form of the *mak* which has appeared in No. 1 of the same line. The rendering is: "*ca Uacthanox katun hunten can mak:*" "then (or where) the speakers of Uac of the army at once said no." The Uac speakers were probably Aztecs, whom the people of Guatemala called Yaqui. Line 3, No. 1, by the two stones, gives *ca tun*; below them is the Palenque *nak* in a new form, and at the back is *ox*, 3. No. 2 at once reveals *Uaxac ich*, shewing at the same time that the *ox* or *ob* forming the basis of the face is not to be read. The two together give: "*katun nacac Uaxac ich:*" "the army ascends into Oaxaca." No. 3 furnishes two *cas*, and the well known forehead and the expedient for the trefoil give *kachilek*. In No. 4, *tun* and *tok* appear, with *zik*, the wing, *uac*, 6, and *tun*, a small stone. We know that the comb-like figure of No. 5 here is *can* not *ca*, in comparison with No. 5 of line 5, which represents it by four units. This *can* includes *ox*, 3, and is followed by *tun* with *ca* inscribed; the whole giving *Canox katunob*. The first character of No. 6, however, is *ka*, followed by *pak*, building, and *tun*, a stone, and its *kapaktun* answers to the later *kebanthan*, to rebel. The whole reads: "*ca kuxilek than toxxic Uacthan Canox katunob kebanthan:*" "when the disaffected spread abroad a word to the Uac speakers of the armies of Canox to rebel."

No. 1 of line 4 furnishes Oxlahun, and *buc*, covering, for *pek*, under which comes the wheel, *pet*, for bet, to make. No. 2 is the counterpart of *caca* in No. 3 of line 2, and, like it, stands for *chuca*, murderer. No. 3 contains *ox*, *pet* and *tok*; and the sentence reads: "*Oxlahun Pek bet chuca Oxpet toc:*" "Oxlahun Pek makes the murderer of Oxpet burn." No. 4 is, by a mere conjecture, supposed to consist of *co* and *pan*, a standard, designating the city and district of Copan. It is followed by *ahau Canox*: and No. 6 consists of *hun*, *ich*, and a final figure which may be *nak* or *xul*, the end. These give: "*Copan ahau Canox Hunich nak:*" "Canox, king of Copan, finishes the Hunich." No. 1 of line 5 repeats No. 2 of line 2, namely, *Hunzichuncabcan*, for which a translation has been proposed. Here, however, it seems to qualify No. 2 which reads *hun*, *ich*, the eye, and a peculiar form of the cross, *pak*; altogether, *Hunich pak or pakob*. No. 3, judging by the analogy of the Palenque Tablet, should be *nakxicin*, to put an end to. No. 4 gives *ox*, 3, *can*, 4, *cab*, a bee-hive, and *dzib*, writing; in other words, *yok can keb cib*, over saying an evil desire. No. 5 plainly reveals *can* and *ox*, with three mats or *ox popob*. In No. 6, *pet*, the circle, has *tun*, the stone, at its right, the inscribed *ca* of which connects with a smaller *tun* over the human head. The remaining four units, and this head, as in line 2, Nos, 1 and 6, give *can mak*. Thus : "*Canox ahpopob patan katun can mak*" signifies, "They say no to the chiefs of Canox asking tribute."

No. 1 of line 6 contains *Oxlahun*, *uuc*, 7, for *hayac*, and *pet* for *bet*. This is followed by *Hunich*, for *ox* or *ob* subscribed are evidently out of place. These two groups seem complete in themselves : "*Oxlahun hayac bet Hunich :*" "Oxlahun causes to destroy the Hunich." No. 3 embraces *uaxaclahun*, *ox* and *dzib ;* and No. 4 is *Uaxac ich*. No. 5 contains *ho dzib*, and Oxlahun Pek ; while No. 6 includes *dzib*, *pet*, *kab*, *uaxac*, *thun*, *ox*, *buc*, and a *pet* so small that it might be mistaken for *hun*. The whole reads : "*Uaxac lukun yok cib Uaxac ich Ahtzib Oxlahun Pek cib bet keb Uaxacthanox pach bet :* " He makes prisoners the Oaxacans, on account of (their) desire to desert to Oaxaca, and making a wicked wish to the Ahtzib (secretary) of Oxlahun Pek."

THE TEXT OF THE INSCRIPTION.

Hodzib Holhun Oxpet puchtun Buluc Hunich.
Secretary Holhun Oxpet fought Buluc Hunich.

Oxlahun Pek Cablahun katun can mazcab
Oxlahun Pek Cablahun army tells imprison

Hunzikhuncabcan Oxpet chuca kalkab Holhun
Hunzikhuncabcan Oxpet slayer prison Holhun

tancab. Ca Uacthanox katun hunten can nak.
within. Then Uac speakers at once say no.

Katun nacac Uaxac ich ca kuxilek than toc
Army ascends Oaxaca into when disaffected word spread

Xic Uacthan Canox katunob kepakthan. Oxlahun-Pek
wide Uac speakers Canox armies to rebel. Oxlahun Pek

bet chuca Oxpet toc. Copan ahau Canox Hunich
makes slayer Oxpet burn. Copan king Canox Hunich

nak. Hunzikhuncabcan Hunich pakob nakxicin
finishes. Hunzikhuncabcan Hunich towns destroys

yok can keb cib Canox ahpopob patan katun
over saying evil desire Canox chiefs tribute asking

can mak. Oxlahun hayac bet Hunich. Uaxac
saying no. Oxlahun destroy makes Hunich. Oaxacans

lukun yok cib Uaxac ich Hodzib Oxlahun Pek
desert over desire Oaxaca into Secretary Oxlahun Pek

cib bet keb Uaxacthanox pach bet.[2]
wish making evil Oaxaca speakers prisoner makes.

TRANSLATION.

"The Hunich of Buluc slew Oxpet of Holhun, the Chief Scribe. Oxlahun Pek tells the army of Cablahun to imprison Hunzikhuncabcan, the slayer of Oxpet, within the prison of Holhun. Then the speakers of Yaqui in the army at once refused. The army is ascending into Oaxaca, when the disaffected spread the word abroad for the speakers of Yaqui in the armies of Canox to rebel. Oxlahun Pek causes the slayer of Oxpet to be burnt, and Canox, the king of Copan, puts an end to the Hunich. He destroys the towns of Hunzikhuncabcan, the Hunich, for expressing their evil desire, and refusing the officers of Canox asking tribute. Oxlahun causes the Hunich to be destroyed, and makes prisoners the Oaxacans, on account of their desire to desert into Oaxaca, and for their evil intentions towards the Chief Scribe of Oxlahun Pek."

CHAPTER IX.

THE INSCRIPTIONS IN THE LIGHT OF OTHER HISTORICAL DOCUMENTS: THE HISTORIES OF THE QUICHES AND THE CACHIQUELS.

The principal names upon the Tablet of Palenque have already been identified with names set forth in the native histories of Mexico and Central America. These native histories have been translated and arranged by the Abbé Brasseur de Bourbourg, and, so far as the writer knows, by no one else. In accomplishing this vast undertaking, a task calling for the sympathy and admiration of all students of history, the Abbé made occasional mistakes, some of which, like the mistakes of Herodotus, are evidences of wisdom; and, over these trivial errors, a reputation for learning has been assumed by certain writers who are not worthy to be named in the same category as that which places in its front rank and in its first place the illustrious author of "The History of the Civilized Nations of Mexico and Central America." The material from which the Abbé derived his histories were chiefly Spanish documents written by natives conversant with the oral traditions or written annals of their peoples, and in some cases, actual native records transcribed in the aboriginal languages, but in European characters. His chief error lies in his attempt to identify the gods and culture-heroes of the Aztecs with those of the Maya-Quiche pantheon, quite forgetting that the two populations are of radically different origins.[1]

The chief names found in the inscriptions read are those of Oxlahun-Pek, Cablahun-Toc, Oxcabuc, and Huntoh, with Lahun-Pek, of Guatemala or the House of Cawek, and of Cakaaxha and Cacab of Oaxaca. To these may be added the names of Nohpat of Uxmal and his ancestor Canich. Speaking of the origin of the House of Cawek, Brasseur says that the four great ancestors of the Quiches were Balam Quitze, Balam Agab, Mahucutah, and Iqi Balam. "Balam Quitze left two sons, Qocaib and Qocawib, who were, adds the Quiche book, the fathers and chiefs of the House of Cawek. Balam Agab equally had two sons, Quocul and Qoacutec, who were the chiefs of the House of Nihaib. Mahucutah was the father of Qo-Ahau, chief of the House of Ahau-Quiche; and Iqi Balam was childless."[2] The Abbé's information was derived from the

Quiche MS. of Chichicastenago. It was discovered at St. Thomas Chichicastenago, otherwise called Chuila, where the descendants of a great part of the ancient nobility of the Quiche Kingdom are found. "It is composed of four thoroughly distinct parts; the first has for its subject the creation of things, the appearance of legislators or creators, and ideas more or less cosmogonic of a flood; the second contains the romantic epic of Hunahpu and Exbalanque, preceded by the history of the pride and chastisement of Wucub-Caquix; the third relates the origin and dispersion of the tribes in America; and the fourth is an abridged history of the Kings of Quiche. The book terminates with a list of the sovereigns of three royal dynasties, and the nomenclature of titles and offices of the court. This manuscript, the most precious for what concerns Central American *origines*, is written in very elegant Quiche, and its author seems to have been one of the princes of the royal family; he composed it a few years after the arrival of the Spaniards, at the time when all their ancient books disappeared."[3]

Quoting the document, Brasseur says: "The chief of the House of Cawek received the title of Ahau Ahpop, which his successors continued to bear until the destruction of the Guatemalan monarchy by the Spaniards, with the privilege of conferring upon the first prince of his blood the title of Ahau Ahpop Camha. The lord of Nihaib was decorated with that of Ahau-Galel, and the lord of Ahau-Quiche with that of Ahtzic Winak." Ahau Ahpop consists of *ahau*, chief or king, *ah*, possessor, and *pop*, carpet or mat, and denotes supreme royalty. The chief names in the inscriptions are not those of Quiche monarchs, but of Cachiquels, hence the Quiche MS. must be compared with Cachiquel documents, if such exist. Such an one is the Cachiquel MS. or Memorial of Zecpan Atitlan. "This curious document begins with memorials and some genealogical notices of the princes of the Cachiquel royal family. Afterwards, the history opens up with the creation of mankind, which seems to be simply an abbreviation of the Quiche manuscript, but with certain details not found in it. The long paragraphs that follow are partly transposed, and evidently belong to different works, of which they are only extracts. The history of the Cachiquel princes, and of the revolution which compelled them to secede from Quiche in order to constitute a separate kingdom at Iximche or Tecpan-Guatemala, occupy a great part of it. The author gives strange details regarding the entrance of the Spaniards into the capital, of which he was an eye-witness, as well as regarding subsequent events down to the complete establishment of Christianity. The style of the work is varied and picturesque, and includes at times animated passages. The author, Don Francisco Ernandez Arana Xahila, of the Ahpotzotzil princes of Guatemala, was the grandson of King Hunyg, who died of the plague five years before the Spaniards set foot in the country, in 1519."[5] This King Hunyg whom Brasseur names was the son of Oxlahun Pek.[6]

Brasseur's chief informant in regard to the history of Oaxaca, and especially of the Zaachilla-Yoho Kingdom, is Francisco de Burgoa, whose History of the Province of the Preachers of Oaxaca was published in Mexico in 1671. "This rare work is full of the most interesting details regarding the history and geography of the Kingdoms of Tzapotecapan and Tehuantepec in the State of Oaxaca." Brasseur calls Burgoa the Walter Scott of Mexico. The Zapotec, Mixtec, and allied languages of Oaxaca and its surroundings, are quite distinct from the Aztec or Nahuatl, on the one hand, and from the Maya-Quiche tongues, on the other. Brasseur cites many authorities in addition to the three named, but these furnish the most important materials for his histories of the Quiches, the Cachiquels, and the Oaxacans, and for the elucidation of the records just deciphered on the monuments of Palenque and Copan. For the history of the Mayas of Yucatan, and the related Tzendals of Chiapas, Brasseur was indebted to the work of Ordonez, a native of Cindad Real in Chiapas in the end of the eighteenth century, who wrote the History of the Creation of Heaven and Earth according to the System of the American Peoples, and edited some Tzendal fragments. He was also familiar with some of the Maya Chronicles, which Stephens brought to light, and which Dr. Brinton has published in extenso.[8] However, he confesses that the early history of Yucatan, Honduras, and Eastern Guatemala, the very history we are in search of, is very scanty and obscure.[9]

The inscriptions make no mention of Quiche and Maya kingdoms. Those of Cawek and Oaxaca are alone recognized in them. According to Brasseur's documents, the Quiche Kingdom, called the House of Cawek, existed in the fifteenth century under a powerful monarch, Qikab I., when the Cachiquels were weak. This king, anxious to limit the power of his feudatories, created from among the plebeian warriors distinguished for courage, a class of Achihab or military tribunes of the people. These Achihab became the champions of the oppressed people, and sought for reforms in government, and Qikab's four sons took part with them. In a rage, Qikab threw himself into the arms of the nobility whom he had alienated, and called around him his Ahpop Camha, a Cæsar to his Augustus, the chief of the

House of Nihaib, the Galal Queema, the Ahtzic Winak Achak Iboy, the Elders of the Cachiquels, Wukubatz and Huntoh, and all the Ahpops in Gumarcaah and its environs. By their advice and aid, he seized the chief of the Achihab and hanged them; but the revolution went on as a peasant war in which many *ahaus* and *ahpops* perished, together with their wives and families, and their wealth became the prey of their murderers. "Qikab had set out some days before the massacre for Pampetak; he thus escaped a cruel death. With the exception of this prince and the members of his family, it may be said that the high nobility of Quiche was completely annihilated on this fatal day." Qikab was only saved by the intercession of his sons who had taken part with the revolters. Then the chiefs of the Achihab who remained met and framed a new constitution, appointing five plebeian Ahpops, whom they compelled Qikab and his surviving colleagues to invest with their new dignity.[10]

Among the nobles who had escaped death at the hands of the populace were the Cachiquel princes Wukubatz and Huntoh. These had been the most faithful to the king; and the Achihab who were now supreme sought their fall. A quarrel between a stout Cachiquel baker-woman and an Achihab of the royal guard, who tried to take her bread without payment, led to an outbreak of hostilities. Qikab advised the Cachiquel princes to withdraw from the capital into their own land; accordingly, they retired to Quauhtemalan, which they named Iximche, burning and destroying the Quiche villages on their way. At Iximche, the four Cachiquel princes, Wukubatz, Huntoh, Chuluc, and Xitamal-Queh, convoked their nobility, with their vassals, and finding them faithful, proclaimed the Cachiquels independent of Quiche. Wukubatz was made Ahpozotzil, or king of the bats, and Huntoh was hailed as Ahpoxahil, the king of the Xahila, which was the proper name of the Cachiquel royal family. Wukubatz drew the sword, defeated the Quiche army and took some Quiche towns. This was the signal for the disaffected Tzotzils, Tzendals, Quelenes, and other tribes to disown Quiche sway; and, little by little, the Cachiquels extended their territory and influence. Although deprived of much of his kingdom, Qikab is said to have retained his absolute power over the people, and to have died peaceably at some point of time between 1440 and 1450, leaving, as his successor in the position of Ahpop, a prince named Tepepul II. and as Ahpop Camha, or heir apparent, Iztayul III. Concerning these monarchs the inscriptions are silent.[11]

"Of the two Cachiquel princes," says Brasseur, "Huntoh died first, one cannot tell when. His eldest son Lahuh-Ah (Ten Reeds) succeeded him in his dignity of Ahpoxahil. Wuxubatz, in his turn, paid the debt of nature, and had for successor Oxlahuh-Tzy (Thirteen Dogs), the eldest of the sons he had by his wife, Queen Ximox. Lahuh-Ah lived but a few years; he left, however, a glorious memory, and a son not less glorious of the name of Cablahuh-Tihax (Twelve Knives), who for a long period administered the affairs of the kingdom conjointly with Oxlahuh-Tzy. But the reign of these two princes only began to acquire renown after the death of king Qikab."[12] After the death of Qikab, the Quiches demanded to be led against the Cachiquels. A large army set out for Iximche; but the Cachiquels were prepared for them. The Quiches were defeated with great slaughter, the two kings made prisoners, and the Achihabs and chief dignitaries of state put to the sword. The victors were Oxlahuh-Tzy and Cablahuh-Tihax, with Woo-Imox, and Rokelbatzin.[13] The Quiche kings disappear from history, and their successors, Tecum, Wahxaki-Caam, and Qikab II. have little behind them but the records of their names. Brasseur was ignorant of the fact so clearly stated on the monuments, that Oxlahuh-Tzy became the Ahau-Ahpop of the House of Cawek, that is, the head of the Quiche kingdom.

Referring to the Quiche kings, he says: "The Ahpozotzil of the Cachiquels, Oxlahuh-Tzy, had a longer career, but this career, as well as the trials through which he passed, and of which his illimitable ambition was the cause, reminded his subjects of the greatness and of the misery of the great Qikab. The disaster of the battle of Iximche had spread terror among the Quiches; during many years they found themselves unable to undertake anything against their rivals. The pride of the Cachiquel king grew on this account, and seeing the greater part of the neighbouring lords bow the head before him, he believed himself henceforth invincible; the principal chiefs of his race had recognized the supremacy of the descendants of Gagawitz, and he set himself to reduce by force of arms those who imagined themselves strong enough to maintain their independence in spite of him. Of all his allies, the most powerful, after the princes of the Zutohils and of the Ahtziquinihayi, was Ychal-Amollac, the Ahau of the Akahales; this nation still constituted a considerable part of the Cachiquel stock; it occupied an important territory which extended to the south from the eastern slope of the mountains of Zacatepec to the warm lands, from the volcano of Pacaya to those which border the highway of the Gulf towards the northeast. Their best known cities were Holom, Qaxqan, Ralabalyg, Guguhuyu, and Wukuciwan.'

"Ychal dwelt in the first; there he maintained a brilliant court, which by its splendour rivalled that of Quauhtemalan. But, if his warlike virtues gave umbrage to the Cachiquel kings, his wealth still more excited the envy of the princes of the royal family. Hunahpu-Tzian, Nimazahay, Aheigahuh, Chooc-Tacatic, Tzimahi, Piaculcan, and Xumac-Cham distinguished themselves among his most ardent enemies, and they were the more to be feared, inasmuch as, in their character of ministers and chief counsellors of the Crown, they possessed the entire confidence of the Ahpozotzil and of the Ahpoxahil. Royal susceptibility was already too much awakened in regard to him, and the least pretext would suffice to render him criminal in their eyes. On the advice of the elders, heralds were dispatched to Holom, instructed to provoke Ychal-Amollac, and to make him know that he had to present himself, with the briefest delay, before the tribunal of the king at Iximche.

"He at once took the road to Iximche, accompanied only by five warriors devoted to his person and the most illustrious in the nation; these were Hukahic, Tameltoh, Huwur the Musician, Wailqahol, and Zoroch, who filled the office of cup-bearer. His face, though calm, bore a melancholy expression when he entered the capital of the Cachiquels. On the report of his advance his enemies again assembled a council with Oxlahuh-Tzy and Cablahuh-Tihax, and his death had been resolved ere ever he set foot on the threshold of the palace. He was introduced alone into the council chamber, but from judges the Zotzils had changed to executioners, and he had barely appeared before them when he fell dead beneath their blows. Zoroch, having followed him up, was first killed, and some moments after his companions were thrown lifeless upon the corpse of their master."

"These iniquitous executions spread terror among the Akahals; the most immediate consequence was the reduction of their territory, and the domain of the children of Ychal became the prey of their enemies. They were expelled from the cities they governed, and had assigned to them as their sole dwelling the town of Xarahapit, which the Cachiquels wished to repeople. Lehuh-Noh, the son of the Ahpoxahil, had the command of it; there only they had the melancholy satisfaction of rendering the last offices to the remains of Ychal and his noble companions, and the Akahales were able freely to signalize their grief at their death, together with that of their nationality. A large number of their vassals rejoined them in this place, leaving deserted the lands they had previously occupied; but their oppressors provided for these promptly, they assigned them to Pokoman tribes, whom a fate, analogous to that of the Akahals, had just driven from the fertile province of Cuzcatlan.

"The power of the Cachiquel kings was, for the time being, the greatest in the Guatemalan States. Nothing seemed to be able to withstand the force of their arms, and the will of Oxlahuh-Tzy was respected almost equally with that of the great Qikab, before whom so many people had formerly trembled. The kings of Atitlan, who had maintaind their independence since the dismemberment of Quiche empire, fearing for themselves the consequences of his ambition, laboured to put a barrier to it; they leagued themselves with the neighbouring princes, and from the shores of Lake Panahachel to the Toltec cities on the coast, and to Itzcuintlan in the south, the kingdom of Quauhtemalan could soon count a multitude of enemies in the lordships formerly not attached to its cause. The Ahpozotzil was going, at last, to suffer the reward of his injustice and cruelty. However, he beheld this formidable league without emotion, and set himself courageously to carry on war against those whom he regarded as most powerful and dangerous; these were, on the one hand, Wookaok, Ahpop of the Ahtziquinhayi, and, on the other, Belehe-Gih, prince of Caokeb, who reigned in the neighbouring mountains of Quiche. The latter had his residence in the strong city of Paraxtunya, the position of which rendered it in a measure impregnable; he thought that in it he could brave all the anger of the Cachiquel despot. The hostile army appeared before his walls, and during twelve consecutive days, sanguinary combats took place on the slopes of the chasms surrounding their circle. But Oxlahuh-Tzy was still accustomed to conquer; on the thirteenth day he made a terrific assault upon the fortress; it was carried with frightful carnage, and Belehe-Gih paid for the audacity of his resistance with his life.

"But Paraxtunya was to be the limit of the Ahpozotzil's triumphs While he was glorying in his victory, preparing a heavier yoke than ever for his vassals and his feudatories, the discontent which lay hid in the depths of men's hearts was ready to break forth. The rebellion began in the very bosom of the royal family. Since the reunion of the Cachiquels under the sceptre of Quauhtemalan, the princes descended from Gagawitz continued to call themselves by the generic name of Zotzil-Tukuche; but the Cachiquel tribes assembled in that capital, being divided into quarters, distinguished themselves, according to their divisions, the one class by the name of Zotzils, the other by that of Tukuches. The first, having their quarters round about the palace of the princes of the reigning branch, were placed under their immediate control, while the second had for chief one of the princes of the junior branch, bearing the title of Atzih-Winak-Cawek. Cay-Hunahpu was invested with this dignity at the time when the league formed by the king of Atitlan against the Cachiquels began to spread into the neighbouring lordships. His personal qualities, no less than the extent of his wealth and the multitude of his vassals, added to the influence that his rank gave him in the State. The absolutism of Oxlahuh-Tzy, recalling memories of the period of Qikab, had awakened his ambitious instincts; from that moment he laboured without relaxation to excite the rancour of the nobility and to foment insurrection, in the hope of so profiting by it as to snatch the sceptre from the reigning family. Skilful as he was enterprising, he adopted a policy directly opposed to that of the Ahpozotzil and the Ahpoxahil; he secretly flattered the independent instincts of the high aristocracy; by his mildness and moderation, by his liberality and the sumptuous show of his house, he drew the greater part of them to himself, and everything was ready for a revolt when an incident, quite unimportant in itself, afforded him the opportunity to hasten the denouement and take up arms.

"Since the death of Ychal Amollac and the annexation of his domain to the crown of Quauhtemalan, the Akahales had shown themselves constantly submissive to their new masters; in consequence of a quarrel which had taken place between them and a party of Tukuches, the latter plundered their fields and withdrew after setting fire to their harvests. This cowardice did not fail to be punished; the Akahales from all sides, fell upon the party at the point of Chiqib, by which it had to pass, and, after a fight of short duration, the Tukuches were compelled to take to shameful flight. On their return to Iximche, they carried their complaint to Cay-Hunahpu, and demanded satisfaction for the injury they pretended to have received. The Akahales, on their part, dreading vengeance, placed themselves under the protection of the Ahpozotzil. The Atzih-Winak saw at a glance the advantage to be derived from this affair; he also resolved at once to work it for the profit of his ambitious designs. The council of the king being met, he naturally took his place in it, together with his relatives, the Ahaus Tziriny-Yu and Toxqom-Noh, advocates like himself of the cause of the Tukuches; but the sentence could not be doubtful, justice being too evidently on the side of the Akahales to allow of there being any balance of opinion in their favour.

"This result was foreseen by all; and Cay-Hunahpu naturally desired it from the depth of his heart; nevertheless, he spoke eloquently in favour of the Tukuches, and ended by haughtily demanding that the Akahales be given up to be put to death. A claim at once so unjust and so audacious filled the members of council with astonishment, to whom the plot was still a mystery; the Zotzil princes gazed at one another stupified, but before they had time to come to themselves, the Atzih-Winak left the judgment hall, threatening them with the vengeance of the Tukuches if they did not at once yield to his demand. Oxlahuh-Tzy understood, but too late, the fault he had committed in alienating the nobility; sedition broke out in every part of the city, and he opened his eyes only to see the Tukuches rising in their quarters, running tumultuously through the streets, provoking the Zotzils, and demanding with loud cries the death of the Akahales.

"The news of the insurrection spread like lightning from the capital to the neighbouring regions. All the proud lords whom the iron hand of the Ahpozotzil had momentarily compelled to bow beneath his yoke, already incited by the intrigues of the Atzih-Winak, took to arms, all ready to proclaim him sovereign as soon as victory declared in his favour. Horrified at the turn the commotion was taking, the Zotzil princes found their courage fail; in the hope of escaping the consequences, they humbled themselves before Cay-Hunahpu, and, in order to appease his wrath, sent him the unfortunate Akahales, the nominal cause of the troubles with which they were threatened. But these victims failed to satisfy the haughty rebel—he desired more illustrious ones. Filled with contempt for the king, who thus revealed his weakness to him, and measuring him by his cowardice, he declared him to have forfeited the throne, and left Iximche, taking in his train all the Tukuche population, so as to place, if it were possible, a deeper gulf between them and the Zotzils.

"The women and children withdrew to Tiboquy and to Roxakan, the inhabitants of which had declared in favour of rebellion, while the Atzih-Winak fortified himself with his vassals in the heights adjacent to the capital, from which it was only separated by the river running along the bottom of the precipice; there he awaited the arrival of the allies by whose aid he hoped soon to re-enter the city, in order to set up his throne on the ruins of the Ahpozotòzil's power. But the expectations he had formed were far from realizing themselves to his satisfaction; the helpers on whom he had counted were few and came slowly, and these delays, while discouraging to his soldiers, gave the royal family time to regain confidence and to fortify itself in Iximche. The Cachiquel princes of the mountains of Zacatepec, and those of the warm lands adjoining the volcanoes of Hunahpu, happy to shake off a yoke which they impatiently endured, had raised the standard of revolt; but, if the voice of the Atzih-Winak had succeeded in easily detaching them from their allegiance, it had not the same power to bring them around him. In place of joining their vassals to his, and marching together against the capital, they found it more convenient to profit by the disorder which reigned there, in order to declare their independence, and constitute themselves sovereign in their own States. Thus were formed at that time the great lordships of Tzolola, Mixco, Yampuk, and Papuluka, which remained independent of the Cachiquel kings until the time of the Spanish conquest.

"At the end of some days, Cay-Hunahpu, tired of waiting in vain for his allies, prepared to attack Iximche with the troops assembled under his orders. Their numbers, however, were much superior to those of the Ahpozotzil, and the Tukuches ranked as the bravest warriors of the Cachiquel nation; the most respected portion of the nobility had gone out with them, and Oxiahuh-Tzy had about him only the members of his family and some chiefs of inferior rank. In his destitution he looked to them; to them he confided the most dangerous posts, and one among them named Cinahitoh, having been invested with the office of commander in chief, with the title of Ahpop Achi, was instructed to defend the ford of the river on the descent of the rebels. This ford led straight to the gates of the city, and opened upon a stone bridge which crossed the ravine at a place named Xechipeken. There the first skirmish took place, and both sides fought with equal valour.

"Cay-Hunahpu, seeing the preparations of the Ahpozotzil, understood that henceforth it was a question of victory or death; and that to amuse himself with skirmishes would be to lose his time; he was urgent to deploy his whole force in one day, and as soon as possible to assail the capital. The Ahau Chucuybatzin who was placed at the head of the rebel forces began the first attack. 'On the eleventh day, Ah, morn now having lighted the horizon, the Tukuches awoke on the other side of the city. Soon the sound of the drums and war trumpets of Prince Cay-Hunahpu resounded; they covered themselves with armour, with shining feathers, with dazzling plumes, they adorned their heads with coronets of gold and jewels. Then they on the other side of the river awoke together; it was indeed a formidable sight, the array of those innumerable Tukuches: for they were not to be counted by eight nor by sixteen thousand. Then the battle began before the city, at the end of the bridge, where Chucaybatzin, at the head of the Tukuche troops had transferred the action. Four ladies clad in coats of mail ensanguined their bows and took part in the defence; accompanied by four young warriors, they launched their arrows, which struck the centre of the ranks of Chucuybatzin. It was truly a terrible thing, this great contest raised at this time against the kings. But, having made them prisoners, the general-in-chief exposed the nakedness of these ladies before the ramparts of the Zotzils and the Xahils, whence they had come. All at once there appeared upon the main road, near the great intrenchments, a division of warriors: alone it scattered all the warriors of Tibaqoy and Raxakan; in routing them it lost only two men, and he who led them from the other side of the city, where he prolonged the fight, was still the same who had won the first victory, Cinahitoh, the Ahpop Achi of Xechipeken. This was the moment of a general attack upon the Tukuches; in an instant they were cut to pieces; not one resisted; their rout was complete; men, women, and children were at once put to death. The prince Cay-Hunahpu was killed in his turn, as well as the Ahaus Tziriny-Yu and Toxqom-Noh; all perished, as well as the fathers and the children of these princes. Immediately after, those of Tibaqoy and Raxakan withdrew, the former to Quiche, the latter to the Tzutohils, and mingled among their vassals. Thus they remained dispersed; thus also the destruction of the Tukuches took place! O, my children, and it was our elders, Oxlahuh-Tzy and Cablahuh-Tihax who accomplished it and completed their dispersion.'

"Such, according to the account of the Cachiquel chronicler, was the end of the ambitious designs of the Atzih-Winak Cay Hunahpu. But, while putting limits to the insurrection which had so boldly threatened their capital, the kings of Quauhtemalan had not yet annihilated rebellion nor restored peace to their States. The triumph they had achieved was not sufficient to compensate for their past humiliation; it did not succeed in regaining the prestige they had lost by their cowardly surrender of the Akahales to the Tukuches. While the remnants of the rebellious tribe withdrew to Chiawar, cutting to pieces at Yaxontzul the Quiches who sought to hinder them retaking possession of this district formerly occupied by their fathers, the Cachiquel ahaus, not long since tributaries of the Ahpozotzil, prepared to maintain by force of arms that independence which the revolt of Cay-Hunahpu had enabled them to reassume. Oxlahuh-Tzy, really incapable of undertaking any important war, had enough to do to bring back under his standard the chiefs whom old obedience to the princes of his family had not yet entirely alienated from his person. But, before being able to turn his attention outside of his capital, he had to contend with internal difficulties, the fatal results of the spirit of insubordination that the revolt had planted in many hearts. After the defeat of Cay-Hunahpu, the Ahpop Achi Cinahitoh, whose valour had so greatly contributed to the triumph of the royal arms, had conceived the hope of being raised to the rank of Atzih Winak as the reward of his services; but, whether the Cachiquel kings, remembering the revolution which had driven their fathers from Chiawar in the reign of Qikab I, feared to bestow too much honour upon a plebeian chief, or sought to avoid wounding the nobility which had so recently suffered a terrible check, they conferred this dignity upon the Ahau Ahmoxnay. Cinahitoh allowed a lively expression of dissatisfaction at this choice to escape from him. Envious persons, whom his glory threw into the shade, hastened to report his words to the king; the Ahpozotzil, whom probably gratitude already burdened too heavily, saw in them danger to his crown, and an outrage to his kingly majesty. The fate of Cinahitoh was at once determined, and the thirty-sixth day since his arm had delivered Iximche had not passed before this illustrious chief fell a victim to the jealous suspicions of the princes to whom he had restored a throne. (From 1499 to 1500 A.D.)"

"Less than a year after this execution, Ahmoxnay, accused of high treason, was in his turn led to death. The high dignity of Atzih-Winak offended the despot, since Cay-Hunahpu had sought to make use of it in order to seize his crown; he spared no means to preserve his authority, and by shedding the blood of the most noble in his kingdom, he terrified the ambitious ones who cherished the least desire to raise their eyes too high. Nevertheless, he did not succeed in reconquering all the provinces he had lost; the less important lordships came back under his domination, but most of those of the mountains of Zacatepec united under the sovereignty of the Prince of Yampuk, who governed them until the conquest, under the title of Galel-Achi. In that quarter he only retook Mixco, which was the domain of the Ahpoxahil Cablahuh-Tihax, as well as the territory of the Akahales, who had risen with their chief Wookaok, at the instigation of the inhabitants of Xiwico; these again were helped by a body of Mexicans, who apparently formed part of the great armed caravans which, at that time, traversed the shores of the Pacific founding trading posts.

"It was the beginning of the sixteenth century, so prolific of events in both worlds, but especially in the western continent, where the native races were about to pass altogether under the yoke of strangers. Everything seemed to conspire to bring about this great event; on one hand the ambition and despotism of the kings; on the other, the jealousy of the inferior classes towards the nobility, whose pride and privileges, while they crushed them, excited universal discontent and unrest. Most of the memoirs of this period shew us on all sides rebellion, either open or ready to break forth, as well as civil or foreign war at the threshold of every State. The Cachiquel kings, at strife with all their neighbours, and contending with their rebellious vassals, prepared the way for Spanish conquest, and gave a prelude to the cruelties of Alvarado by removing the heads of the most illustrious. The Tzutohils, after having profited by the insurrection of the Tukuches to take possession of Zakcab, in the following year (1500-1501) saw the Ahpozotzil fall upon them and cut their armies to pieces; Zakcab was retaken, and its defenders, commanded by the Ahaus Nahtihay and Ahgibihay, put to the sword. Wookaok, king of the Ahtziquinihayi, afterwards besieged in Atiblan, on the other hand, routed the Cachiquel forces.

"In Quiche the situation was not more satisfactory. In fact, since the defeat of the successors of Qikab I. national sentiment had revived, and royalty had recovered its authority over a portion of the ancient feudatories of the empire. But, under the reign of Wahxaki-Caam, and of the Ahpop Camha Qikab II., a new revolt broke out, the reasons and details of which are little known. The Tukuches returned to Chiawar profited by it to establish themselves there more solidly, and had themselves visited the scene of the insurrection for the purpose of taking part in it. The Cachiquels, whose brothers they always were in spite of their dissensions, made use of them to excite disorder among their neighbours. Each hated the other with equal hatred, the Quiches being unable to forgive them for having been the first to break the ancient unity of the empire."

Brasseur then proceeds to tell the story of the Xahoh Quiche Winak, the speaking ballet of the Quiches. It is that of a Cachiquel prince, supposed to have been a son of Oxlahuh-Tzy, who was a famous magician, and, as such, annoyed King Wahxaki-Caam of Quiche, by transforming himself into a noisy beast or bird and making night hideous on the roof of the Ahpop's palace. A Quiche magician, of greater skill, at the urgent request of the monarch, caught the Cachiquel intruder, and brought him before the court. Arrayed in costumes representing eagles, tigers, and lions, the warriors danced about the victim preparatory to sacrificing him on the altar of their gods. In the midst of his sufferings, the captive prince beckoned with the hand, and cried in a voice of authority: "Wait a moment and hear what I have to say to you. Know that the time is near when you will give yourselves up to despair because of the calamities that will fall upon you. This hateful old man" he added, indicating the king, "will die first, however. Learn that those who shall come will not be half naked like you, but clothed and covered with complete armour from head to foot, men terrible and cruel. Perhaps it will be to-morrow, perhaps after to-morrow, that they will appear. These are they who will destroy these stately buildings, and leave these palaces to the wildcats and the owls. Then this greatness of which you are so proud will end, then the glory of this kingdom will disappear forever."[15]

Elsewhere, Brasseur takes up the story of the Cachiquels. "After terrible shakings, three powerful kingdoms remained facing each other, but ever ready to take up arms to avenge past injuries and commit new ones. These were the kingdom of the Quiches, more properly called that of Gumarcaah, known to the Spaniards as that of Utlatlan; that of the Tzutohils, a fraction of the Cachiquel stock, the capital of which was Atitlan on Lake Panahachel; and, finally, that of the Cachiquels, the chiefs of which resided at Iximche, otherwise called Tecpan-Guatemala. . . . After Qikab II. the throne of Quiche had been occupied by Wucub-Noh, and the dignity of Ahpop Camha was borne by Prince Cawatepech, to whose name the chronicler Fuentes adds that of Qikab; Wookaok reigned over the Tzutohils; and the Cachiquels continued to have for kings the Ahpozotzil Oxlahuh-Tzy and the Ahpoxahil Cablahuh Tihax. . . . . . In the midst of the struggles of the Ahpozotzil with his vassals, the Mexican garrisons of the neighbourhood willingly offered their aid to the feebler against the stronger; thus, they had helped the Akahales, so cruelly humiliated some years before, to shake off his tyrannical yoke. Oxlahuh-Tzy, momentarily cast down by the revolt of Cay-Hunahpu, had since recovered all the energy of his character, and spared no efforts to break the power of his former tributaries and bring them to his feet. They remained independent in spite of his efforts; but he took his revenge on those that had not succeeded in breaking his iron yoke by making it harder than ever for them. He compelled them to leave their domains and come to live in Iximche, where he kept them under his eye, without allowing them to withdraw for a moment from his presence. This despotism, which the native author himself points out with astonishment, lasted four years; it only ended with the life of the Ahpozotzil in the year 1510. Oxlahuh-Tzy, whom his descendants regarded as one of the greatest monarchs of Cachiquel, had arrived at an advanced age; by his wife, Queen Makuxguhay, he left two sons, Hunyg, who was his successor, and Beleche-Qat, as well as four others by two concubines. Two years after, Cablahuh-Tihax followed him to the tomb, leaving the dignity of Ahpoxahil to his eldest son Lahuh-Noh, who reigned conjointly with Hunyg. The vassals of the crown, who no longer felt the pressure of the terrible hand of Oxlahuh-Tzy, profited at once by the change to relax the bonds that held them, and resume their independent life, working with emulation to enfeeble royalty and thus prepare the way for foreign domination. At the beginning of the reign of these two princes, the Mexican ambassadors, of whom we have made mention in the history of Montezuma II., arrived at Iximche."[16]

Such are the materials furnished by Brasseur to illustrate the life of the chief actor in the events narrated on the tablets. There are discrepancies between the two stories, and, as the evidence of a contemporary monument is always more to be trusted than that of a later document, several important corrections in the latter must be made in the light of the former. Other portions of the history of the civilized nations of Mexico and Central America must yet be examined, however, prior to any reconstruction of the careers of Oxlahuh-Tzy and his colleagues.

CHAPTER X.

THE INSCRIPTIONS IN THE LIGHT OF OTHER HISTORICAL DOCUMENTS: THE HISTORIES OF THE OAXACANS, MAYAS, ETC.

The earliest traditions of the people of Oaxaca relate to the arrival in their midst at Yopaa, the great remains of which are now known as Mitla, of the prophet Wixipecocha, venerable, white of complexion and beard, attired in a long robe and a mantle which partly covered his head like a capuchin. His preaching was similar to that of Gotama Buddha, and when he disappeared on the enchanted island of Monapostiac, he left behind him the priesthood of Yopaa under a supreme pontiff called the Wiyatao.[1]

" It is impossible to tell how long the power of the Zapotec kings had lasted before these princes began to extend their conquests ; nor is it less difficult to assign an epoch for the origin of the Zapotec kings, nor to determine by what course of events they found themselves in possession of sovereignty in the regions in which the pontiff of Yopaa held sway. The high priesthood, from lack of male children, having become their heritage some years before the discovery of America, it may be inferred that the stock of the kings of Zapotecapan sprang from the Wiyataos, one of the younger sons of whom was probably invested with the principality of Zaachilla-Yoho, under the sovereignty of the pontiff king.[2]

"The first royal name that is met with in our documents in a definite form is that of Ozomatli, who reigned, it is said, at Mictlan, at the time of the great defeat of the Mixtecs by the warriors of Teohuacan in 1351. Whether this prince was the pontiff of Yopaa or the king of Zapotecapan, we cannot tell. Zaachilla is the first Zapotec monarch who afterwards figures with some brilliancy in the vague fragments of their annals that have survived; there is every reason to believe that it was he, or one of his predecessors of the same name, who built the city of Zaachilla-Yoho, the capital of that country, The author whom we follow in his narrative attributes to him the conquest of Nexapa, and the reduction of the Chontals."[3]

Passing over two other Zaachillas, the ally of Oxlahuh-Tzy comes into view. "The Zapotecs, irritated by the numberless barbarities of the Mexican king Ahuitzotl, had resumed the offensive. Cocyoëza had just mounted the throne of Teotzapotlan, left vacant by the death of Zaachilla III. A warrior not less skilful than his predecessor, he had formerly distinguished himself at the taking of Tehuantepec, and had acquired, in spite of his youth, the reputation of a chief as prudent as he was brave. More moderate than his father, he sought, from the first day of his accession, to conciliate his neighbours: he renewed the old alliance, broken by the ambition of Zaachilla, and laboured in concert with them to increase the honour of the nations he commanded. His most ardent desire was to deliver his country from the yoke of the stranger and to drive the Mexicans from the fortress which they held in the heart of his dominions. They did not delay to give him the opportunity for so doing. Since the expedition of Ahuitzotl, Tehuantepec had remained in their hands: they had made a strong place of it, occupied by a large garrison, intended to hold the Zapotecs in check, and to protect the passage of subjects of the empire who traded on the borders of Soconusco and Xachiltepec. An unfortunate campaign against these regions, undertaken anew by the Mexican generals, by weakening their forces and diminishing their prestige, taught the people that they were not invincible; some unhappy efforts made to repair former defeats had the result of exhausting their garrison and of discrediting them in the eyes of their enemies.

"These enemies were quite ready to profit by the circumstances. Cocyoëza was on the watch, looking for the moment to thrust himself upon their prey and tear it from them. The uprising of the people against the traders of Anahuac was then, as ever, the prelude to hostilities. On every side they fell upon their caravans; they plundered their merchandise, scattered their escorts, tracked them into the woods and mountains, and massacred in cold blood those in the towns who had been unable to escape the first impulse of revenge. Then appeared a remarkable instance of what constancy joined to skill and valour can accomplish. A caravan leaving Tlatilolco arrived in the south, a short distance from the shores of the Pacific, on the way to some one of the towns on the coast of Anahuac-Ayotlan, whither it was drawn by the great fairs in which such caravans annually took part. In face of the danger that threatened them, the Tlatilolcas made a resolute determination; the city of Quauhtenanco, which they had just entered, was strong and capable of being easily defended. They were but few in number, but their courage made up for numbers, and they were well aware of the kind of enemies they had about them. Without hesitating a single instant they threw themselves upon the inhabitants at unawares, disarmed them, and made themselves masters of the place; the chiefs were kept in sight in a palace, and their persons answered for the future good behaviour of their vassals, until their situation could be made known in Mexico and relief be sent to them.

"During this interval the insurrection spread over all the provinces of Mixteca and Zapotecapan. After a succession of sanguinary engagements, Cocyoëza was restored to the possession of most of the towns of the kingdom of Tehuantepec; the garrison of this capital, reduced by starvation, was obliged in its turn to surrender, and there soon remained to the Mexicans no more than the isolated fortresses of Huaxyacac and Teotitlan, with the place Quauhtenanco where the brave Pochtecas of Tlatilolco continued to defend themselves with rare heroism. The adjoining towns joined forces in vain to drive them from their position, where it was felt that their presence was a blot on the honour of the country; Izoatlan, Xochitlan, Amaxtepec, Atlan, Omitlan, and Mapachtepec exhausted themselves before its walls, without succeeding in making a breach. All these efforts only served to make more illustrious the heroism of this handful of traders; for four consecutive years, they succeeded in maintaining themselves in spite of their enemies, and in thwarting their designs; they not only repelled them with incredible vigour, but, more than once in their sorties, they succeeded in capturing from among their assailants famous chiefs whom they fattened in order to drag them afterwards to the altars of the inhuman divinities of Tenochtitlan.

"The news of these events came to Ahuitzotl in the midst of his troubles over the war with the province of Oztoman. His indignation and rage were equal. But, too much occupied in restoring his authority over the regions dependent upon the great city, he found himself unable to go to Zapotecapan in person; he contented himself, in the meanwhile, with sending thither his most capable officers, with orders to spare nothing in reducing the revolted country, and in gaining possession, at whatever price, of the person of Cocyoëza. An army of sixty thousand fighting men once more climbed the rugged mountains of Mixteca, and, without resting for an instant, marched on Zapotecapan. This was the second time that magnificent country became the prey of a foreign soldiery; this time, however, its capital seems to have been spared. Instead of entering by Huaxyacac, the Mexicans took the road to Teotitlan. For the first time perhaps in their existence the venerated sanctuaries of Yopaa were sullied by the presence of a fierce conqueror; those of the inmates who had time to fly went and hid themselves among the crags of the neighbouring mountains: but a great number of priests perished in their sacred abodes, and the ancient memories of the prophet of Tehuantepec and of Pezelao could not save the Wiyatao from the fated lot of his worshippers. History has not preserved the record of these terrible days; but it is known that the Mictlan prisoners went, that year, to swell the files of victims destined for the altars of Huitzilopochtli, and that the pontifical family suddenly became extinct, in the midst of the disorders occasioned by the Mexican invasion. From lack of more direct heirs, the Zapotec priesthood passed to the royal family, in which it remained until the death of the last of these chiefs.

"Cocyoëza saw, without being able to hinder them, the outrages with which the ministers of his religion were treated; but, foreseeing that the Mexicans would not leave him long in the enjoyment of Tehuantepec, he had taken measures to receive them, and prepared to teach them at last to respect the rights of his nation. Three miles from this city, the road which leads to the interior of Zapotecapan enters a deep gorge through which the river Nexapa flows rapidly. On each side rise steep hillocks, forming a succession of impassable plateaus, which extend to the neighbourhood of Xalapa. There the king of the Zapotecs had raised his chief defensive works. The whole mountain had been converted into a double line of formidable fortifications, which dominated the valleys and plains below. Into one of these he had withdrawn the greater part of his army, with provisions and supplies for a year. Twenty thousand Mixtecs occupied the other bank, the bold crests of which extended like promontories into the plain. For further precaution, he had had all the ground capable of cultivation over this vast enclosure planted with maize and frijol (beans), and had put fish in abundance into the natural ponds that were found on the summit of the most lofty of the chain. Seen from the city, from which it is only some fifteen miles distant, this portion of the mountain, bearing in the country the name Guiengola, has the form of a truncated cone, level at the summit; it is a table land surrounded by frightful precipices, and generally enveloped in clouds. There may be seen even to-day the fine ruins of the fortress of Cocyoëza, and the remains of the palace in which that prince awaited the arrival of the Mexicans and the Acolhuas.

"*After having sacked the temples of Yopaa, these continued their* march to Tehuantepec. On their descent from the mountains, they saw themselves at once assailed by a myriad of invisible enemies; projectiles of all kinds were shot at them, and masses of stone rolled down upon them from the mountain tops. Already harassed by a long march, the end of which they had been looking forward to, when they arrived in the plain of Dani-Guivedchi, they not only found themselves deceived in the most cruel way, but instead of rest and the pleasures they had hoped for in this happy country, instead of enemies half conquered by the terror of their name and fleeing in dismay at their very aspect, they found hosts of warriors filling all the defiles, perfectly sheltered behind their ramparts, whence they were able at any moment to fall upon and crush them, without leaving them time to place themselves in the attitude of defence. Henceforth sides were changed. From aggressors, as they thought themselves, they were now compelled to look to their own safety; far from thinking of attacking Tehuantepec they had not hands enough to set to work trenching the plain, so as to shelter themselves from the fury of the Zapotecs. This was the work of the first who came safe and sound from the gorges of Guiengola, but, owing to the advance guard's ignorance of the preparations of Cocyoëza, a large number perished before they could escape from these dreadful precipices.

"Once delivered from this danger, the Mexican army did not find much amelioration of its circumstances; on all sides it was surrounded by enemies, and was incapable of acting with any chance of success, whether it determined to besiege Tehuantepec or return on the road to Anahuac. Decimated by unexpected assaults, of which it had been the object since its arrival, deprived of provisions which it had expected to find in the capital, harassed incessantly by a powerful enemy that allowed no relief to reach it and allowed it no rest night or day, it looked forward, not without dread, to the moment when it should fall altogether into the hands of the Zapotecs. This was not all; in their nightly excursions, the warriors of Cocyoëza, darting from their rocks by paths known only to them, fell without warning on the enemy's works, like tigers on their prey. They were not content with killing the Mexicans, but, in the barbarous pleasure they experienced in their distress, they took them captive to bring them alive into their fortress, where they made them suffer a thousand tortures before putting them to death; afterwards they salted their flesh to preserve it, or ate it in cannibal feasts, and made use of their bones to build an edifice commemorative of their victory, in reprisal for the sacrifice of so many human victims led by Ahuitzotl to the temple of Huitzilopochtli. One of the chief officers of the army, having been made prisoner, was purposely led, by order of the king, through these ghastly remains: he was allowed to survey at his ease the formidable ramparts erected by the Zapotecs, as well as the vast resources they had amassed; after which he was allowed freely to return to his own people, to whom he described with terror the things he had seen.

"The news was carried to Mexico. Anahuac was in consternation. Three times the heads of the empire sent more numerous troops to the relief of the army shut up before Tehuantepec, but they were unable to penetrate the defile, and if some succeeded in forcing a passage, it was only to be slowly wasted away with their brethren, after being decimated at the feet of the Zapotec fortresses on their entrance to the plain. This terrible situation lasted seven whole months, during which the imperial armies succeeded in exhausting themselves. Then Ahuitzotl, sensible of the uselessness of his efforts, and professing a hypocritical admiration of the constancy and courage of Cocyoëza, sent to him to make proposals of peace. Before concluding any arrangement, the Zapotec monarch, profiting by the state of humiliation to which the Mexicans were reduced, descended from Guiengola at the head of a numerous body of Chiapanec auxiliaries, and went to make the conquest of Soconusco, which was added a second time to his kingdom.

"The ambassadors of Ahuitzotl, having arrived about this time, concluded the treaty in their master's name. It is not known what the details were. It appears, however, from the evidence of later events, that the kingdom of Tehuantepec remained a definite acquisition of the kings of Zapotecapan: the province of Soconusco was returned to the Mexican empire, which stipulated for its merchants free passage through Zapotec territory, guaranteeing their non-interference in any of the affairs of the kingdom; it kept also the citadel of Huaxyacac, too important from a political point of view to be parted with. The only condition clearly announced by the chroniclers was the obligation imposed upon Cocyoëza to accept as his wife a princess of the royal family of Tenochtitlan: it would be hard to understand the persistence of Ahuitzotl on the execution of this article, did not subsequent events in history sufficiently reveal his perfidious designs in connection therewith."[4]

Brasseur gives a romantic account of the meeting of Cocyoëza and Coyolicatzin, the sister of Montezuma, whom the Zapotecs afterwards called Pelaxilla. They were married, and at once the treachery of Ahuitzotl appeared in his attempts to induce his niece to put her royal spouse to death. The queen remained true to her husband, and the treacherous Mexican was compelled to surrender all hopes of becoming ruler over the Zapotecs of Oaxaca. The son of Cocyoëza and Pelaxilla was Cocyopi, who was on the throne of Oaxaca at the time of the arrival of the Spaniards, who baptized him with the name of Don Juan Cortez. Cocyoëza was still alive when the Spaniards came, and, in his inveterate hatred of Mexico, which increased with the weight of years, counselled his son to become the friend of its new and powerful enemy. Brasseur says nothing of the alliance between the Cachiquel rulers and those of the Zapotec kingdom. The insufficiency of native documents, however, adequately accounts for this omission.[5]

The Palenque inscription states that the House of Cawek, or the Quiche kingdom, made Canich, the ancestor of Nohpat, Holpop or governor of the city of Uxmal, the chief city of Yucatan. Conache is mentioned by Brasseur's authorities as one of the earliest kings of the House of Cawek, but nothing is said of his connection with any part of Yucatan. The last genuine king of Uxmal was Nohpat, but his story is so full of the mysterious and romantic as to have led many students of Central American tradition to doubt even the existence of such a personage. According to Brasseur's account, he appears upon the scene alone, without predecessor, without legitimate successor. His court at Uxmal was one of great splendour, his subjects were obedient, his neighbours friendly. Nohpat himself was pious, virtuous, and benevolent; but a prophecy concerning the downfall of his kingdom weighed on his mind and embittered his life. An aged woman brought up her grandson, the hope of her declining years, and taught him wonderful secrets, giving him the name of Ahcunal or the Diviner. This youth found, in the temple at Kabah, the silver *tunkul*, or drum, and the silver *zoot*, or rattle, which it had been prophesied should come to light just before the monarchy fell by foreign invasion. He sounded them in the city, and terror fell upon the king and his superstitious people. The priests took part with Ahcunal, who agreed to test his word against the king's by a singular duel. Four baskets of *cocoyoles*, a nut with a very hard shell, were to be broken on the head of each of the competitors. The wily grandmother prepared Ahcunal's head for the ordeal, and one of Nohpat's stoutest warriors broke the nuts with a heavy stone club without injury to the victim. Then, Nohpat, relying upon the divinity of his royalty, exposed himself to the same test, and met his death with the first descending blow of the club. Ahcunal sat on the vacant throne, and, while his grandmother lived, ruled well. After her death, he gave way to his passions, and committed sacrilege. Then the statue of his protecting deity, Kinch Ahau, disappeared mysteriously from its temple, and all knew that the new king's fate was sealed. The Mayas, tired of his yoke, rose in rebellion, marched on Uxmal, and the Diviner died fighting on the threshold of his palace.[6]

"It is known," says Brasseur, "that, during the thirteenth century, Yucatan was invaded by barbarian hordes, to whom the chronicle gives the name Ah-Witzil, or Mountaineers, which corresponds in sense and etymology to that of the Quiches. This coincidence, no less than the accordance of that period, leaves no doubt as to the origin of the invasion. The pride of the kings of Quiche, augmented by their recent victories over Ilocab and the neighbouring nations, already sought more distant conquests. It was about the time of the reign of Iztayul I.; and there is every reason to believe that it was his arms, or those of his successor, which then devastated the rich provinces of the Mayas. The warriors of Izmachi or of Gumarcaah descended from the Chuchumatanes, called by parties who had set on foot an agitation in the peninsula, or attracted by the hope of a brilliant and easy conquest. Spite of the ignorance we are in of the events which led to this invasion, we at least know that the citadel of Ichpaa was taken by the Guatemalan mountaineers, and that Mayapan, which had begun to rise from its ruins, was given to the flames and overturned from top to bottom by the Ah-Witzils."[7]

Concerning the Huastecs, another people mentioned on the Tablet of Palenque, Dr. Brinton says: "It cannot be denied that the Mayas, the Kiches, and the Cachiquels, in their most venerable traditions, claim to have migrated from the north or west, from some part of the present country of Mexico. These traditions receive additional importance from the presence on the shores of the Mexican Gulf, on the waters of the river Panuco, north of Vera Cruz, of a prominent branch of the Maya family, the Huastecs. The idea suggests itself that these were the rear guard of a great migration of the Maya family from the north towards the south. Support is given to this by their dialect, which is most closely akin to that of the Tzendals of Tobasco, the nearest Maya race to the south of them, and also by very ancient traditions of the Aztecs.

"At a very remote period, the Mexicans, under their leader Mecitl, from whom they took their name, arrived in boats at the mouth of the river Panuco, at the place called Panotlan, which name means 'where one arrives by sea.' With them were the Olmecs under their leader Olmecatl, the Huastecs under their leader Huastecatl, the Mixtecs and others. They journeyed together and in friendship southward, down the coast, quite to the volcanoes of Guatemala, thence to Tamoanchan, which is described as the terrestrial paradise, and afterwards, some of them at least, northward and eastward toward the shores of the Gulf." During "this journey, the intoxicating beverage made from the maguey, called *octli* by the Aztecs, *cii* by the Maya, and *pulque* by the Spaniards, was invented by a woman, whose name was Mayauel, in which we can scarcely err in recognizing the national appellation *Maya*. Furthermore, the invention is closely related to the history of the Huastecs. Their leader, alone of all the chieftains, drank to excess, and in his drunkenness threw aside his garments and displayed his nakedness. When he grew sober, fear and shame impelled him to collect all those who spake his own language, and leaving the other tribes, he returned to the neighbourhood of Panuco, and settled there permanently.

"The annals of the Aztecs contain frequent allusions to the Huastecs. The most important contest between the two nations took place in the reign of Montezuma the First (1440-1464). The attack was made by the Aztecs, for the alleged reason that the Huastecs had robbed and killed Aztec merchants on their way to the great fairs in Guatemala. The Huastecs are described as numerous, dwelling in walled towns, possessing quantities of maize, beans, feathers, and precious stones, and painting their faces. They were signally defeated by the troops of Montezuma, but not reduced to vassalage.

"At the time of the Conquest the provinces of the Huastecs were densely peopled; 'none more so under the sun,' remarks the Augustinian friar Nicolas de Witte, who visited it in 1543; but, even then, he found it almost deserted and covered with ruins, for a few years previous, the Spaniards had acted towards its natives with customary treachery and cruelty. They had invited all the chiefs to a conference, had enticed them into a large wooden building, and then set fire to it and burned them alive. When this merciless act became known, the Huastecs deserted their villages and scattered among the forests and mountains."[8]

The writer has furnished these extracts from the works of reputable authors, each possessing a more than ordinary acquaintance with ancient American literature, to illustrate in the best possible way the light which traditional history sheds upon that which is monumental. Without that traditional history it would be the next thing to impossible to assign the monumental records a place in time; therefore the former are of very great value, and their importance should not be underrated. But the inscriptions reveal much of which history is silent, leaving indeed links to be desired, yet correcting several false notions for which either the traditions or their interpreters are to blame. The writer, while cherishing admiration for the valuable work performed by the Abbé Brasseur de Bourbourg and Dr. Brinton, does not homologate their dogmatic inferences and critical conjectures. Palenque and Copan, as yet but very partially read, constitute a touch-stone for testing the credibility of contemporary records of Mexican and Central American history.

Chapter XI.

An Analysis of the History of the Inscriptions in the Light of Written Documents.

According to Brasseur's documents, Oxlahuh-Tzy died in 1510, and his great victory over the Atzih Winak Hunahpu was gained in the Cachiquel year corresponding to 1499-1500. The death of Qikab I of Quiche, which apparently preceded by a very short time Oxlahuh's accession to power, is placed at a point not later than 1450, so that 1499 might easily have been the forty-eighth year of the Cachiquel king's reign. He was thus contemporaneous with Montezuma I. of Mexico, who began to reign in 1440, with Axayacatl, whose accession dated from 1467, with Tizocicatzin from 1481, with Ahuitzotl from 1486, and with Montezuma II. from 1503. His contemporaries in Oaxaca were Zaachilla III., whom Ahuitzotl of Mexico defeated in 1486, and Cocyoëza, with whom the same monarch made a treaty of peace in 1497. Assuming that Brasseur is right in his date of 1499-1500 for the victory of Oxlahuh, the main difficulty is to reconcile the presence of Cocyoëza's son Cocyopy in the campaign with the apparent fact that he was not born till 1498. The inscription calls him the Zaachilla king Cocyopi, and states that he ceased to parley with the rebels of Palenque, language utterly inappropriate in the case of an infant a year old. There must, therefore, have been an earlier Cocyopi, uncle perhaps of the king known to the Spaniards twenty years later.

The Tablet of Palenque nowhere makes any allusion to the Mexicans, which is hardly to be wondered at, inasmuch as the Oaxacan kingdom interposed between them and the seat of war. It virtually denies the existence of an independent Quiche kingdom by calling Oxlahuh-Tzy, or Oxlahun Pek, the Ahau Ahpop of the House of Cawek, a title exclusively reserved for the supreme ruler of the Quiche nation. The title Ahpozotzil, given to him in the Cachiquel MS., nowhere appears in either inscription. Evidently, therefore, the Quiche title assumed by the conqueror was superior to the Cachiquel. Oxlahun tells the manner of his accession. His father Wukubatz, or Oxcabuc, and his uncle Huntoh had been *ahkulels*, or lieutenants of Quiche, probably after the death of Qikab I., and to them the united Quiche and Cachiquel people had addressed a request that he should be appointed sole emperor or king of kings. He further claimed Uxmal in Yucatan, from the fact that the House of Cawek, over which he was ruler, had established Canich in that city, this Canich being the ancestor of the last king Nohpat. If Canich be the Conache of the Quiche MS., he belonged to the early part of the thirteenth century. That is the time when Yucatan is said to have been invaded by the mountaineers of Guatemala. In a note to The Series of the Katuns from the Book of Chilan Balam of Chumayel, Dr. Brinton says: "The Itzas who resided in the Peten district left the region around Chichen-Itza some time in the fifteenth century, probably after the fall of Mayapan. They were ruled by an hereditary chieftain, called by the Spaniards the great king Canek. Under him the territory was divided into four districts, each with its own chiefs, with whom the Canek consulted about important undertakings."[1] This name may have been a survival of that given to the first Quiche king of Uxmal The Maya chronicles so strangely intermingle comparatively modern historical matter with traditions so ancient as almost to merit the title mythological, that little trustworthy information can be derived from them.

In the Palenque inscription, Bolon evidently denotes that city, but it seems to have designated a district as well as a city, for *Bolon pak*, or the city of Palenque, is distinguished from *popol Bolon*, or the Palenque people. Closely allied to this region was that called Buluc, which is also mentioned on the Copan altar inscription, along with Holhun and Copan. Holhun is doubtless the Holom of the Cachiquel MS. which Brasseur seems to place in Vera Paz. It is, therefore, not unlikely that Buluc denotes some place on the Belize river north of Copan. Brasseur, as it has appeared, makes Belehe-Gih or Belehe-Tzy, prince of Caokeb, one of the opponents of Oxlahuh-Tzy, and gives the name of his fortress as Paraxtunya, which, however, he seems to place in the west towards the Pacific coast.[2] Another region mentioned is Tunxic or Tunxicob, of which one Cacul was the *ahau*; and Nakhun appears to denote a place as well as a person belonging to the Uactoks. Old maps set down Naco and Tencoa as towns on the south bank of the Guanacos river, south of Vera Paz.[3] Tansuche and Nauhtlan were to the north and south respectively of the Huastec settlement on the Panuco, and, near the latter place, at Tuzpan, the Huastecs destroyed a Mexican colony in the time of Montezuma I.[4] A more southern colony of Huastecs along the Guanacos may easily have existed in the time of Oxlahun-Pek.

It is known that Cocyoëza of Oaxaca added Chiapas to his dominions, and, as Palenque is situated in that province, it is natural to read of its four monarchs deserting Oaxaca; but, on the other hand, Oxlahun-Pek states that Palenque rebelled when he was appointed sole king of kings. His prominence also in the scene of the Tablet, his use of the first person, his executing judgment, all seem to denote that, so far as the city was concerned, he was ruler. Again, he says that Uxmal asked tribute from Palenque, and Uxmal he plainly claims for the House of Cawek. In the Copan inscription, Oxlahun-Pek is recognized as supreme over Copan, Holhun and Buluc, while, in that of Palenque, Buluc is regarded in the light of a rebel against Oaxaca. The truth seems to be that these two powerful monarchs to the south of Mexico, Cocyoëza and Oxlahun-Pek, had made an alliance to unitedly conquer and hold in possession the lands lying between their original kingdoms, thus extinguishing the independence of several small States. In certain cases there seems to have been a joint military occupation, for an Oaxacan Hunich dwelt in Palenque, and there were Oaxacan troops in Copan; but it is more than probable that Palenque was the point where the two kingdoms marched, the rest of Chiapas belonging to Oaxaca, while Yucatan, Vera-Paz, Guatemela, and part of Honduras were under the sway of the Cachiquel usurper of the Quiche throne. Oxlahun-Pek's representation of the anti-tribute revolt as undertaken against Oaxaca may have been an aboriginal way of complimenting a great ruler.

In Cachiquel history, the origin of hostilities is made the ambition of the Atzih Winak Hunahpu. On the Tablet, it is set forth as the refusal of Palenque to recognize Oxlahun-Pek by paying to the governor of Uxmal the tribute which he asked in the king's name.

Some of the inhabitants of Palenque itself, and of the country round about, united with those of Buluc, and afterwards with the Nakhun division of the Huastecs, and the people of Holom, in this refusal. They marched on Uxmal, and devastated the country in front of it. They sought to gain over Nohpat, its king, but it is not said with what success. They did, however, succeed in inducing some of the chiefs of Uxmal to take part with them, and also three celebrated lords, Ox-Winik or Winik-Yub (who may have been the Atzih Winak Hunahpu), Cacul, and Caichxik. At what particular time in regard to this alliance they killed the Hunich, or resident of the kingdom of Oaxaca, is not stated, nor is it definitely recorded where the Hunich resided. It seems probable, however, that his residence was Palenque. The rebellious chiefs were four of Palenque and three of Buluc, making seven, to whom were added the original three, he of the Nakhun of the Huastecs, the nameless lord of Holom, and a nameless lord of Palenque city, making ten. The names of Cacul and Caichxik may belong to these, in which case it is possible that the former was lord of Holom, and the same person as Ychal-Amollac, whom the Cachiquel MS. makes to have reigned there, and to have been foully murdered by the Cachiquel kings. In the inscription, however, he is called the lord of Tunxic or Tunxicob.

The Oaxacan kings, Cocyoëza and Cocyopy, informed Cablahun-Tok of the rebellion, and at once the Cachiquel kings set forth to crush it, in concert with Cocyoëza. It is hard to tell who is meant by the Chunbezah or leader; it may denote the general Cinahitoh of the Cachiquel MS., who afterwards aspired to the dignity of Atzih Winak, and was put out of the way by the tyrannical Oxlahuh-Tzy. The Chunbezahs of the city of Palenque were doubtless its senate under Quiche-Cachiquel and Oaxaca. The warriors of Oxlahun-Pek, under the Chunbezah, destroyed the hopes of the rebels, and either took or killed, for in Maya *chaa* or *chaab*, through national barbarity of disposition, means both, Cacul, Winik-Yub, and a chief of the Nakhun. In the history, Ychal of Holom was murdered treacherously, and the Atzih Winak Hunahpu was killed at the battle of Xechipeken. The Nakhuns nowhere appear, nor does Caichxik, who seems to have been regarded by Oxlahun-Pek with special detestation.

The whole story is one of unsuccessful rebellion against the exactions of a tyrant more powerful by far than the Cachiquel MS. represents him. Whether through fear or from some other motive, the rising was by no means universal in the three disaffected regions, Chiapas, Yucatan and Vera Paz; and in the dominions proper of Oxlahun-Pek, it would seem that the Ox Winik Yub or Atzih Winak Hunahpu, was the only rebel of importance. Whatever sympathy may have existed between the Quiche-Cachiquel monarchs and Cocyoëza of Oaxaca, it is evident that it was to their interest to act in concert, not so much for purposes of territorial aggrandizement as to oppose a united front to Mexican encroachment. This encroachment generally began through bodies of traders, who sought to detach from allegiance to their rulers the inhabitants of the regions in which they made their temporary or permanent trading posts, these preparing the way for the entrance of the Mexican armies. Doubtless the refusers of tribute counted upon Mexican interference on their behalf, for, in 1469, Axayacatl had led a victorious army along the Pacific coast of Guatemala; but the campaigns of Tehuantepec had so weakened the military power of the Mexican empire as effectually to shut out all hope of support from that quarter. Divided among themselves, the unhappy revolters were speedily crushed between the upper and nether millstones of Oaxaca and Guatemala, and at least eight hundred victims were slaughtered in cold blood by the sanguinary conquerors, as the penalty of their opposition, in addition to the number that fell in battle. Large as this number of the sacrificed may seem, it was a mere trifle compared with the human holocausts of the Mexican monarchs. Ahuitzotl, after his victory over Zaachilla III., offered no fewer than 80,400 prisoners on the altars of the bloodthirsty god Huitzilopochtli.[5]

The deity to whom these eight hundred captives were offered is called Puchtunox, more briefly Puch or Vuch. This bird seems to have been the war-god of the Quiches and their allied peoples, for the full name *Puchtun Yok* means "the fighter over or conqueror." This god is associated on the Tablet with one called Holhun, which name stands for Holcan, a warrior, and this Maya name undoubtedly denotes the Quiche god Hurakan, whose messenger Vuch was. The other pair of deities mentioned are Ca-kulel, an epithet of Tepeu, and Hun-nak-pet, who can be no other than the Quiche Hunahpu, an ancestral god, and the same originally as the Egyptian Anubis. No reference is made to any Oaxacan divinity, although Cocyoëza appears, taking part in the sacrifice, which makes it evident that Palenque city belonged to the government of the Quiche-Cachiquel kings. As the Oaxacan king was *pontifex maximus* in his own dominions, so does Oxlahun-Pek appear to have been in his. He, therefore, offered the chief among the captives, leaving the common soldiers and people to be sacrificed by the priests.

The Copan altar tablet meets with no illustration from historical documents beyond those which have already revealed the names of the

Cachiquel kings. Brasseur explains these peculiar names: "At the birth of the first child they gave it the name of the deity who presided over that day according to the Calendar. Each day of the Calendar bore a different name, but at the end of the month the same name returned, though with a difference in the number. It is thus that there was a prince called Cablahuh-Tihax, Twelve Knives, Lahuh-Tzy, Ten Dogs, etc."[6] This inscription shews that the story of Oxlahun-Pek extended over Copan, Buluc and Holhun, and that the Hunich of Buluc, like the officer of the same kind who was killed in Palenque, was a native of Oaxaca, inasmuch as the Oaxacans in the Copan army deserted on his account. The Uacthanob, or speakers of Uac, must denote the Mexicans, whom the Maya-Quiche peoples called Yaqui. These Mexicans, however, cannot have been soldiers in the true sense of the term, but armed traders, capable, as has appeared, of holding their own against the best warriors of the lands they traversed. They offered their services, doubtless, in reward for permission to establish trading posts in Copan and the region dominated by it. The imprisonment of the Oaxacans by command of Oxlahun-Pek is an evidence, along with his execution of the Hunich, that, in spite of his humble language towards Cocyoëza on the Palenque Tablet, he was in no sense subject to, nor afraid of that monarch.

What remains there may exist of the work of Oxpet, the royal scribe in Holom, cannot be known until the process of interpretation is applied to existing manuscripts of a hieroglyphic nature. He was *hodzib*, Quiche *ahtzib*, a writer or secretary, not *ahqot*, an engraver, who was a different officer, and one probably who transferred to stone the hieroglyphics sketched by the former. These officers were very highly esteemed by the Quiche-Cachiquel kings and ranked among the nobility of the nation.[7] A proud conqueror like Oxlahun-Pek, desirous of having his great actions put on record, would be specially offended at the murder of such an officer, and his naturally ferocious disposition would make the assassin's penalty a cruel one. There is much to interest in these inscriptions, in spite of their melancholy character, and comparatively modern origin, and, now that it has been proved a not very difficult task to read them, the student of history may look forward hopefully to further decipherments.

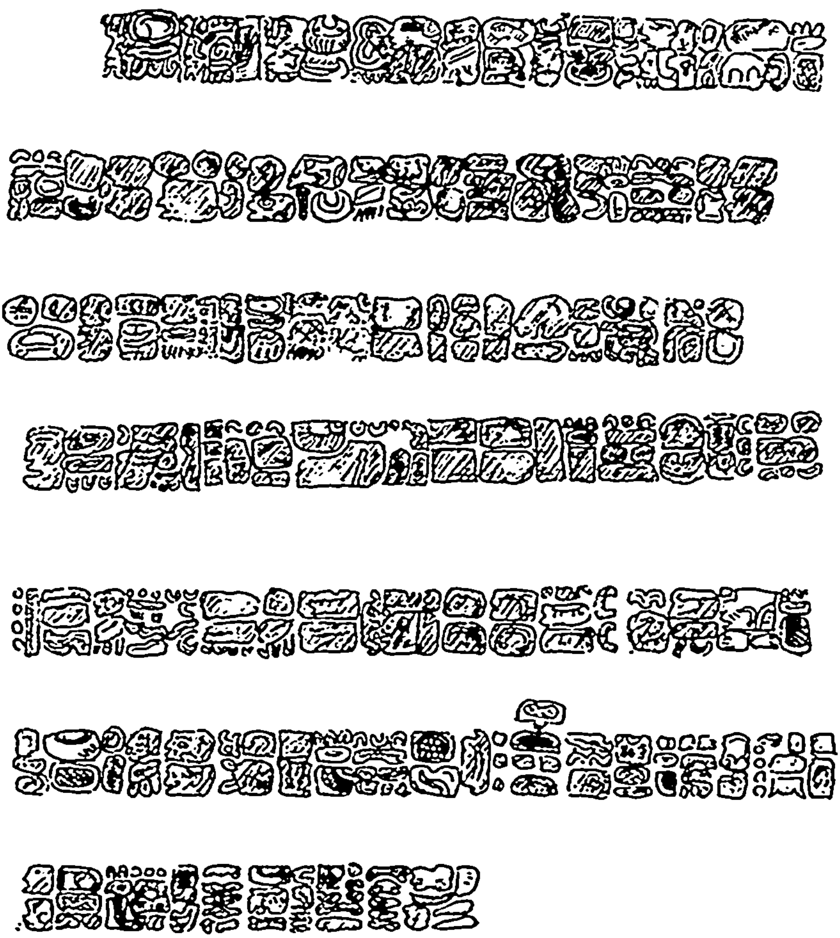
CHAPTER XII.

THE INSCRIPTIONS FROM CHICHEN-ITZA: THAT OF THE CHICHANCHOB.

The writer's original intention was to confine himself to the Tablet of Palenque and the allied inscription from Copan; but three circumstances led him to make additions to these. The chief circumstance was that, as a text book for the student of Maya-Quiche documents, the work was imperfect, presenting only the more elaborate and easily deciphered forms of the Central American hieroglyphics, such as would afford little help in reading the more rudely executed Maya codices. In Stephen's representation of the inscription in the Chichanchob, or Casa Colorada, of Chichen-Itza, he found hieroglyphics mediating between the elaborate ones of Palenque and Copan, and the rough outlines of the codices. It became a duty, therefore, to connect therewith the hieroglyphics already described. The writer has no present intention of interfering with the work of Messrs. Léon de Rosny and Cyrus Thomas, whose main attention has been unsuccessfully given to the codices. The other reasons for adding to the hieroglyphic material already presented were to give representation to Yucatan, the land of the Mayas, and to set forth documents, not much indeed, but still, a little more ancient than those of Palenque and Copan, The writer claims the indulgence of the general reader for reëntering the field of hieroglyphic explanation, as tedious for himself to write as for others to read, but of the utmost utility to the careful student of Maya script.

Mr. Stephens' description of the edifice containing the first set of Yucatan hieroglyphics is as follows: "It is called by the Indians Chichanchob, meaning in Spanish, Casa Colorada, and in English, Red House. The terrace is sixty-two feet long and fifty-five wide, and is still in good preservation; the staircase is twenty feet wide, and, as we approached it on our first visit, a cow was coming quietly down the steps.

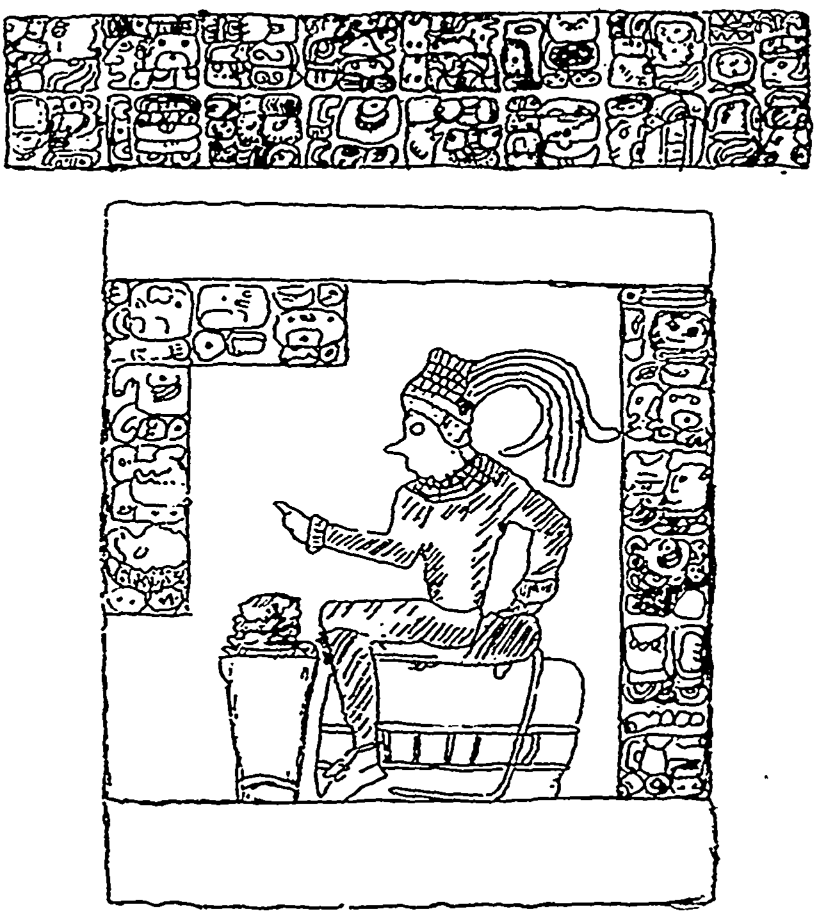
"The building measures forty-three feet front and twenty-three feet deep, and is still strong and substantial. Above the cornice it was richly ornamented, but the ornaments are now much decayed. It has three doorways, which open into a corridor running the whole width of the building; and along the top of the back wall was a stone tablet, with a row of hieroglyphics extending all along the wall. *Many of them* *were defaced, and from their height, in an awkward position to copy;* but we had a scaffold erected, and obtained copies of the whole. The plate above represents these hieroglyphics, so far as they could be made out. *When not distinct, to avoid misleading, they are not given at all.* Under the hieroglyphics, in the plate, is given a plan of the building, with its terrace and staircase. It has a back corridor, consisting of



The Chichanchob Inscription of Chichen-Itza.

three chambers, all of which retain the marks of painting; and from the convenience of its arrangements, with the platform of the terrace for a promenade, and the view of a fine open country in front, but for the greater convenience of being near the hacienda, we should have been tempted to take up our abode in it."[1]

Mr. Stephen's division of this long, and imperfect, inscription is into seven lines, the direction of which, from left to right, he has accurately judged. The first two characters of the first group in line 1 are the same as those constituting D 8 in the Palenque Tablet, and their phonetic equivalents, as has appeared, are *hun toh*. But these are followed in the same group by the symbol *than*, after which comes *cab*



The Akatzab Inscription of Chichen-Itza.

or *caban* in a cartouche. Below it is an apparent *lahun*, 10, followed by *ox*, 3; but on comparison, it appears that the supposed *lahun* is an expedient for *yib*, a bean, and that the *ox* must be read, not after, but before it. This group, therefore, furnishes the sentence: "*Huntoh tan cab Oxyib:*" "Huntoh in the land of Oxyib." The second group also begins with *hun toh*. After the *hun*, 1, comes *pet*, the circle, then *tun*, the stone, inscribed with *ca*, 2, and, under it, the same characters as gave *ox yib* in the preceding group. At the back of all is the semblance of a wing or of drapery, which, from its position, however, has the simple meaning of *xul*, the end. This group 2 reads: "*Huntoh bet katun Oxyib xul:*" "Huntoh makes an end of the army of Oxyib." Group 3 begins with Oxyib, which is followed by *pak* as in Palenque G. Below come *hun*, 1, *ich*, the face, and *ob*, plurality; and behind, from top to bottom, are *pet*, circle, *ca*, 2, *tun*, stone, and the well known figure denoting *hol*, end, hole, door. These furnish: "*Oxyib pak Hunichob bet katun hol:*" which may be read, "The army puts the Hunichob to the door of the town of Oxyib," or "The Hunichob of the town of Oxyib put the army to the door." Group 4 reads from the bottom up, beginning with *ox*, 3. Then comes *ca*, 2, within the covering *buc*, followed by *hun*, 1, *ich*, face, and a lower face traversed by two lines, furnishing another *ca*. The whole is: "*Oxcabuc, hunich Caich:*" or "Oxcabuc, the Hunich of Quiche." The small group 5 begins with *dzib*, writing, under which come *hun*, 1, and *tun*, stone, with two lines for *ca;* thereafter follow four lines for *kal*, 20, and a *than, or* drop. Arranged in order, these set forth: "*dzib than hunkal katun:*" "he writes word (that) twenty soldiers." No 6, as consisting of *ca*, 2, *dzibs*, is Katzib, the name of a place. No. 7 begins with *hol*, which is followed by *ho*, 5, or *yib*, a bean; then come *can chi*, 4 mouths, and *pet* the circle. Together these may be read: "*Katzib holob xanac bet:*" "in the holes, (or cells) of Katzib makes to remain." The first character in No. 8 is compound, consisting of *buc*, to envelop, and *tun*, a stone. Below it are *ca tun*, 2 stones, and then *tun*, a stone, resting in *hol*, a hole. These give the subject of the sentence: "*puchtun katun holthan:*" "the chief speaker of the quarrelling army." No. 9, as comparison shews, reads from below upwards, consisting of *ox*, 3, and *ich*, the face. It is a word like Hunich, the *ich* representing *eds*, established, and *ox* being an expedient for *yok*, over. The next group, No. 10, is very interesting. It consists of *chi*, the mouth, *tun*, a stone, *ich*, the face, and *ox*, 3. This Chitun Ichox is the nearest the engraver or his scribe could come to Chichen-Itza. After its hieroglyphics appear the conventional *ca*, the circle *pet* and the cross *pak*, to represent *kebat pak*, "the wicked town." The next group of two characters gives *pet*, the circle, and an object doubly inscribed for *ca*, 2. Then comes *tun*, a stone, over an aberrant form of *ahau*, and an inverted *ca*, which from its position, becomes *xul*, the end. The whole is: "*Yokich Chichen-itza kebat pak bet katun ahau xul:*" "The Yokich of Chichen-Itza, wicked town, makes an end of the chief of the army."

The final group of line 1 belongs syntactically to line 2; it consists of

"*Oxyib pop:*" "the carpet or mat, *i.e.*, the ruler of Oxyib." No. 1 of line 2 exhibits *ox*, 3, *buc*, cover, *pet*, circle, *tun*, stone, a figure that may denote vegetation but which is certainly *ka*, and another *tun* of different form from the one above it. These read: "*Oxbuc patat katan:*" "Oxbuc asking tribute." The characters following look like *tun* and *hol*, but as this furnishes no sense, the supposed stone must be *pak*, a stone wall, the whole being *paxal*, to desert. Next comes *hun*, 1, *ich*, the face, and a vague figure which may once have been *yub*, an article of clothing. The next group is one of five characters; a stone inscribed with three lines gives *ox tun*. At its right is the circle *pet*, followed by the conventional *ca*. Underneath these are *chi*, the mouth, and *xul*, the end, making in all: "*paxal Hunichob yoktan Cachixul:*" "the opposers desert the Hunichob (and) make the Cachiquels." The following group is of five, being *tun*, a stone, *xul*, a bird's head, *hol*, *kax*, united, and *ich*, the face furnishing: "*dzan xul hol kak ich:*" "to be destroyed in the fire hole." Three characters make up the next clause, *dzib*, *tun* and *uac*, 6, for *hayac*, to destroy. These precede *ca*, *dzib*, two *dzibs*, or writings, which are followed by *uac*, 6, differently written and inserted in *tun*, a stone over *pet*, a circle. The whole is: "*dzib than hayac Katzib hayac tan bet:*" "writing a word to destroy, they make destruction in Katzib." Two dots in a *tun* make it *katun*; below are *hun*, *ich* and *ob*, followed by *bat*, an axe, and a *buc*, or cover, together with *ca*, *tun* and *xul*. This is a complete sentence: "*katun Hunichob bet pach katun xul:*" "the army of the Hunichob makes an end of the prisoners of the army." Oxyib now reappears over *tun*, after which is Oxbuc over *katun*. Below is a compound figure consisting of *ca*, 2, *ox*, 3, and *tun*, to represent *chuuctan*, "spoiling in." The back of the head, *pach*, is over *xul*, an end, and then come two faces, *ca ich*, for Quiche. This imperfect line ends: "*Oxyib tan Oxbuc katun chuuctan paxal Caich:*" "the army of Oxbuc plundering in Oxyib deserts Quiche."

The first sentence of line 3 is, for a Maya-Quiche document, a long one. The first group is evident, being *katun ahau*. The two following characters are peculiar, but the top one is simply a stone with inscribed *ca*, and the lower is *xul*, end, similarly inscribed. The upper part of the next two gives *thun*, a drop, in the plural, and the lower is *dzib*, writing. Hunichob is represented by *hun* at the right-hand corner of *ich*, a face. under which are the folds of *yub*, a dress. The four subscribed U's read simply as *can*, 4; and afterwards comes *oxlahun*, 13, followed by a symbol denoting *pak*, a building. Thus we have: "*katun ahau katun kuxil thanob dzib Hunichob can Oxlahun-Pek:*" "the army, hating the chief of the army, writes words (for) the Hunichob to tell Oxlahun-Pek." Oxlahun-Pek is repeated below, and following it are *pet*, *yok*, over, and *muyal*.

Next are *can*, 4, *tun*, *pop*, the mat, and *bak*, a bundle, making in all: "*Oxlahun-Pek bet Yokmal chunthan pop pak:*" "Oxlahun-Pek makes the president of Uxmal *pop* of the town." The next group presents difficulty at first, but, read from the bottom upwards, consists of *chi*, a border, *chi*, a mouth, and *xul*, an end, *Chichixul*. Next comes the well-known *katun*, followed by *pet tun*, and the following top character to make sense should be *ca*, but *ca* is never thus represented. It is, therefore, probably *yok*, on, over. Two *katuns* follow, and then come *buc* and *pet*. Thus the sentence is: "*Chichixul katun patan yok katan katun pach bet:*" the Cachiquel army in asking tribute makes soldiers prisoners." Reading upwards, the next group contains *ox*, 3, *yub*, a coat, and *xic*, division. Then comes another *ox*, and in the top line appear *hol* and *tun* over *pak*, under which are *pet*, and *xul*, the end. The bird's head supplies another *xul*, followed by *hun* and *tun*, under which come, from right to left, *pet*, *hun*, *chi*, a border, and *yub*, an article of dress. These furnish: "*Oxyib xic yok holthan pak bet xul; xul hunten bet Hunichob:*" "he makes an end of the dividers of Oxyib by the executioner of the town; the Hunichob made an end (of them) at one time."

The first character of line 4 is *chi*, the mouth, and it is followed by *chen*, a well, like an inverted T, roughly representing the *aguadas* of the country. Under it is Oxyib inverted; and in the next group, *pak*, building, is read before *xul*, the C like end. These give: "*Chichen Oxyib paxal:*" "the Oxyib desert Chichen." At the back of the *pak* are Oxyib and *katun*, and these are followed by *pach*, a back, after which come two ends, furnishing *ca xul*, and *tun*, a stone. The next group contains *ox*, 3, *yub*, a dress, represented by a few lines, not enough to set forth *pop*, then *tun* and *katun*. Afterwards comes *chi*, a border, with *ox*, 3, and *yab*, a shoe, to which are added *ca*, 2, *chi*, a mouth, *pet* and *tun* Next are *dzib* and *tun*, with *chi*, a border, and *tun*, another *tun*, and *Oxyib tun*. All of these furnish: "*Oxyib katun pak kuxil than Oxyib-than katun chi Oxyib xache betun dzib tun ci than tan Oxyib-than*" "the Oxyib army hates the town, the Oxyib speaking army saying a word (that) Oxyib seeks to make written stones sweet-worded in Oxyib speech." The rest of the line contains Oxbuc rather than Oxtun, followed, as in line 2, by *katun* and *caoxtun*, the latter being obscure in the plate. Afterwards come *pak*, and *hol*. The apparent bracket furnishes either *kax*, united, or *yok*, over; next, a writing in two divisions is *ca tzib*, and below is *pet*. The last group consists of *ox*, *tok*, *chi*, a border, and *ahau* in the plural. These make up: "*Oxbuc katun chunctan paxal kax Katzib bet yoktok chi ahauob:*" "the army of Oxbuc, deserting to plunder, makes the united of Katzib chiefs of the speakers of rebellion."

The fifth line begins with *canlahun*, 14, followed by *buc*, cover, *tun*, and *yab*, a shoe. Reading from below, the next group is *oxyip dzib;* it is followed by Oxlahun; and the subsequent group, composed of *ca*, 2, *can*, a snake, and a rude shoe, *yab*, supplies *caxanob*. Then come *ca* 2, the conventional *ca* before *tun*, and another *katun* over *can*, 4. From below, the following reads *Oxyibthan*. The top character following it is *tok*, and the cleft stone below probably gives *tun xic* for *dzanxic*. The sentence is: "*canlahun puchtunob Oxzib dzib Oxlahun caxanob ca katun katun can Oxyibthan toc dzanxic:*" "Oxlahun writes, when the army finds fourteen rebellious Oxyib, telling the army to burn and destroy the speakers of Oxyib." The bracket enclosing two dots is doubtless to be read *caox* for *chuuc*. It is followed by *katun*, and that by *xul*. Below, there is no difficulty in recognizing *Hunichob*, the *ob* being represented by *yub*, the cloak at the back. The next upper hieroglyphic is *pet;* so this brief sentence reads: "*chuuc katun xul Hunichob bet:* "the Hunichob make an end of the plundering army." On the right of the last circle, *pet*, is *chi*, the mouth, with three lines inscribed, making *oxchi*. Below, and to the left of it, are two *bucs*, giving *cabuc*. The next group furnishes *ox*, *tok*, and *ahau;* the next *ca*, *ca;* and the next *ca dzib* Then comes *tun*, followed by *kulel*, the unseemly symbol, under which are *ca*, 2, and *hol*. In the succeeding group, Hunich appears, and *dzib* in the lower right corner must take the place of *yub*. Two hands are *ca kab;* and the last series furnishes *ox*, *yib*, *pop*. These may be read: "*Yokchi Cawek yoktok ahau caca Katzib tan kulel kahal Hunichob cacab Oxyib pop:*" "the Atzih Cawek in Katzib, the town of the chief of the rebels, recalls to rule the Hunichob, *pop* of the commune of Oxyib."

The first hieroglyphic in line 6 is the border, *chi;* it is hard to say why the one below it, a stone with four lines inscribed, should be *chen*. Under it is *katun*, the *ca* being expressed by the two lines on the right. Next comes *buc* over *tun*, followed by *pop;* then *pet* precedes a bean, *yib*, inscribed with *uuc*, 7. The next group reads from below, *ox*, *yib*, *ich*. Two faces are *ca ich;* and *ca puch*, *ca tzib* follow, while *hol* and *tun* read from the bottom upwards. These yield: "*Chichen katun puchtun pop bet hayacob Oxyib ich Caich Cawek Katzib holthan:*" "the Holthan of Katzib of Quiche Cawek causes (that) they destroy the *pop* of the rebellious army of Chichen in Oxyib." There is no difficulty in reading *oxyib pop* and *oxbuc*, but the succeeding two borders are not so easily recognized as *ca ich*. Next follow *ca*, 2, *tun*, and *pop*, after *pop*, the inverted basket-like character proves, on comparison to be a *ca*, and to be read before *yub*, a dress. Then *oxbuc* reappears, followed by *ca tun* and *pet*. The irregular character at the top of the next group denotes *yok*, over, and unites with *ca*, 2, to make what so far has been *caox* for *chunc.* The same *yok* unites with an irregular *muyal* to form Uxmal. *Ahau* is the first word in the following group; below it is *bak*, a bundle, and the small character beneath it is most comprehensive, embracing *buc*, covering, *hun*, 1, and *tun*, a stone. Thus identified, they say: "*Oxyib pop Oxbuc Caich katun pop Cayub Oxbuc katun bet chunc Uxmal ahau bak hun puchtun*:" "Oxbuc, *pop* of Oxyib, Cayub, *pop* of the army of Quiche, and the army of Oxbuc, make prisoners 400 rebels of the *ahau* of Uxmal." The next group consists of *ca* and *yib*, followed by *pop*; and that following, of *katun*, *buk*, *tun*, and *ox*. The group after unites *chi*, a border, in the left hand lower corner of the first *dzib*, with it and the one below, giving *chi ca dzib*. One more *caox* appears over *can*, 4. The following *chi*, border, and *chen*, well, or *tun*, stone, are vague. The stone, *tun*, is read next, then *buk* with *tun*, and finally *yub*, a robe, to the left. This sentence is: "*Cayub pop katun puchtun Yokchi Katzib chunc can Chichen tan puchtunob*:" "the *pop*, Cayub, tells the Yokchi of Katzib of the rebellious army to seize the rebels in Chichen."

The seventh line begins with *ca ich*, two faces, followed by a *pak* and a *bak*, giving *ca bak*, two *baks*. Below these come *katun*, two *tuns*; and the next group is *ca*, *yib*, *pop*. That following contains *ox*, 3, *ca*, the two spaces within three lines on the succeeding figure, and the figure itself, *buc*. Below *buc* are *dzib* and another *buc*, and, below them, *ca-tun*. The figure under the next *pop* is a mystery; it is inscribed, and may be *dzib*. The following long group is made up of *yok*, over, *hol*, *can*, 4 with *tun*, another *yok* of different form, and *katun*. The next character gives *buc* and *tun*, followed by *yub*, a coat. Leaving the lower *hun tun*, and taking the first of the next group *ca*, it is followed by *bat*, an axe, after which are three ends or *xuls*, which, with *hun tun*, may be read "*xul yok hunten*." The whole may be read: "*Caich Cawek katun Cayub pop Oxcabuc dzib puch katan cib pop hokol chunthan yok katun puchtunob kebat xul yok hunten*:" "Cayub, the *pop* of the army of Quiche Cawek writes Oxcabuc a letter, asking permission (for the) *pop* (for) the president to set out over the army to end at once the wicked rebels." The next short sentence begins with *dzib*, followed on the right by *pet*, after which come *buc* and *tok*, with *hol* to the left, and *buc* and *tun* below. It thus reads: "*dzib bet pach dzocol puchtun*:" "he writes to cause the rebel prisoners to be destroyed." The top character of the next group is *yok*, over, the second, *hun tun*, after which are three beans, *ox yib*. A stone with a hole in it provides *hol tun*; three lines on another stone give *ox tun*; then follows *katun*, and, going backwards, an irregular *yok*, and a *xul*, or end. Together they read: "*yok hunten Oxyib holthan yoktan katun yok xul*:" "at once the holthan of Oxyib over ended the rebel army."

CHAPTER XIII.

THE INSCRIPTIONS FROM CHICHEN-ITZA: THAT OF THE AKATZEEB.

Referring to the valuable illustration in his "Incidents of Travel in Yucatan," Mr. Stephens writes: "The plate opposite represents the general plan of the ruins of Chichen. This plan is made from bearings taken with the compass, and the distances were all measured with a line. The buildings are laid down on the plan according to their exterior form. All now standing are comprehended, and the whole circumference occupied by them is about two miles, which is equal to the diameter of two thirds of a mile, though ruined buildings appear beyond these limits. By referring to the plan, the reader will perceive the position of the hut in which we lived, and, following the path from our door through the cattle-yard of the hacienda, at the distance of two hundred and fifty yards, he will reach the building represented in the plate opposite (the Akatzeeb). It does not stand on an artificial terrace, but the earth seems to have been excavated for some distance before it, so as to give it elevation of position. It faces the east, and measures one hundred and forty-nine feet in front, by forty-eight feet deep. The whole exterior is rude, and without ornament of any kind. A grand staircase, forty-five feet wide, now entirely in ruins, rises in the centre to the roof of the building. On each side of this staircase are two doorways; at each end is a single doorway, and the front facing the west has seven. The whole number of apartments is eighteen. The west front opens upon a large hollow surface, whether natural or artificial it is not easy to say, and, in the centre of this, is one of those features before referred to, a solid mass of masonry, forty-four feet by thirty-four, standing out from the wall, high as the roof, and corresponding, in position and dimensions, with the ruined staircase on the eastern front. This projection is not necessary for the support of the building; it is not an ornament, but, on the contrary, a deformity; and whether it be really a solid mass, or contain interior chambers, remains to be ascertained by the future explorer."

"At the south end the doorway opens into a chamber, round which hangs a greater and more impenetrable mystery. This chamber is nineteen feet wide by eight feet six inches deep, and in the back wall a low narrow doorway communicates with another chamber in the rear, of the same dimensions, but having its floor one step higher. The lintel of this doorway is of stone, and on the soffite, or under part, is sculptured the subject represented in the engraving opposite. This tablet and the position in which it exists, have given the name to the building, which the Indians call Akatzeeb, signifying, the writing in the dark; for, as no light enters except from the single doorway, the chamber was so dark that the drawing could with difficulty be copied. It was the first time in Yucatan that we had found hieroglyphics sculptured in stone, which, beyond all question, bore the same type with those at Copan and Palenque. The sitting figure seems performing some act of incantation, or some religious or idolatrous rite, which the 'writing in the dark" undoubtedly explains, if one could but read it. Physical force may raze these buildings to the ground and lay bare all the secrets they contain, but physical force can never unravel the mystery that involves this sculptured tablet."[1]

The groups of hieroglyphics in this tablet are twenty-eight in number, of which sixteen are arranged in two lines above the central figure, while six are placed to the left and an equal number to the right of it. Making a commencement with the left hand figure of the first upper line, it is found to consist of *pet*, the circle, *ox*, 3, *pak*, building, and a face-like *hun*, 1, with *ich*, the face proper, and *yub*, a garment; the whole being *bet Oxbuc Hunichob.* The second group holds *lahun-tu-kal*, 30, *ca*, the equivalent for the trefoil forehead ornament, *chi*, the mouth, and six small circles at the back of the head, which, from their position, are not to be read simply as *uac*, 6, but as such together with *xul*, an end. Next to the number 30 comes a circle *pet*, followed by 7, *uuc*, and *pak*, tilled ground. Below are *ca*, 2, *buc*, covering, *tun*, stone, and *katun*. These two groups furnish: "*bet Oxbuc Hunichob lahun-tu-kal Cachixul hayac bet hayac pak ca puchtun katun:*" when the army rebelled it caused to destroy the city, it caused to destroy thirty Cachiquels of the Hunichob Oxbuc." The third group begins with *uac*, 6, followed by *pet*, after which a stone inscribed with two lines furnishes *katun*. Below *uac* and *pet*, comes *buc*, covering, embracing *tun*, stone, and below are *ca*, 2, *ox*, 3, inscribed in another *tun*. To the right of *katun* above is *chi*, a border, and just under *katun* is *ich*, face, followed by what has been claimed as a representation of the breast, *tzem*, but which really stands for *tan*, *than*, *tun*, *thun*, and *dzan*, and is often replaced, even as in the name Chichen, by the figure of a stone, *tun*. These are followed by another face, *ich*, and by another *tzem*. In the fourth somewhat obscure group are *ca*, the roll, as at Palenque, and below it, *pak*, under which is *holhun*, 15; behind appear *ca*, 2, *xic*, division, and a final ball, which from its position is *xul*, the end. Below is a form of *ahau*, with plurality. These two groups add another sentence: "*hayac bet katun puchtun* *chuuctan Chichen-Ichzen chabach holhun Cachixul ahauob:*" "the rebellious army made destruction, seizing Chichen-Itza, (and) capturing fifteen Cachiquel chiefs."

The fifth group begins with two stones, each inscribed with 3, the whole giving *ca*, *ox*, *tun;* then comes *holhun*, 15, followed by *ca*, 2, *chi*, border, and *xul*, end. Below are two *nak's*, which might give *xanac*, "will remain," in some cases, but not here; they furnish *nakob*, "they ended." The brief sentence reads: "*chuuctan holhun Cachixul nakob:*" "the spoilers destroy fifteen Cachiquels." No. 6 is difficult as it commences with an inverted *ca*, that should be a *xul*, according to general rule. Inscribed in the upper part of it is *thun*, a drop. At the opposite end appears *lahun*, 10, and embraced by the limbs of the *ca* is *pak*, cultivation. These are followed by *muyal*, the cloud, *pop*, the mat, and *ca*, *ox*, *tun*, again. Thus: "*katun Lahun Pek mulbab chuuctan:*" "the army of Lahun-Pek joins the spoilers." No. 7 contains *ca*, *tun*, *ox*, *tun*, *can*, *tun*, and what follows should be Hunichob, but Mr. Stephens has replaced the face by the sign *caban*, unless it be intended for a border *chi*. Finally, group 8 has 17, or *uuclahun*, which at Palenque stands for Zaachilla of Oaxaca. Five, within a circle subscribed with mark of plurality, should be *hopetob*, and as *hopet* is the Palenque form of *ubah*, to hear, it is doubtless such in the present case. The last of this group are *ox*, *tok* and *ich*. Taken together they furnish: "*katun yoktan can Hunichob Uuclahun hopetob yoktok ich:*" "Zaachilla tells the Hunichob they hear the rebel army (is) in rebellion."

The first of line 2 begins with two *nak's*, the latter being followed by mark of plurality; they may be read as a reduplication of intensity, *naknakob*. Then in the same group follow *ox*, 3, *chi*, face, *ca*, 2, and *dzib*, writing, *oxchi katzib*. No. 2 begins with the conventional *ca*, which encloses *ox*, 3. At the top is *bak*, bundle, over *can*, 4; below these may be *katun*, but there certainly is *xic*, division, with plurality. In 3, the border, *chi*, is first, and the figure below it is probably *ich*, the eye or face, while to the right is an ornamental *tun* or *thun*. Here the sentence ends: "*naknakob Yokchi Katzib ca Oxbuc can katun xicob Chichen:*" "they destroy Yokchi Katzib when Oxbuc says the army divides Chichen." Below the central *thun*, 14 is represented by two wavy fives and four strokes, *canlahun*. In the border, *chi*, are *uac*, 6, which should be read first, and at its extremity is *xul*, an end. Next, above the *thun*, is *pet*, followed by *pak*, cultivation, over *thun*, under which is *buc*, covering. Group 4 contains *ox*, 3, *hun*, 1, *tun*, stone, and *can*, 4, inside *hol*, while beneath is the well known *katun*. No. 5 begins with *tun;* to the right is *ox*, and below *tun* come *chi*, border, *ca*, 2, and *dzib*, writing. The whole reads: "*canlahun hanac tzicil bet puchtun pach yok hunten holcan katun tan Yokchi Katzib:*" "the holcan of the army made prisoners of the rebels in Yokchi Katzib at one time, fourteen ceasing to obey." The remaining part of group 5 is *ox muyal* or Uxmal. No. 6 begins with *ahau*, followed by *dzib* and *katun*; back of these are *buc*, covering, *tun* and *xicob*, as in No. 2. The order of No. 7 is peculiar, beginning with *ox* over *ahau*, then coming to the face, *ich*, which should properly be a mouth, *chi*, moving up to the frontal ornament *ca*, and ending with the first character *dzib*, writing, to furnish *oxchi katzib*. The sentence, therefore, is: "*Uxmal ahau dzib katun puchtun xicob Yokchi Katzib:*" "he writes the king of Uxmal (that) the rebel army divides Yokchi Katzib." The last hieroglyphic of No. 7 is *ahau*. In No. 8, Uxmal is represented by three links of a chain, and the *muyal* or cloud figure, at the other end of the cartouche. Thereafter come *pet*, the circle, *dzib*, writing, a *hun* over the ear of *ich*, the face, and the robe, *yub*. Unitedly they afford: "*ahau Uxmal bet dzib Hunichob:*" "the king of Uxmal makes to write to the Hunichob."

Coming down to the hieroglyphics about the seated figure, so mysterious in Mr. Stephen's eyes, the series on the left stands first, and is to be read first horizontally, and afterwards perpendicularly, as at Palenque. No. 1 contains *ca*, 2, *kab*, hand, and the main part of it is *katunob*. No. 2 consists of *tun*, *pet*, and *chi*, a border. In No. 3, *katun* appears; then come *ca*, 2, *buc*, covering, and *tun*. Below is a distinct *pet*, and the indistinct figure beside it is probably *buc*. Coming now to No. 2, in perpendicular order, its main hieroglyphic is *mazcabcun*, a kettle, below which are the conventional *ca*, *hol*, and *pet*. No. 3 perpendicular consists of *pet*, *tun*, and a confused figure evidently meant for *kak*, fire. Below are three stones, two of which are inscribed with *ca*, 2; these must yield *caoxtun*, or *chuuctan*. No. 4 perpendicular consists of *hun*, 1, *thun*, a drop, on *tun*, a stone, over *katun*. These six groups read: "*cacab katunob than bet cihi katun ca puchtun pach bet mazcab xanac; hol bet bet tan kak chuuctan chunthan katun:*" "the armies of the state made a word, saying, the army when it rebelled made prisoners to remain in prison; the chunthan of the army of spoilers made a hole (and) made fire in it."

The series on the right begins with *pet* over *pak* and *tun*. Next comes *buluc*, 11, over *ca* and *tun*. No. 2 has the frontal ornament *ca*, the mouth, *chi*, and a figure over the face, which might be a roughly executed hand, glove, or split stone; but sense requires it to be *xul*, end, or *hol*, hole. Then follows Hunichob. In No. 3, *dzib* is followed by *ca*, 2, and *kab*, hand, while, to the right, Hunichob again appears. No. 4 contains *can*, 4, followed by *ox* and *tun*, and *katunob*, to the right of which comes *caoxtun*. These complete a sentence: "*bet puchtun Buluc katun Cachixul Hunichob dzib cacab Hunichob can yoktan katunob chuuctan:*" "the Hunichob of Cachiquel make the army of Buluc rebel, writing to tell the rebel soldiers to plunder the state of the Hunichob." The last character in No. 4 is *nak*, and it belongs to the next sentence. No. 5 is rather difficult. It consists of *ox*, 3, on *chi*, a border, over what should be *ho*, 5, but, on comparison with the Chichanchob inscription, must stand for *ca;* under it is *yub*, a garment. The opposite cartouche furnishes *ox*, 3, *tun*, stone, and below, *ahau*. Finally, No. 6 gives *ox*, *bolon*, 9, and *hunichob*. This last sentence is: "*nak Yokchi Cayub yoktan ahau yok Bolon Hunichob:*" the Yokchi Cayub destroys the chief of the rebels by means of the Hunichob of Palenque."

Thus, by a strange but most fortuitous coincidence, the study of these inscriptions brings the reader back to the starting point in Chiapas. Varying, as the hieroglyphics do in many particulars, owing doubtless to locality, and the skill of the artist, they are one in historical character as in speech, and among them furnish a vocabulary extensive enough to enable the student to attack any Maya-Quiche document, with good hope of success in the work of interpretation. It remains to set these two Chichen-Itza inscriptions forth in connected form.

CHAPTER XIV.

THE TEXT AND TRANSLATION OF THE CHICHEN-ITZA INSCRIPTIONS.

TEXT AND LITERAL TRANSLATION OF THE INSCRIPTION OF THE CHICHANCHOB.

Line 1. Huntoh tan cab Oxyib; Huntoh bet katun Oxyib xul.
Huntoh in land Oxyib; Huntoh makes army Oxyib end.
Oxyib pak Hunichob bet katun hol. Oxcabuc Hunich Caich
Oxyib town Hunichob makes army end. Oxcabuc Hunich Quiche.
dzib than hunkal katun Katzib holob xanac bet puchtun
write word 20 soldier Katzib cells to remain makes rebelling
katun holthan. Yokich Chichen Ichzen kebat pak bet katun
army speaker. Yokich Chichen-Itza wicked town makes army
ahau xul. Oxyib pop [1]
chief end. Oxyib ruler

Line 2. Oxbuc patan katan paxal Hunichob yoktan bet Cachixul
Oxbuc tribute asking desert Hunichob opponents make Cachiquel

dzan xul hol kak ich. Dzib than hayac Katzib hayac tan-bet.
waste end hole fire in. Writing word destroy Katzib destroy in make.

katun Hunichob bet pach katun xul. Oxyib tan Oxbuc katun
Army Hunichob makes prisoner army end. Oxyib in Oxbuc army

chuuctan paxal Caich.[2]
plundering deserts Quiche.

Line 3. Katan ahau katun kuxil thanob dz'b Hunichob can
Army chief army hating words write Hunichob tell

Oxlahun Pek. Oxlahun Pek bet Yokmal chunthan pop pak
Oxlahun-Pek. Oxlahun-Pek makes Uxmal president ruler city

Chichixul katun patan yok katan katun pach bet. Oxyib
Cachiquel army tribute over asking soldier prisoner makes. Oxyib

xic yok holdzan pak bet xul: xul hunten bet Hunichob.[3]
dividing by executioner city makes end: end at once makes Hunichob.

Line 4. Chichen Oxyib paxal. Oxyib katun pak kuxil than Oxyib-than
Chichen Oxyib desert. Oxyib army city hates word Oxyib speakers

katun cihi Oxyib xache betun dzib tun ci than tan
army saying Oxyib seeks to make written stone sweet word in

Oxyib than. Oxbuc katun chuuctan paxal kax Katzib
Oxyib speech. Oxbuc army plunder deserting united Katzib

bet yoktok cihi ahauob.[4]
makes rebellion speakers chiefs.

Line 5. Canlahun puchtunob Oxyib dzib Oxlahun caxanob ca katun
14 rebellious Oxyib writes Oxlahun find when army

katun can Oxyibthan toc dzan xic. Chuuc katun
army telling Oxyib speakers burn destroy divide. Plundering army

xul Hunichob bet. Yokchi Cawek yoktok ahau caca
end Hunichob makes. Yokchi Cawek rebel chief town

Katzib tan kulel kahal Hunichob cacab Oxyib pop.[5]
Katzib in to rule recalls Hunichob commune Oxyib ruler.

Line 6. Chichen katun puchtun pop bet hayacob Oxyib ich Caich
Chichen army rebellious ruler makes destroy Oxyib in Quiche

Cawek Katzib holdzan. Oxyib pop Oxbuc Caich katun
Cawek Katzib executioner. Oxyib ruler Oxbuc Quiche army

pop Cayub Oxbuc katun bet chuuc Uxmal ahau bac
ruler Cayub Oxbuc army make prisoner Uxmal king 400

hun puchtun. Cayub pop katun puchtun Yokchi Katzib
1 rebels. Cayub ruler army rebellious Yokchi Katzib

chuuc can Chichen tan puchtunob.[6]
seize tells Chichen in rebels.

Line 7. Caich Cawek katun Cayub pop Oxcabuc dzib puch katan
Quiche Cawek army Cayub ruler Oxcabuc writes letter asking
cib pop hokol chunthan yok katun puchtunob kebat
permission ruler set out president over army rebels wicked
xul yok hunten. Dzib bet pach dzocol puchtun. Yok
end at once. Writes make prisoner end rebellion. At
hunten Oxyib holdzan yoktan katun yok xul.[7]
once Oxyib executioner rebel army over ends.

TEXT AND LITERAL TRANSLATION OF THE INSCRIPTION OF THE AKATZEEB.

Line 1. Bet Oxbuc Hunichob lahun-tu-kal Cachixul hayac bet
Makes Oxbuc Hunichob 30 Cachiquel destroy makes
hayac pak ca puchtun katun. Hayac bet katun puchtun
destroy city when rebels army. Destruction makes army rebel
chuuctan Chichen Ichzen chabach holhun Cachixul ahauob.
seizing Chichen-Itza capturing 15 Cachiquel chiefs.
Chuuctan holhun Cachixul nakob. Katun Lahun Pek
Spoilers 15 Cachiquel end. Army Lahun-Pek
mulbab chuuctan. Katun yoktan can Hunichob Uuclahun
join spoilers. Army rebel tells Hunichob Zaachilla
hobetob yoktok ich.[8]
hear rebellion in.

Line 2. Nak nakob Yokchi Katzib ca Oxbuc can katun xicob Chichen.
Ending they end Yokchi Katzib when Oxbuc tells army divide Chichen.
Canlahun hauac tzicil bet puchtun pach yok hunten holcan
14 ceasing obey makes rebel prisoner at once speaker
katun tan Yokchi Katzib. Uxmal ahau dzib katun puchtun
army in Yokchi Katzib. Uxmal king writes army rebel
xicob Yokchi Katzib. Ahau Uxmal bet dzib Hunichob.[9]
divide Yokchi Katzib. King Uxmal makes write Hunichob.

Line 3. Cacab katunob than bet cihi katun ca puchtun pach bet
Commune armies word make saying army when rebel prisoners makes
mazcab xanac; hol bet tan kak chuuctan chunthan katun.[10]
prison remain; hole makes make in fire spoiling president army.

Line 4. Bet puchtun Buluc katun Cachihol Hunichob dzib cacab
Makes rebel Buluc army Cachiquel Hunichob writing commune
Hunichob can yoktan katunob chuuctan. Nak Yokchi
Hunichob telling rebel soldiers to seize in. Ends Yokchi
Cayub yoktan ahau yok Bolon Hunichob.[11]
Cayub rebel chief by Palenque Hunichob.

FREE TRANSLATION OF THE INSCRIPTION OF THE CHICHANCHOB.

Line 1. Huntok in the land of Oxyib. Huntok makes an end of the army of Oxyib. The Hunichob puts the army out of the town of Oxyib. To Oxcabuc, the Hunich of Quiche, he writes word that the chief speaker of the rebel army makes twenty warriors remain in the cells of Katzib. The Yokich of Chichen-Itza, wicked city, puts an end to the chief of the army. The ruler of Oxyib,

Line 2. Oxbuc, asking tribute, the rebels desert the Hunichob, and cause the Cachiquels to be destroyed in the fire hole. Writing a word to destroy, they make destruction in Katzib. The army of the Hunichob makes an end of the prisoners of the army. The army of Oxbuc, plundering in Oxyib, deserts Quiche.

Line 3. The army, hating the chiefs of the army, writes words for the Hunichob to tell Oxlahun-Pek. Oxlahun-Pek makes the president of Uxmal ruler of the town. The Cachiquel army, in asking tribute, makes prisoners of warriors. He makes an end of the dividers of Oxyib by the chief executioner of the town; at one time the Hunichob makes an end of them.

Line 4. The Oxyib desert Chichen. The Oxyib army hates the town, the Oxyib-speaking army saying a word that Oxyib seeks to make written stones sweet-worded in Oxyib speech. The army of Oxbuc, deserting to plunder, makes the united ones of Katzib chiefs of the declarers of rebellion.

Line 5. When the army finds fourteen rebellious Oxyib, Oxlahun writes, telling the army to burn and destroy the speakers of Oxyib. The Hunichob makes an end of the plundering army. The Yokchi of Cawek, in Katzib, the town of the chief of the rebels, recalls to rule the Hunichob, ruler of the commune of Oxyib.

Line 6. The chief executioner of Katzib of Quiche Cawek causes that they destroy the ruler of the rebellious army of Chichen in Oxyib. Oxbuc, ruler of the Oxyib, Cayub, ruler of the army of Quiche, and the army of Oxbuc, make prisoners 400 (one *bak*) rebels of the lord of Uxmal. The ruler Cayub tells the Yokchi of Katzib of the rebellious army to seize the rebels in Chichen.

Line 7. Cayub, the ruler of the army of Quiche Cawek, writes Oxcabuc a letter, asking permission of the ruler for the president to set out over the army to destroy at once the wicked rebels. He writes to cause the rebel prisoners to be destroyed. At once, the chief executioner of Oxyib finally put an end to the rebel army.

FREE TRANSLATION OF THE INSCRIPTION OF THE AKATZEEB.

Line 1. When the army rebelled, it caused the city to be destroyed; it caused thirty Cachiquels of the Hunichob Oxbuc to be destroyed. The rebellious army made destruction, seizing Chichen-Itza, and capturing fifteen Cachiquel chiefs. The spoilers destroyed fifteen Cachiquels. The army of Lahun-Pek joined the spoilers. Zaachilla told the Hunichob the rumour that the rebel army was in rebellion.

Line 2. When Oxbuc told the army to depart from Chichen, they destroyed Yokchi Katzib (or the Yokchi of Katzib). The holcan (chief caller) of the army made prisoners of the rebels in Yokchi Katzib, fourteen at one time, of those ceasing to obey. He wrote the lord of Uxmal that the rebel army divided Yokchi Katzib. The lord of Uxmal made the Hunichob to be written to.

Line 3. The warriors of the commune made a word (promise), saying that the army when it rebelled made prisoners to remain in prison. The president of the army of spoilers made a hole and put fire in it.

Line 4. The Hunichob of Cachiquel made the army of Buluc to rebel, writing to tell the rebel soldiers to plunder the commune of the Hunichob. The Yokchi Cayub destroyed the chief of the rebels by means of the Hunichob of Palenque.

CHAPTER XV.

THE HISTORY RECORDED IN THE CHICHEN-ITZA DOCUMENTS.

The theatre of the rebellion recorded in the two inscriptions was the Cacab, or commune, of Oxyib, in which was a town bearing the same name, and near which, or at least at no great distance from which, were Katzib and Chichen-Itza. Uxmal, Palenque, and Buluc, or Baliz, are also mentioned in the inscription, and the first of these must have been within reasonable distance. The ruins of Uxmal are thirty-five miles south of Merida, and those of Chichen-Itza are about seventy-eight miles to the southeast of the same city. From Chichen-Itza a paved road of ancient construction is said to run eastward to the coast, opposite the island of Cozumel.[1] That coast was, in the days of Maya independence, the boundary of the province of Ekab, one of whose rulers was Ex Box, who, in 1547, destroyed a Spanish vessel.[2] Mr. Stephens found ruins called Yakatzib, near Tekax and Mani, that is to say, to the north of Uxmal.[3] In his Indian map of Mani, however, no such plan appears, but the principal town to the east of Mani is called Oxkuzcab.[4] The Bolon and Buluc of the inscription may be Bolonchen and Bulucchen of Yucatan rather than Palenque and Baliz, yet the latter supposition is not at all improbable.

The Oxyib were evidently a people speaking a different dialect from that employed by the inhabitants of Chichen-Itza, as they wished to have inscriptions in their own tongue, which to them was sweeter or pleasanter than the Maya. The only Maya-Quiche people whose name approaches that of the Oxyib were the Uxab, a branch of the Pokomans, who, in the time of Qikab of Quiche, dwelt in Vera Paz. The Ahau of Rabinal in Vera Paz had first wasted this people, and then Qikab subdued them and him. The remains of the population of their cities constituted that which occupies, even to-day, Coban and its suburbs, called by the Indians of the country, Uxab Pokoma.[5] The Pokomans themselves were a branch of the Mams, and Poko was their distinguishing title. There is no tradition known to the writer of these Uxab of Poko migrating in part to northeastern Yucatan, yet few migrations of peoples have more probability on their side than this. Hemmed in by the aggressive Quiche and Cachiquel rulers, it was but natural that some of their more adventurous spirits should skirt the eastern coast of Yucatan nearest to them, and seek, in its northern part, a home in which, for a time at least, they might preserve their independence.

There is, indeed, little doubt that the Oxyib were the same people as the Uxab of Vera Cruz, and the Ekab of northeastern Yucatan. Poko was the chief title of the Uxab, and Box of the Ekab, while the ruler of the Oxyib or Oxyub was named Ox Buc. These are not fortuitous resemblances. The Mani, and thus the Uxab, dialect was related more closely to the Quiche-Cachiquel group of languages than to the Maya, which explains the desire of the Oxyib to have inscriptions in their own tongue. It would be interesting to know if there are any remains of the old Pokoman dialect in what used to be the province or canton of Ekab, east of Chichen-Itza.

The inscriptions so far read have nothing to say of the conquering Qikab, unless he be the Yokchi Cayub of the armies of Quiche Cawek, whom both the Chichen-Itza documents represent as in a subordinate position to Huntoh and Oxcabuc, the Cachiquel rulers. The inscription of the Chichanchob sets forth Huntoh as the principal personage in the suppression of the rebellion, although the communications with Oxcabuc, the father of Oxlahun-Pek, who is called the Hunich of

Quiche, seem to indicate that he was Huntoh's superior. Oxlahun-Pek is present, an able and active general, but in a subordinate position, as well as Lahun-Pek, who is probably the Cachiquel Lahuh-Ah, Huntoh's son. These documents therefore, are older than those of Palenque and Copan, and, as such, show that the Quiche and Cachiquel MSS. of Brasseur are not to be fully trusted Cayub was the Yokchi, probably the same as the Cachiquel Atsih, of Quiche Cawek, but he had to ask Oxcabuc's permission to put an end to the rebellion, which sufficiently indicates Cachiquel supremacy. The chief officers in Chichen-Itza and Yokchi Katzib were apparently Cachiquels, under the native rulers, whom it would have been suicidal policy to remove.

The revolt of the Oxyib army of occupation in Chichen-Itza, in Katzib, and probably in Uxmal, arose from the tyranny and exactions of their Cachiquel officers, who, among other things, made slaves of the Oxyib warriors as a matter of tribute, and refused to allow them to perpetuate their language in mural inscriptions. It broke out in the town of Oxyib, wherever that may have been within the province of Ekab, and spread to Chichen-Itza, which belonged to another province, that of Conil, adjoining it. The Hunichob Oxbuc, whose jurisdiction seems to have extended to Chichen, succeeded in expelling the revolters from the city, after they had done much mischief in it; but they carried off with them as prisoners a number of Cachiquel officers, whom, apparently, it was their first intention to hold as hostages. These they took to Katzib of which they acquired full possession, and imprisoned there to the number of thirty. Then Oxbuc of Chichen-Itza wrote letters in all directions, asking for help against the rebels, who had already made complaint through him to Oxlahun-Pek of the treatment which the Cachiquel officers had meted out to them. Oxlahun-Pek had appointed the Chunthan or President of Uxmal to take charge of affairs, which he does not seem to have done save by writing letters. Oxbuc and the Yokchi Cayub wrote also to Oxcabuc, and Oxbuc had communications with Zaachilla III. of Oaxaca, and with the ruler of Uxmal on the subject of the rebellion.

Meanwhile the chief of the rebels violated the promise which the revolting army had made in regard to the Cachiquel officers. He made an excavation, filled it with fire, and cast these tyrannical foreigners into it, having, doubtless, been set the example in so doing by his own victims. This is the mystery of the Akatzeeb, which means no dark chamber, but is the name of the town in which the deed of darkness was committed by a much oppressed soldiery. The rebels were joined by the warriors of Lahun-Pek, who is probably the same as Lahuh-Ah of the Cachiquel MS., the son of Huntoh, and the father of Cablahun-Tox, whose name does not figure in these inscriptions. As the army of Buluc is made rebellious in the Akatzecb document, it is likely that it is the same as that of Lahun-Pek. If Buluc were in Vera Paz, in the neighbourhood of the main body of the Uxab, it is easy to understand how the sympathies of its native troops would be with the rebels of the Oxyib or Ekab of Yucatan.

The main instrument in the subjugation of the mutinous troops was Cayub, who is called the *pop* of the army of Quiche Cawek, and also the Yokchi Cayub. The term *yokchi* appears to mean "one set over," but is not unlike Achih, conferred upon the principal leaders among the Achihab or plebeian champions of Quiche. He, in concert with Oxbuc of Oxyib, whom the defection of his main force did not leave without military resources, crushed the rebellion, and took fourteen prisoners, doubtless chiefs or captains of the rebels, whom, according to the counsel of Oxcabuc and his son, Oxlahun-Pek, they burned to death. In addition to these, they made four hundred prisoners, who are called rebels of the Ahau of Uxmal, on account of Oxlahun-Pek having appointed that Ahau, perhaps Nohpat, to be governor of Katzib. Four hundred, in the Maya language *huñ bak*, occurs twice in the Palenque Tablet, denoting the number of rebel soldiers and of civilians, refusing tribute, whom Oxlahun-Pek and Cocyoeza put to death. The use of this favourite number arises out of the vigintesimal method of computation characteristic of so many American peoples. Twenty times twenty probably denoted a very large number, yet, on the other hand, it may have been sacred among the Maya-Quiches, who, seizing so many, may have been satisfied with the sacrifice, and have thereafter stayed their hands. While Cayub and Oxbuc were warring in Yucatan the ruler of Palenque, acting under the orders of the former, subdued the revolters of the army of Buluc or Baliz.

The chief historical import of these Chichen-Itza inscriptions is what they tell of the constitution of the countries of Guatemala, Vera Paz, and Yucatan, at a period not later, according to Quiche and Cachiquel documents, than 1450, the latest possible date for the death of Qikab. But the period must have been a good deal earlier; for Oxcabuc, Huntoh, and even Lahuh-Ah, are represented as having died before him, whereas the inscription exhibits them in the height of their activity. As, however, Oxlahun-Pek did not quit the scene of his conquests till 1510, he must have been a very young man at the time of the Oxyib revolt, even though he is said to have died at a very advanced age. Since Qikab, according to Quiche tradition, was alive at the time, it is evident from there being no mention of him in the inscriptions, unless the Yokchi Cayub be he, that Cachiquel sovereignty was complete, under Oxcabuc and Huntoh, over Guatemala, Vera Paz, and part of Chiapas, as well as over Yucatan. The only apparent competitors with these joint sovereigns in that part of the world were the Zaachillas II. and III. of Oaxaca, whose kingdom interposed between theirs and that of Montezuma I. of Mexico. At the same time, the title Ahpop of the House of Cawek, assumed by Oxlahun-Pek at a later period, nowhere occurs in these two inscriptions, so that it would seem as if the Quiche royal family had, for the time, ceased to be recognized.

Nevertheless, all was done in the name of Quiche and the House of Cawek. Oxcabuc is called the Hunich of Quiche; the Oxyib army is said to have deserted Quiche in rebelling against the Cachiquel officers. Cayub is termed the Yokchi of Cawek; and even the *holdzan*, or chief executioner, in Katzib, is said to be of Quiche Cawek, as well as the *pop* of the army of Quiche. The supremacy of Quiche as the first of the Central American kingdoms is thus recognized, but it is a supremacy under foreign, that is, Cachiquel domination, with no reference to royalty in the line of Qikab. Already the usurpation, which Oxlahun-Pek was yet to make complete in name, had begun in reality in the persons of Oxcabuc and Huntoh. The very rebellion recorded may have been the results of a transference of authority from Quiche to Cachiquel. That the latter were a more cruel race than the former cannot be determined until other monuments of greater antiquity yield up their secrets; certainly, it would have been hard for the Quiche monarchs to have excelled the barbarities of Oxlahun-Pek and his immediate predecessors.

Finally, the position of Oxbuc is a peculiar and not very honourable one. He appears to have been the legitimate ruler of the Oxyibs or Uxabs, his very name in the form Yok Pok marking him as being over the Pokos of the Mams, or Poko-Mams, to whose family the Uxabs belonged. The rebellion of his people was not directed against himself, even as a Quiche Hunichob, but against the domineering Cachiquels; yet he identified himself with the conquerors at his people's expense; otherwise, doubtless, he would have perished with them, and his name and deeds remained unrecorded. His loyalty to so-called Quiche-Cawek was prudent, but the reverse of patriotic. The wonder is that his tribe did not resent his treatment of their warriors, and that his family continued, even after the Spanish conquest, to exercise authority in Ekab.

CHAPTER XVI.

THE AFFILIATION OF THE MAYA-QUICHE LANGUAGES AND TRIBES.

The writer has already indicated points of connection between the Maya-Quiches and the Malay-Polynesian peoples. The erection of massive stone buildings within the Central American area inhabited by the Maya-Quiches causes that area to differ from all others in America, for the stone structures of the Pueblo Indians, of the Mexicans, or even of the Peruvians, are not worthy to be compared with those of Yucatan and the neighbouring countries. There is, therefore, no evidence that the Maya-Quiche architects and masons came to the scene of their labours overland from any other part of the American continent. The nearest point affording ancient works in stone, combined with groups of hieroglyphics resembling those of Palenque, Copan, and Chichen-Itza, is Easter island in the Pacific. It does not follow that colonists of this island passed on to Central America. Its latitude suits better a former habitat of the Mbaya-Abipone tribes of the Gran Chaco in the southern half of the continent, which linguistically are allied, on the one hand, to the peoples of Polynesia, on the other, to the Maya-Quiches of Central, and the Algonquins, etc., of North America. Other Polynesian islands, exhibiting similar stone remains, are the Sandwich Islands in the north, and Tongatabu in the south, with Rota and Tinian of the Ladrones, and the Marshall, Gilbert, and Kingsmill Islands, between. The Ladrones connect, on the one hand, with Formosa, on the east side of which there are similar remains, and on the other, with the Philippines and the Malay Archipelago. In Java and in others of the islands of the archipelago are the ruins of ancient temples and other works, showing more analogy to the architectural remains of Central America than to those in any other part of the world.

It is generally allowed that the Malay Archipelago was the secondary starting point from which the populations called Polynesian and Melanesian were distributed over the islands of the sea. There is historical evidence for the existence of great ocean scouring fleets of large vessels in the Archipelago, at the time when it was first explored by Europeans, and of wholesale expatriations of tribes upon the ocean, consequent upon their defeat by more powerful neighbours or invaders. Those who could successfully reach the Sandwich and Easter Islands, could as successfully discover the western shores of America.[1] The universal Polynesian belief in the enchanted island of Bolootoo doubtless led many adventurous spirits to search for it as a place of rest and happiness, just as Ponce de Leon explored the Caribbean Sea in quest of Bimini, the fountain of youth. But what speaks more strongly in favor of the Malay-Polynesian origin of the Maya-Quiches is the voice of language and tradition. Uniting the Algonquins with the Maya-Quiches in his comparison, and having drawn attention to physical resemblance and similarity of character, together with softness of speech, the writer has said elsewhere: "According to Sir John Lubbock and Dr. Tylor, the Polynesians do not worship the heavenly bodies. I do not know whether this is the case with the Mbaya-Abipone family or not, but solar worship had, at least, no prominence among the Maya-Quiches, and was unknown among the Algonquins, before the adoption of the Delawares into the Iroquois confederacy. On the other hand, the Dacotahs, Iroquois, Choctaws, Natchez, Mexicans, Peruvians, Muyscas, and Chilenos were sun worshippers. The heaven of the latter peoples was supposed to be continental, happy hunting grounds in some distant region, or it was celestial, above the clouds; but the Algonquin heaven was, like that of the Polynesians, an island in the ocean. The Abbé Maurault, in his Histoire des Abénaquis says: 'Ce Grand Esprit résidait sur une île du grand lac (l' Océan Atlantique).' In this we find an evidence of insular derivation. The same appears in the story of the creation of the world. Maui of New Zealand, with whom Dr. Tylor compares the Algonquin Manitou or Monedo, fished up the earth with a hook from the universal ocean, as did Tangaloa of the Friendly Islands. The Quiche Tohil, Tzakoll or Tockill, who is undoubtedly the Malay-Polynesian Tangaloa or Tagala, according to the Popol-Vuh or sacred book of the Quiches, called the earth into being in a similar waste of waters. The Ojibbeways and Delawares tell an identical story of Manitou; while other Algonquin tribes made the rat his agent in the work of creation. The notion of the Ojibbeways of Lake Superior that they inhabited an island, and their habit of alluding to the American continent as such, seemed surprising to Kohl, the traveller, who imagined it to be the result of knowledge acquired by exploration, instead of a necessary result of their system of cosmology.

"In their un-Darwinian account of the origin of man, the Malay-Polynesians, Algonquins and Maya-Quiches agree. The Tagalas of the Philippines believed that 'mankind sprang out of a large cane with two joints, and the man came out of one joint and the woman out of the other.' In Samoa the tradition is that the first land brought forth wild vines, and, from the worms which developed when they rotted, men and women were produced. According to the Delawares, Manitou, having brought up the first land from the ocean, made man and woman out of a tree; and in one of the Ojibbeway legends in Kitchi-Gami, the first man appears among the reeds which Manitou had planted upon the shore. Compare this with the Quiche legend, in which, 'man was made of a tree called *tzite*, woman of the marrow of a reed called *sibac*,' and there appears an agreement in tradition to which I know of no parallel. I have already stated that the Quiche or Maya-Quiche Tockill is the Polynesian Tangaloa, and the eponym of the Tagalas in the Philippines. This is confirmed not only by the identity of the Tagalan and Quiche accounts of the creation of man, but also by the appearance of the Quiche deity Bitol in the Tagalan Bathala, just as the Algonquin Waubuno reappears in the Polynesian Ofanu. The Algonquins, Quiches and Abipones agree with some Polynesian peoples in identifying the soul with the shadow; and Dr. Tylor in his Primitive Culture, draws special attention to 'the conception of the spirit voice as being a low murmur, chirp or whistle, as it were the ghost of a voice, a conception common to the Polynesians and the Algonquins.'"[3]

Besides Tohil or Tockill and Bitol, the name of the Quiche god Tepeu occurs in Tongan and other Polynesian mythologies, as that of one of the sons of Tangaloa, namely Toobo, while the other, Vaca-acow-ooli, probably represents the warlike Vaku, the Quiche bird-god in attendance upon Hurakan. The deity Onafanna of Navigator's Islands answers to the Maya-Quiche Hunahpu. Turning to tribal names, the Mayas probably have their eponym in the Polynesian god Maui, and some of the Maories and the inhabitants of Moa bear their name. The Poko-Mams may be compared with the Bugis of Celebes. As the Algonquin Abenakis and Illinois connect with the island of Opoun of the Navigator's group, and many places similarly named elsewhere in the area, and with the Illinoans of Borneo, so the Ititepanes of the Philippines, and the Marquesas' island names, Fatuhiva and Nukahiva, probably represent slightly aberrant forms of the Oxyib, Uxab, and Ojibbeway name. In the Malay archipelago, the influences, first of Hinduism, both Brahman and Buddhist, and afterwards of Mahometanism, have done much to obliterate the traces of the original inhabitants, so far as history and tradition are concerned. Nevertheless, it may yet be possible to point out the precise localities whence the Maya-Quiche, Mbaya-Abipone, and Algonquin tribes first set out for their long voyage over the Pacific Ocean. For such a task the writer has, at present, neither the time nor the opportunity. The evidence of language is what he desires mainly to present. By extracts from a previous paper published elsewhere, he seeks to shew the radical agreement of the American families here affiliated, and their radical disagreement with the Iroquois and the great group of languages to which it belongs.

"There are three important differences in structure which separate Algonquin from Iroquois grammar. The former frequently makes use of prepositions like the Aryan and Semitic languages; the latter invariably employs postpositions, like the (northern) Turanian tongues Thus, in Cree, one of the most widely distributed Algonquin dialects, *tchik-iskutek* means 'near the fire,' *tchik* being the preposition 'near;' but, in Iroquois, the same expression is translated by *ontchicht-akta*, in which *akta*, 'near,' is a postposition. The place of the temporal index in the order of the verb is a second distinguishing feature of the two grammatical systems. In the Iroquois the mark of time is final, although it is sometimes implemented by a prefix to the initial personal pronoun; thus in *ke-nonwe-s*, I love, *ke-nonwe-skwe*, I loved, *wake-nonwe-hon*, I have loved, and *enke-nonwe-ne*, I shall love, *s*, *skwe*, *hon*, and *ne* are the indices of present, imperfect, perfect and future time, *nonwe* being the verbal root, and *ke*, the pronoun. But in Algonquin, the temporal index is, in the more important tenses at least, prefixed to the verbal root; so that in *nin-gi-sakiha*, I have loved, and *nin-ga-sakiha*, I shall love, *gi* and *ga* are the indices of the perfect and future respectively, *sakiha*, the verbal root, and *nin*, the personal pronoun. A third peculiarity of Algonquin grammar is that the accusative or direct regimen follows the verb. It is true that the same order appears frequently in Iroquois, but the principle of the group of languages it represents, as exemplified in the case of pronominal accusatives, is to place the verb after its regimen. As regards phonology, the difference between the Algonquin dialects and those of the Iroquois is well marked. The soft vocalic forms of the Ojibbeway, the Nipissing, the Cree, the Delaware, present a remarkable contrast to the more manly, but harsh and guttural utterances of all the members of the Iroquois family."

"In Central America there is an important family of languages, known as the Maya-Quiche. Of the Maya, Dr. Daniel Wilson (the late Sir Daniel), in his address before the American Association for the Advancement of Science says: 'It strikingly contrasts in its soft vocalic forms with the languages of the nations immediately to the north of its native area.' Here then is the same phenomenon that is presented by the Algonquin languages. I do not propose to make the Mayas Algonquins, nor the Algonquins Maya-Quiche, but simply to indicate their common relation to a parent stock. All the Maya-Quiche dialects use prepositions, while the surrounding languages, Aztec, Mixtec, Pima, Tarahumara, etc., employ postpositions. The Quiche verb, again, is the precise analogue of the Algonquin, the only difference being that the pronoun, instead of occupying an initial position, intervenes between the temporal index and the root. Thus, in *ca-nu-logoh*, I am loving, *xi-nu-logoh*, I have loved, and *ch-in-logoh*, I shall love, *ca*, *xi* and *ch* are the indices of present, past and future time, *xi* and *ch* being the equivalents of the Algonquin *gi* and *ge*, or, better still, of the Cree *ki* and *ka*. In Maya also the accusative seems to follow the governing verb as in Algonquin. There is, however in these languages an important syntactical peculiarity which does not appear in Algonquin, so far as is known to me; it is the postposition of the genitive without sign, as in the Semitic and Celtic languages. Thus in Maya, *upoc Pedro*, 'the hat of Peter,' reverses the order of the Iroquois, Dacotah and Choctaw, which is that of the English, 'Peter's hat.' The Algonquin dialects follow the latter order, and it may fairly be asked whether this be not a result of surrounding influences rather than one of the original forms of Algonquin speech. Apart from this, however, there are, in the use of prepositions, the preposition of the temporal index and the postposition of the accusative, together with phonetic coincidence, links sufficient to ally the Algonquin with the Maya-Quiche languages.

"The next great family of languages which employs prepositions is found in La Plata and Paraguay on the Gran Chaco, and is known as the Mbaya-Abipone, including the Mocobi, Toba, Lengua, and other dialects. Here, again, we meet with "soft vocalic forms," contrasting more or less with the manlier utterances of the Peruvian and Chileno tribes, who almost invariably employ postpositions. The verb, again, is essentially the same as that of the Quiche, the pronoun intervening between the temporal index and the root; thus in *ne-ya-enagui*, I came, *de-ya-enagui*, I shall come, *ne* is the index of past, and *de* of future time. But, in the neighbouring Peruvian and Chileno languages, the temporal index follows the verbal root, as in Iroquois, Dacotah, etc. Of the positions of the accusative and genitive in this family I am not able to speak. It is worthy of note, however, that in Mbaya the adjective follows the noun it qualifies, while in the Maya-Quiche and Algonquin languages it precedes, as in the majority of American tongues. The identity in form of the Mbaya and the Quiche verb, a form in itself so peculiar, and differing so widely from those of nearly all other American languages, is the main link uniting the earlier fortunes of the Mbaya-Abipone family with those of the Maya-Quiche and the Algonquin.

"Turning now from America, where can the philologist discover a language or group of languages that will satisfy the grammatical conditions of the prepositional American family in comparison? Such language or languages must be soft, abounding in vowel sounds, must employ prepositions, must set the temporal index before the verbal root, and, if we take the Quiche and Mbaya as typical, must also make it precede the pronoun before the root, must postpone the accusative to the verb, and probably the genitive to its governing word, and the adjective to its noun. These conditions are numerous enough to satisfy the most exacting critic. I do not profess an exhaustive acquaintance with the grammatical systems of the Old World; but after a survey of the most important of these, I find one that does fulfil all the conditions and only one. It is that of the Malay-Polynesian languages, which cover the vast area from Malacca to New Zealand, and from Madagascar to the Sandwich and Easter Islands. Every one who has ever heard of these languages knows that they carry the palm for soft liquid sounds over all other tongues. They use prepositions, and prepositions exclusively. Their verb is identical in structure with that of the Quiche and Mbaya. Take, for instance, the verb "to make," in the language of the Tonga or Friendly Islands, which is *gnahi*, and compare it with the corresponding Mbaya verb *yoeni*; the Tongan *ne-oo-gnahi*, I made, and *te-oo-gnahi*, I shall make, are not simply analogous to, but identical with, the Mbaya *ne-ya-yoeni, de-ya-yoeni*. In the case of the accusative *na-ia-gnahi he togi*, "he made axes," is a Tongan sentence exhibiting its position after the verb in the Malay-Polynesian languages, thus furnishing a fourth point of agreement between these languages and the prepositional American forms of speech. The nominative was found to precede the genitive in the Maya-Quiche, and this is its position in the Tongan, as in *tama he mataboole*, "the child of the chief." Finally, in Mbaya the adjective follows the noun; and the Tongan *he tangata lille*, a man good," shews that it is thus in accordance with Malay-Polynesian order."[4]

The agreement between Malay-Polynesian and Maya-Quiche grammar would be unconvincing in regard to the relationship of the peoples speaking these languages, without the support of their respective vocabularies. The comparison of these exhibits certain peculiar tendencies of the Maya, which, for the sake of unity, is alone compared in the list furnished in the Appendix, with the Malay-Polynesian dialects, such as its replacement of the insular t by c, and its addition of final l to the roots of verbs in many cases. As a literary language, however, it is more likely to have retained the ancient forms of the original Malay-Polynesian classical speech than those languages and dialects with which it is now compared. It is well known that in many parts of Polynesia the priesthood employed hymns, prayers and incantations, the meaning of the language of which was entirely lost when the islands were first explored by Europeans.[5]

CHAPTER XVII.

FACTS CONNECTED WITH THIS AFFILIATION.

The Maya-Quiche peoples had the rite of circumcision which they administered along with that of baptism, called in Maya *caputzihil*, or the second birth. According to Landa this took place at the age of three, or at some point between three and twelve, but, according to Brasseur, it was not long after the birth of the child.[1] The writer has not been able to find the Maya word for circumcision. The rite is observed in Java and other islands of the Malay Archipelago, but as in eastern Africa, it seems to have come through Mahometan influence.[2] It existed, however, in the Fiji, Friendly and Society Islands of Polynesia.[3] In the Tonga or Friendly Islands it was called *tefe*, and in Fiji, *camo*. The forms of this ceremony are described by Mariner, as practised in the two groups which have contributed largely to the comparative vocabulary.[4] The Mexicans did not circumcise, and the late Rev. Abbé Cuoq, in conversation with the writer, stated that the Iroquois have a word for circumcision, the mention of which excites in them violent hatred or abhorrent contempt. Like the Maya cartouches, this rite leads back to Egypt, where circumcision prevailed, though by no means universally, to Ishmael, Ammon, Moab, and Edom on its borders, to the Sanni of the Black Sea, and the Odomantians of Thrace, rather than to Lord Kingsborough's Lost Tribes of Israel. The union of baptism with circumcision among the Maya-Quiches is much more difficult to account for, yet the Mexican priests baptized.

The *mishla* drink described by Mr. Squier in his Adventures on the Mosquito Shore is of the same nature and of the same disgusting preparation as the *cava* of the Tonga Islands, and seems to have been the liquor with which Mayas, Quiches and Cachiquels made beasts of themselves in ancient days, for, according to Brasseur, sobriety, on the occasion of festivals, was not characteristic of these peoples.[5] The Maya name of the pulque liquor which takes the place of the Polynesian *cava* is *cii*. In the number of their feasts, in their dances, their caste system, the absolute rule of their kings, their excessive imposts, their human sacrifices, and idolatrous scarifications, as well as in a host of other things, the Polynesians and the Maya-Quiches were virtually one people. The writer has not discovered the *taboo* of Polynesia in Yucatan and Guatemala, but as the ceremonies of the two populations were the same it is not likely that this was wanting in Central America.

A reference to the comparative vocabulary will show that, while the Tagala of the Philippines exhibits numerous correspondences with the Maya, the fuller dictionary of the Tonga displays a closer resemblance. The Tongan *how*, a king, answers to the Maya *ahau*; its *cow catanga*, the suite of a chief, to the obscure Maya *katun*, a body of troops; and its *fatongia*, a tax, impost, work to be done to discharge a tax (statute labour), to the equally obscure Maya *patan*, tribute. Java supplies the best equivalents of the Maya *uinic*, man, and *atan*, wife, in its words *wong* and *wadhon*. The Maya numerals are very unlike those of the Malay-Polynesians at the present day, and have most of their affinities with those of the Pelew and Caroline Islands. This would suggest a migration route north of the equator. The Maya name has undoubted connections with that of Maui, the ancestral god of many Polynesian peoples, which, geographically, is represented by the native names of important islands, in New Zealand in the south, and in the Sandwich or Hawaiian group in the north.

One important result of word comparison is that of the Maya *ixim*, maize, with the Malay *jagung* or *yagung*. The Huastec form of the word is *ajam*. The discovery of maize forms a striking episode in the native legendary histories of the Quiches and the Aztecs. The Popol-Vuh of the former represents Gucumatz, or The Plumed Serpent, as going in search of it; and the Mexican Codex Chimalpopoca attributes its discovery to Quetzalcoatl, whose name is supposed to have the same signification. One of my former correspondents, the late Dr. Short, in his North Americans of Antiquity, indicates that the Mexican account was probably borrowed from the Quiche.[6] Referring to the introduction into Mexico of the cultivation of maize and cotton, Dr. Pickering says: "Now, the art of cultivation could not have been derived from Oregon, where the idea was aboriginally absent, a state of things connected apparently with the high northern source of the Mongolian population of America, the climate precluding agriculture in the parent countries.

If, then, this art was introduced from abroad into America, it must have arrived by a more southern route, and, to all appearance, through the medium of the Malay race. I would remark further, that the route must have been yet south of San Francisco, where I observed only one, and that a doubtful, instance of aboriginal agriculture."[7] But Humboldt says, "It is no longer doubted among botanists that Maize, or Turkey corn, is a true American grain, and that the old continent received it from the new." Humboldt was in his day a very wise man, but far from infallible. To his statement Mr. Crawford replies, referring to the Malay name for maize: "The word *Jagung*, which I imagine to be purely native, is the term by which this plant is known from one extremity of the archipelago to another. There can, therefore, be little doubt, as in the case of rice, that one tribe instructed all the rest in its culture. As far as a matter of this nature is capable of demonstration, it may also be conjectured that maize was cultivated in the Indian islands before the discovery of America, and that the plant is an indigenous product. The name bears no analogy to that of any language of America, although, in respect to their other exotic productions, whether animal or vegetable, either the native term, or one which points at the origin of them, is invariably preserved in the languages of the Indian islanders."[8] There can be little doubt that Mr. Crawford is right, even although the Malay name looks like a corruption of the older Maya, the original of which may have been *gucum*, as in Gucumatz, to denote its feathery aspect, upon which the Algonquin mind dwells in the fable of Mondawmin.[9]

When the migration took place that brought the Maya-Quiche peoples to the west coast of America it may be difficult, even impossible, to tell, for it is evident that the Books of the Katuns, or chronological tables, of the Mayas embrace events belonging to periods in their history so ancient as to be generally regarded as mythological. They were undoubtedly in their seats when the Othomis and Toltecs arrived in Mexico, in the beginning of the eighth century, A.D. Between that time and the fifteenth, to which the inscriptions read in this treatise belong, there was abundant time for developing the high culture of a certain kind which they indicate. There is no evidence of Sanscrit or Arabic influence in their dialects such as is found in the languages of the Malay Archipelago, as would naturally be expected from the distance of their time of separation from the parent stem; nor does the Javanese calendar, the only native Malay calendar surviving, shew any affinity to that of the Mayas.[9] We have not even the means of determining when the Malay islands were first peopled. It is possible that hieroglyphic texts on stone may yet be found in the line of Malay-Polynesian migration. The writer observes that Dr. A. Carroll, of the Polynesian Society of Wellington, New Zealand, has presented some translations of the Easter Island Tablets, which are said to deal with South American history prior to the times of the Incas of Peru, but has not so far been able to examine them.[11] If Dr. Carroll's readings be correct, the result rather inverts the order of thought on the subject, and favours De Zuniga's derivation of the South Sea islanders from America.[12]

Many of the commoner and almost universal Malay-Polynesian words are wanting in Maya, nor are they found in the allied dialects. Such are *lima*, the hand, *mata*, the eye, *langi*, the sky, *api*, fire, and *weh*, water. But the words that remain evidence as plainly their Malay-Polynesian origin, and, with a little trouble, and more extensive vocabularies than the writer possesses, the laws of phonetic change governing their permutations might easily be formulated. Thus, *xicin*, the ear, stands to the Tagalan *tayinga*, as *uinic*, a man, does to the Polynesian *tangata*. Perhaps the fairest way to exhibit relationship is to confine the comparison to two dialects, placing the Maya and the Tagala side by side, it being kept in mind that the author's vocabularies of each, and especially of the Tagala, are far from complete.

	Maya	*Tagala*		*Maya*	*Tagala*
enemy	ahaual	caauay	dem. pronoun	lai	yari
night	akab	gaby	east	likin	silangan
child	al	aro	to leave	lukul	lacar
mat	bac	banig	earth	luum	lupa
flesh	bak	paa	mother	naa	yna
to pay	botah	bayar	south	nohol	tanghali
when	ca	cay lan	old	nucte	matanga
we	ca	cami	to break	pa	punitin
tree	che	cahuy	servant	palil	bulisic
to seize	chuuc	coha	coast	pay	bay-bay
to sew	chuy	tahi	to call	pay	ta-wag
head	hol	olo	fighting	puchtun	pagaanay
brave	holcan	halga	heart	puzcical	pozo
husband	ichan	asauah	to deceive	tabzah	daya
hand, arm	kab	camay	to return	tulpach	toloy
gold	kantakin	guinto	moon	u	buan
to bear	koch	hatir	good	utz	ygui
to come	kuchul	pan-galing	to remain	xantal	hintay
aversion	kuxil	sala	ear	xicin	tayinga
rel. pronoun	lai	alin	father	yun	ama

These languages have existed apart, with all the Pacific Ocean between them, for, at the very least, a thousand years. The wonder, therefore, is not to be able to find so few and such distant resemblances, but so many and so close. Where in the Old World did the civilization originate, which, driven from its primeval seat, left its architectural traces in Java, and scattered them over the islands of the Pacific, which carried literature in its train to ornament the present savagery of Easter island, and to adorn the walls of Palenque, Copan and Chichen-Itza? It was the civilization of the oldest nations of the world, told in many an ancient song and story. The writer has much to say on that subject, but reserves himself until the critics have begun to be critics indeed, that is, to drop preconceived notions, falsely termed those of science, which, in many fields of antiquarian research, have led to and will always lead to nothing, and to adopt a little real study of their subjects in the light of common sense. Misled by Landa's spurious alphabet, the interpreters of the Maya codices are still floundering in obscurity, while the true method of interpretation is patent to any candid observer. The same is true regarding Sinaitic, Hittite, Susian, Lat Indian, Siberian, Mound-Builder American, Etruscan interpreters and many more, whose labours proceed upon a pin-head of worthless authority, as valueless to the interpreter as the traditional straw to the swimmer. Authority, in many cases of the mysterious at least, is a useful thing to discard.

APPENDIX I.

NOTES TO THE CHAPTERS.

Chapter I.

1. Ap. Brasseur de Bourbourg, Nations civilisées du Mexique, etc., Tome I., p. 68.
2. Stephens and Catherwood, Incidents of Travel in Central America, Chiapas, and Yucatan; Bancroft, Native Races of the Pacific States, Vol. IV.; Baldwin, Ancient America; Short, North Americans of Antiquity; see also a good essay in the American Antiquarian, Vol. VI., p. 53.
3. Nations civilisées, Tome I., page 82.
4. Baldwin, Ancient America, 105 seq. Mr. Baldwin was in error in supposing the Maya characters to be understood.
5. Short, North Americans of Antiquity, 344 seq.
6. Morgan, Houses and House Life of the American Aborigines, Smithsonian Contributions to North American Ethnology, Vol. IV., pp. 268-9.

Chapter II.

1. The Tablet of the Cross at Palenque, American Antiquarian, Vol. VI., p. 53.
2. Warren Watson, The Tablet of the Cross, Kansas City Review, Vol. VI., p. 269.
3. Stephens, Incidents of Travel.
4. Brinton, The Names of the Gods in the Kiche Myths, p. 22.
5. Brasseur, Nations civilisées.
6. Kenrick, Ancient Egypt under the Pharaohs, II., 277.
7. Edinburgh Review, April, 1867, p. 341.
8. Crawford's Indian Archipelago, I., 283, plate.
9. Prichard, Latham, Brassey.
10. Thomas, A Study of the Manuscript Troano, pp. 205-6.

Chapter III.

1. Orozco y Berra, Geografia de las lenguas y Carta Etnografica de Mexico; Malte Brun, Tableau de la Distribution ethnographique des nations et des langues au Mexique.
2. Brinton, Aboriginal Authors.
3. Brinton, Introduction to Codex Troano, and Introduction to The Maya Chronicles Thomas, A Study of the Codex Troano; Léon de Rosny, Codex Cortesianus, Codex Peresianus.
4. The Maya Chronicles, etc.
5. Perez and De Rosny ap. Short.
6. Brinton, Introduction to A Study of the Manuscript Troano, p. xx.

CHAPTER IV.

1. Rau, Tablet of the Cross at Palenque, Smithsonian Contributions.
2. Brasseur, Nations civilisées, Tome II., p. 525.
3. Brasseur, II., 478.
4. Brasseur, III., 338, 355.
5. Brasseur, II., 530.
6. Brinton, The Maya Chronicles, 247.
7. Brasseur, II., 579.
8. Brasseur, II., 478.
9. Brasseur, II., 533-4.
10. Brasseur, II., 535, seq.
11. Brinton, The Names of the Gods in the Kiche Myths, 11.

CHAPTER V.

1. Brasseur, III., 369. There are chronological difficulties in the way of Cocyopi at this time.
2. Brasseur, IV., 624.

CHAPTER VI.

1. Brinton, The Names of the Gods in the Kiche Myths, 11.
2. Popol Vuh; Brasseur, Nations; Brinton.
3. Brinton, The Names of the Gods, 16.
4. Brinton, The Names of the Gods, 11.

CHAPTER VII.

1. Analysis of the Palenque Tablet: Left side.
   ox, three.
   kaxul, kuxil, disgusted.
   ahauob, chiefs.
   Nakhun, proper name of a Huastec tribe.
   Uactokob, Huastecs, in the genitive of position to Nakhun.
   Bolon pak, literally, the nine building or stone wall, meaning the fortress of Palenque.
   Holhun, literally, fifteen, standing for Holom, a town of Vera Paz.
   puchtunob, plural of puchtun, quarreling, fighting.
   Uaxac, literally, eight, denotes the State of Oaxaca.
   Hunich, literally, one face, or it may be *hun edz*, the one established, a new word.
   nak-xicin-ob, a compound verb, consisting of *nak*, to finish, and *xic*, to split, divide, in the third person plural. It is hard to account for the *in* of *xicin*, and one is tempted to make the verb still more complex, as *naki-dzanob*, they finished devastating, for *dzan* is to devastate.
   Oxmuyal, the three clouds, denoting Uxmal in Yucatan.
   ox, three, standing for *yok*, before.
   tzem, *tan*, breast, for *dzan*, to devastate.
   xulob, third plural of *xul*, to end.
   holpop, a chieftain.
   cah, town.

Cawek, the name of the Quiche dynasty.
pet, wheel, for *bet*, *betah*, to do, to make.
Canich, a proper name, the ruler given to Uxmal by Quiche.
Nohpat, the last king of Uxmal.
cah, the verb substantive.
xkan dzulop, for *yaxchun*, beginning, *tsolob*, lines.
chitsol for *tsicil*, obedient.
ahauob, lords, needs no further notice in the Analysis, nor does
Uaxac, Oaxaca.
ppoc ppul, for *popol*, people; *ob*, the plural.
kabbak, for what the dictionary gives as *keban*, sin, evil.
dzib for *cib*, desire.
ox, three, for *yok*, over.
kak for *coch*, to spread.
kachilek for *kuxil*, disgusted; the final *ek* resembles the *ac* in *kebac*, wicked.
kuxilek ahauob Uaxac are now known words.
xic-mol, composed of *xic*, to divide, and *mol*, together.
can, four.
Bolon, Palenque.
tokob for *toxob*, which is the plural of *tox*, to pour out, but also to divide towns to different rulers. As a noun I read it *nomarch*.
ox Buluc tokob, three nomarchs of Buluc, perhaps, Baliz. Literally, *buluc* is eleven.
uuc, seven.
caantok, perhaps for *catac*, and.
ox xic ahauob have occurred before, as have *Uxmal ahauob*.
Ox Winic, literally three men, but denoting a dignitary called in Cachiquel the Atsih Winak.
canob, plural of *can*, to converse, talk.
xic, division, *mol*, together.
ox for *yok*, over.
dzib for *cib*, desire.
kab for *keb*, an abbreviation of *keban*, wicked.
caan u, for *cah*, the verb substantive, and *u*, the possessive pronoun.
Uxmal pak, the Uxmal building, fortress or city.
Nohpat ahau are known terms.
thun-xicin-ob, an expedient for *than*, word, *ci*, sweet, pleasant, and *canob*, they talk, or rather, *can-ob*, they talked.
Cah Cawek akkuleh, the *ahkuleh* or lieutenant of the House of Cawek.
Oxcabuc, in Cachiquel Wukabatz, the chief Cachiquel adviser of King Qikab of Quiche.
Hunco should evidently be read *Huntoh*, for such is the Cachiquel name of the colleague of Wukubatz.
poppol for *popol*, people.
pet for *bet*, to make.
nakkab for *nahuba*, to desire for one's self.
chipettokob for *cib betahob*, they make the wish.
Oxlahun Pek, the Cachiquel Oxlahuh-Tzy, literally Thirteen Dogs.
hun ahau ahauob, one king of kings.
Bolon pak no longer needs translation.
kapettan for *kebanthan*, to plot evil, to commit treason.
toh as in *Huntoh*, right, just.
hokachiob for *hokzahuba*,, to take oneself away from.
xicin, the ear, hearing.

ca, two.
canob, from *can*, to tell.
Cablahun Tok, in Maya *Lahca Tok*, in Cachiquel *Cablahuh Tihax*, Twelve Flint Knives, the name of the colleague of Oxlahun Pek.
lahun, ten.
hun xicin ox ox kab chup, for *hun xicin czah yok keb cib*, in which *ezah* is to discover, make public, while *yok keb cib*, over evil desire, are well known.
ppoc-chi for *paxi*, aorist of *paxal*, to abandon.
kax, united.
cabaktun for *kebacthan*, now *kebanthan*, to rebel.
pettunyub for *patan*, tribute, and *ob*, plurality.
ca, when.
catunob for *katanob* from *kat*, to ask. The *au* or *un* is unexplained.
mazcabcun, for *ma*, no, *edzcab*, promptly, and *can*, to say.
kabox for *kubuc*, compare Maya *kubulte*, delivery, deposit. This form is new.
poppul for *popol*, people.
catunob for *katun*, a body of warriors.
nakob, from *nak*, to finish in the sense of defeat.
Cacul, a proper name of a rebellious chief.
Winic Yub, the same as Ox Winic, who in the Cachiquel story bears the name Cay Hunahpu.
Uaxaclahun, literally eighteen, but standing for *Oaxaca* and *lukun*; compare *lukul*, *luki*, *lukuc*, to leave, and *lukanil*, that which is separated.
capetchi, query the Maya *chunbezah*, to begin, and *cambezah*, to instruct; some officer or leader. A new word.
huntun, for *hunten*, at one time.
caich, probably for *chaac*, to take.
cacaueb for *caxan*, to seek, to find.
kab chup for *keb cib*, evil desire.
ppoc for *pach*, to take possession of.
ox ca meex, for *yok*, over, and *kamah*, to take possession of.
zuc for *hayac*, but in Maya, *hayal*, to destroy.
tok for *toc*, to burn.
ox kulel for *yoklal*, by reason of, because of: query, by means of,
Uaxaclahun, literally eighteen, but containing *Uaxac*, Oaxaca, *lai*, those, and *u*, their.
ich, in.
ox hun-xul for *yok hunkul*, over forever.
kax, united, as above.
nakxicinob, as in the beginning of the inscription.
ox hol, query *nacchahal*, to emerge forcibly.
capetchi, see above, an unknown office.
oxtokob for *yok*, over against, and *tock*, to contend, hence opponents or rebels.
capethun, a variant of unknown *capetchi*,
Caichxik, a proper name of a revolting chief.

2. Analysis of the Palenque Tablet: Right side.

ahpop, a Quiche title of royalty, Brasseur.
puchtunob, plural of *puchtun*, quarreling, fighting.
Uuclahun, literally seventeen, stands probably in its Cachiquel form *uuclahuh* for Zaachilla of Oaxaca.
Cakaaxha, the proper name of the 4th Zaachilla, namely Cocyoëza.
Cackxuk, or the Caichxik of the left side.
xic, united, *mol*, together.

can, very, *kax*, united.
nakob, they finish.
katunob, is a verb meaning to make war, to fight, in this place. See Brinton, Maya Chronicles, p. 58.
pak, building, town, *mol*, together.
lahun for *lukun*, deserting. See left side.
Uaxaclahun, eighteen, for *Uaxac lai u*, Oaxaca those its.
ox tokob, for *yok-tockob*, fighters before or against, rebels.
ho caban, query an expedient for *yok chaben*, I take over.
canlahun, fourteen.
kaaxob, for *chuucob*, prisoners.
ppoc-ppul for *popol*, people.
ca, when.
kin for *ahkin*, priest.
Cablahun, the colleague of Oxlahun.
ich, in.
katun, army, body of troops.
can, to tell.
dzib for *cib*, desire.
puchtunob, they fight.
chi, border.
canlahun, fourteen.
holokob for *holoch-ob*, houses.
yok, over.
bet for *betah*, to make.
canbaktun for *can*, very, and *puchtun*, quarreling.
oxtokob for *yok-tock-ob*, rebels, opposers.
oxkin for *hokin*, I set out.
Uaxac-lahun, eighteen, for *Uaxac lai u*, Oaxaca these its.
lahun for *lukun*, to desert, separate.
pakmol-ob ; *pak*, town, *mol*, together.
Uaxaclahun is *Uaxac lukun*.
Tunxicob, the name of the city or State of Cacul.
Cacul, a rebellious chief, in genitive of position to the preceding.
canpak. Is this the Chunbezah again?
kalkab for *kal*, to imprison, and *chab*, to take.
Tunxicinob, a variant of Tunxicob. Could the ear have been simply *xic?*
ca, when.
hopet for *ubah*, to hear, understand.
holokob for *holochob*, houses.
uuc-kin for *hayac*, to destroy. The following *kin* is unaccounted for.
Caheab Uuclahun ahau, is a Zaachilla king, and the only one so called is Cocyopi, son of Cocyoëza.
uuc for *hauac*, *hani*, *haual*, but *hauac* is future, to cease, to stop.
can, to speak, *mol*, together, *canmol*, to parley.
hopoppet for *ubah bet*, to hear makes.
cancax, very united.
capach for *chab*, to take, *pach*, possession.
uaxaclahun, eighteen.
Uactokob, Huastecs. See beginning of left side.
nakob, query from *nakal*, to approach, join.
canpakchi, more like the Chunbezah or leader.
Lahun Pek, probably the Cachiquel Lahuh-Noh, son of Cablahuh-Tihax.

Bolonlahun, nineteen, but here Palenque and *lukun*, separating.
uuc tokob for *hayac tockob*, they will cease to fight.
nakob, as above; they join.
pak-ca pek-bak for *pach*, possession, *chab*, to take. This leaves *ek-bak* unexplained.
hunkal, one twenty or score.
nakob, as above, they join.
hokin, I set out.

3. Analysis of Detached Groups: G to L 6.
kachilek for *kuxil*, disgusted.
ca, when.
pettun for *patan*, tribute.
katun for *kat*, to ask.
cantun for *chunthan*, president.
ox kulel for *yoklal*, by means of, because of.
ca, then.
kachilek, as above.
chabob from *chab*, to seize, to kill.
Hunich, an officer otherwise unknown.

4. Analysis of L 7-10.
uaclahun, sixteen, as the Cachiquel *uaclahuh* might stand for *yoklal*, because of, but is somewhat doubtful.
huntun for *hunten*, at one time.
tokob for *tecob*, they burn.
capetich, another variant of *chunbezah*.

5. Analysis of O, P, Q and O 2-3.
pethun for *patan*, tribute.
Bolon ich, Palenque in.
ca yub for *chaal*, to take, kill.
ox pet kab for the common formula *yok bet keb*, over doing evil.

6. Analysis of R.
pakob uac, towns six.
tokob for *toc-ob*, they burn. This makes the plural name of Oxlahun Pek require a plural verb.
uaxac, eight.
Cah Cawek Ahau Ahpop, the full title of the Quiche kings.
caxul, perhaps *cuchul*, family and retainers, subjects.
ox pet kab, the old formula *yok bet keb*, over doing evil.
caox, query, *chaah*, to kill.
ca, when.
oxtokob for *yoktock*, to fight before or over against.
pattun catun for *patan katan*, tribute asking.
pet tun catun pop for *patan katan pop*, the tribute asking, *pop* or mat, the mark of office, a Cachiquel seat of custom.
ca, then,
ppocxul for *paxal*, to depopulate.
cacab, a commune.

7. Analysis of M and N.
Ho Cakulel for *Ku*, a god, and *Cakulel*, a name of Tepeu. Brinton's Names of the Gods in the Kiche Myths, 11.
Ho Hunnakpet for *Ku*, and *Hunahpu*, a famous deity, like the Babylonian Nabu or Nebo.
Ho Paktunox, perhaps *Ku Puchtun-yok*, the fighting over or conquering god, identified with the bird of the Tablet, *Vor*, *Vaku*.

Ho Holhun for *Ku Holcan*, the warrior god, also known as *Hurakan*.

8. Analysis of Basal Inscription.
   ca, two.
   popob, mats or thrones.
   Holhun for Hurakan.
   nuc for *hayac*, destroy.
   Buctanox for *Puchtunox*, the bird *Vaku*.
   cankax, very united.
   kulel, enter.
   hun, one.
   Pak is the only remaining new word, and its meaning here is unknown.
9. Analysis of Inscription on the Cross.
   ca, then.
   canpetchi, the *chunbezah* or principal.
   nac for *hayac*, destroy.
   cabuchun for *chabac-on*, we killed, or *chabac-en*, I killed.
   cantun, the *chunthan*, or president.
   tun for *than*, a word, used as the verb to speak.
   bak, the number 400.
   capet for *kebanthan*, to rebel.
   pet pak for *bet pach*, made a possession or prisoners.
   capetxic, still another form of *chunbezah*.
10. Analysis of the Inscription suspended from the bird's tail.
    thun for *than*, a word.
    cacanlahun ich for *chacanhal Hunich*; *chacanhal* means to manifest.
    ox ca yub for *yok chaab*, over the killing.
11. Analysis of inscription behind the left-hand figure.
    Cheoxak for Cakaaxha or Cocyoëza.
    ox tun pak ca yub for *yok tan pak chaab*, before centre city kills.
    ox thun pet hun can buc tun ca for *yok than patan can puchtun ca*, over word tribute saying fight when.
    catun ca' pet tun buk tun ca pet ca yub for *katun kebatthan puchtun kebat chaab*, army rebelling quarrelsome rebel kills.
12. Analysis of inscription behind the right-hand figure.
    Oxlahun Pek.
    ca, when.
    ox tun for *yok tan*, before the middle.
    ca pet tun for *kebatthan*, rebel.
    thun pet hun ca yub for *tan patan chaab*, towards tribute kills.
    ca thun for *katun*, army.
    ca pet tun for *kebatthan* or *kebanthan*, rebel.
    can, to tell.
    ca tun ca for *katun ca*, two katuns of 20 years.
    tsuc ca, two tsucs of 4 years.
13. Analysis of the line to the right of the Ns.
    ca tun for *katun*, army.
    pet for *let*, makes.
    huntun for *hunten*, at one time.
    ca tun bak, two to the *bak*, or four hundred.
    pet hun for *patan*, tribute.
    pak for *pach*, possession, prisoners.
14. Analysis of the line to the left of the Ms.
    xic, to divide.

hun tun for *hunten*, at one time.
Cheoxak for *Cakaaxha*.
capet for *kebat*, wicked.
nak, the abdomen.

15. Analysis of line between lower part of L and base of Cross.
ox for *yok*, before, over.
xic, to divide.
lahun for *lukun*, separate.
capet for *kebat*, wicked.
ahau pet tun for *ahau patan*, king's tribute.

CHAPTER VIII.

1. Baldwin, Ancient America, III.
2. Analysis of the Copan Tablet.
hodzib, in Cachiquel *ahtzib*, chief writer.
Holhun, fifteen, but here denoting Holom in Vera Paz.
Oxpet, the name of the chief scribe.
ppoc tun for *puchtun*, fighting.
Buluc, probably Baliz, but not necessarily Belize in Honduras.
Hunich, the same officer as the murdered one at Palenque.
Oxlahun Pek as at Palenque.
Lahca or *Cablahun* without Tok.
catun for *katun*, army.
can to tell.
mak kab for *mazcab*, a prison, here used as a verb.
Hunzic-Huncabcan, the offending Hunich's name.
Oxpet, proper name, see above.
caca for *chuca*, to grasp, kill, here slayer.
kalkab, compare *kal*, to imprison, and *mazcab*, a prison.
thun dzib for *tancab*; compare *tan*, middle, within, and *tancabal*, the premises of a house.
ca, then;
Uac tun ox for *Uac than ox*, the speakers of Uac or Yaqui, that is, Mexicans; Brinton, Brasseur, etc.
ca tun for *katun*, army.
hun tun for *hunten*, at one time.
can, say.
mak for *ma*, no.
nak ox for *nacac* of the verb *nacal*, to ascend.
Uaxac ich, Oaxaca into.
ca, when.
kachilek for *kuxil*, disgusted.
tun tok for *than toc*, the word pour out or spread.
xic, to split, divide.
Uac tun for *Uac than*, speaker of *Uac*.
Canox, the ahau of Copan.
kapaktun for *kebanthan*, to rebel.
Oxlahun Buc for *Pek*.
pet for *bet*, makes.
caca for *chuca*, slayer, see above.

Oxpet, the chief scribe, in genitive of position to *chuca*.
tok for *toc*, to burn.
Copan, conjectural, but as followed by *Ahau Canox*, undoubtedly is the name of the place where the inscription was found.
nak, to finish, governing *Hunich*.
pakob, towns.
nak-xicin, the compound verb of destruction found at Palenque.
ox can cab dzib for *yok can keb cib*, over speaking evil desire.
ox popob for *ahpop*, the Quiche title of royalty.
pet tun ca tun for *patan katun*, tribute asking.
can mak, now *can ma*, say no.
uuc pet for *hayac bet*, destroy makes.
Uaxatlahun ox dzib for *Uaxac lukun yok cib*, Oaxacans desert over desire.
dzib pet kab for *cib bet keb*, desire making evil.
Uaxac thun ox for *Uaxac than ox*, the speakers of Oaxacan.
buc pet for *pach bet*, prisoner makes.

Chapter IX.

1. This has been very fairly and temperately set forth by Dr. Brinton, who is *facile princeps* in Maya-Quiche studies, in his Names of the Quiche gods, and elsewhere.
2. Brasseur, Nations civilisées, II. 142.
3. Brasseur, Nations civilisées, I., lxxx.
4. Brasseur, Nations civilisées, II., 146.
5. Brasseur, Nations civilisées, I., lxxxii.
6. Brasseur, Nations civilisées. IV., 624.
7. Brasseur, Nations civilisées, I., xc., III., 34.
8. Stephens, Incidents of Travel in Yucatan, Vol. II., Appendix; Brinton, The Maya Chronicles.
9. Brasseur, Nations civilisées, II., 578.
10. Brasseur, Nations civilisées, II., 508 seq.
11. Brasseur, Nations civilisées, II., 516., seq.
12. Brasseur, Nations civilisées, II., 525.
13. Brasseur, Nations civilisées, II., 526 seq.
14. Brasseur, Nations civilisées, II., 529-543.
15. Brasseur, Nations civilisées, II., 543.
16. Brasseur, Nations civilisées, IV., 621-624.

Chapter X.

1. Brasseur, Nations civilisées, III., 9, seq.
2. Brasseur, Nations civilisées, III., 37.
3. Brasseur, Nations civilisées, III., 45.
4. Brasseur, Nations civilisées, IV., 355-362.
5. Brasseur, Nations civilisées, III., 362-369, IV., 545, 785.
6. Brasseur, Nations civilisées, II., 578, seq.
7. Brasseur, Nations civilisées, II., 590,
8. Brinton, The Maya Chronicles, 21, seq.

CHAPTER XI.

1. Brinton, The Maya Chronicles, 183.
2. Brasseur, Nations civilisées, II., 533.
3. Atlas de Toutes les Parties connues du Globe terrestre, dressé pour l'Histoire Philosophique et Politique des Etablissemens et du Commerce des Européens dans les deux Indes.
4. Brasseur, Nations civilisées, III., 267.
5. Brasseur, Nations civilisées, III., 341.
6. Brasseur, Nations civilisées, II., 568, note.
7. Brasseur, Nations civilisées, II., 528.

CHAPTER XII.

1. Stephens, Incidents of Travel in Yucatan, 300.

CHAPTER XIII.

1. Stephens, Incidents of Travel in Yucatan, 290-292.

CHAPTER XIV.

1. Analysis of the Chichanchob Inscription: Line 1.

Huntoh, the Cachiquel lieutenant of Quiche.
tan, within.
cab, the land.
Oxyib, a district including the country east of Chichen Itza.
Huntoh, see above.
pet for *bet*, makes.
catun for *katun*, army.
Oxyib, see above.
xul, an end, to end.
Oxyib pak, the fortress (Maya *paa*) of Oxyib.
Hunichob, a plural form for the name of one person, the same, probably, as the Hunich of Palenque and Copan. For Hunich, the Maya *hun edz*, one established, was proposed. Hunichob may be the allied *hun edzcab*.
pet catun hol for *bet katun hol*, places army door or end.
Oxcabuc, the Cachiquel lieutenant, as at Palenque.
Hunich, the one established, as at Palenque and Copan.
Caich, the inscription's form of the word Quiche. Dr. Brinton proposes Kiché. So far no Maya hieroglyphic equivalent to the sound *ki* has been found, so that Caich may be a mere necessary expedient.
dzib thun hunkal catun for *dzib than hunkal katun*, write word twenty warrior.
ca dzib for *katzib* or *Akatzib*, a town or fortress near Chichen Itza.
holob, holes or cells.
canchi for *xanac* or *xanchi*, future of *xantal*, to stay behind, remain; futurity lies in, in order to remain.
pet for *bet*, makes.
buc tun for *puchtun*, quarreling, fighting.
catun for *katun*, army.

holtun for *holthan*, the chief of speech, answering to the Maya *chunthan*, president or first of speech.

oxich for *yok-edz*, established over, a new official title.

chitun ichox stands for *Chichen Itza*, there is no doubt, and suggests that *tun* must have been pronounced *tsun*. The final *ox* is harder to account for; *ca* would have been better.

capet pak for *kebat pak*, wicked city. The later termination *an* of *keban* does not appear on these monuments.

katun ahau and *xul* need no more explanation.

Oxyib pop denotes the ruler of the Oxyib by his *pop*, mat or throne.

2. Analysis of line 2.

Oxbuc, the name of the ruler of Oxyib, the author apparently of the inscription.

patan katun, asking tribute.

pakhol for *paxal*, to desert.

Hunichob, see line 1.

ox tun pet ca chi xul for *yoktan bet Cachiquel*. I suppose *yok tan*, opposite the breast, to mean an opponent. This is the first time the Cachiquel name has appeared.

tun xul hol kax ich for *dzan* to ruin, *xul* to end, *hol* hole, *kak* fire, and *ich* in.

dzib tun for *dzib than*, writing word.

uac for *hayac*, destroy.

cadzib or *Katzib*, the fortress or town.

uac again for *hayac*.

tun for *tan*, within; and *pet* for *bet*, to make.

Katun Hunichob need no explanation.

bat for *bet*, make.

buc for *puch*, possession, captive.

katun and *xul* must by this time be as familiar as any English words.

Oxyib tun for *tan*, within.

Oxbuc katun reverses the usual order of the genitive.

caoxtun for *chuuc* and *tan*, seizing in or plundering.

pach xul for *paxal*, to desert.

Caich for Quiche.

3. Analysis of line 3.

katun ahau katun need no more explanation.

caxul for *kuxil*, disgusted.

thunob for *thanob*, words.

dzib Hunichob, write the Hunichob.

can, to speak, tell.

Oxlahun Pek as in Palenque and Copan, but occupying a subordinate position.

pet yokmuyal for *bet Uxmal*, makes Uxmal.

cantun for *chunthan*, president.

pop, ruler, *pak*, of the city.

chichixul for *Cachiquel*.

katun patan yok katan, army tribute over asking.

katun, warrior.

buc pet for *pach*, a possession, *bet*, makes.

Oxyub, probably a truer phonetic than *Oxyib*.

xic, to divide.

ox holtun pak for *yok*, over, *holthan*, the chief speaker, or *holdzan*, the chief destroyer *pak*, of the city.

pet xul for *bet xul*, makes an end.

xul, an end.

huntun pet Hunchiyub for *hunten*, at one time, *bet*, makes, *Hunichob*; the form of the last looks like careless writing.

4. Analysis of line 4.
   Chichen, an abbreviated form of *Chichen Itza.*
   pak xul for *paxal*, to desert.
   pach for *pak*, town.
   caxul for *kuxil*, disgusted.
   tun for *than*, word.
   Oxyub tun for *Oxyub-than*, speakers of Oxyub.
   chi for *cihi*, aorist of *cen*, to say, tell.
   cache for *xache* of *xachetah*, to seek, procure.
   pet tun for *betun*, a new form of the verb to make.
   dzib tun, written stone.
   chi for *ci*, sweet, pleasant.
   tun for *than*, word.
   tun Oxyib tun for *tan Oxyib than*, in Oxyib word.
   caoxtun for *chuuc-tan*, seizing in or plundering.
   pak hol for *paxal* to desert.
   kax, united.
   pet ox tok for *bet yoktok*, makes in front fighting.
   chi for *cihi*, see above.
5. Analysis of line 5.
   canlahun, fourteen.
   buctunyab for *puchtunob*, fighters.
   cacanyab for *caxanob*, they find.
   tok tun xic for *toc dzan xic*, burn, ruin, divide.
   caox for *chuuc*, to seize.
   oxchi cabuc for *Yokchi Cawek*, which seems an error, for *Yokich*, as in line 1; perhaps the mouth is a face *ich*.
   caca in the Copan inscription was read as *chuca*, slayer; here it may be simply *cah* a town.
   tun for *tan*, within.
   kulel, to govern.
   cahol for *kahal*, to recall.
6. Analysis of line 6.
   chitun for *Chichen*.
   katun, *puchtun*, *pop*, *bet*, are well known.
   uucyib for *hayacob*, they destroy.
   holtun for *holthan*, chief speaker, or *holdzan*, chief executioner.
   Cayub, a new proper name connected with Quiche.
   pet caox for *bet chuuc*, makes a seizure.
   bak, the number 400.
   oxchi for *Yokchi*, instead of *Yokich*, the one placed over.
   caox for *chuuc*, to seize.
7. Analysis of line 7.
   caich cabak for *Caich* or *Quiche Cawek.*
   buc for *puch* or *wooh*, a letter.
   catun for *kat-an*, asking.
   dzib for *cib*, permission.
   yokhol for *hokol*, to set out.
   cantun for *chunthan*, president.
   ca bat xul ox huntun for *kebat xul yok hunten*, wicked end over at one time.

pet buc for *bet pach*, make possession.
tokhol for *dzocol*, to end.
yok huntun for *yok hunten*, at once.
holtun for *holthan* or *holdzan*. See line 6.
oxtun for *yoktan*, opposer.

8. Analysis of the Akatzeeb Inscription: Line 1.
lahun ta kal, thirty.
uac pet uuc for *hayac bet hayac*. It seems as if the scribes employed both *uac*, 6, and *uuc*, 7, for *hayac*, destroy.
uac again for *hayac*.
katun, *puchtun* and *bet* have occurred so often as to need no further comment.
caoxtun for *chuuc-tan*, seizing in or spoiling.
chitun ichtun for *Chichen Itza*.
capak for *chab-ac*; *chab* is to capture or to kill; *ac* is unaccounted for.
holhun, fifteen.
caoxtun for *chuuc-tan*, used as a noun.
Lahun Pek can hardly be the *Lahun Pek*, son of Cablahun Tok, whose name appears at Palenque, but the so-called Lahuh-Ah, Ten Reeds, the eldest son of Huntoh, who did not live long.
muyal pep for *mulbah* or *mulba*, to congregate, come together.
caoxtun again for *chuuctun*.
Cuclahun, as at Palenque, Zaachilla of Oaxaca.
hapetob, as at Palenque, for *ubah*, *ubatob*, they hear.
yokteck, to fight in front of; *yoktan*, in front of the breast.

9. Analysis of line 2.
nak nakob, reduplicate of intensity.
xicob, they divide.
chitun for *Chichen*.
canlahun, fourteen.
uac is not *hayac* here, but *hauac*, to cease.
chixul for *tzicil*, to obey.
pak for *pach*, possession.
ox hun tun holcan, *yok hunten holcan*, at once the chief caller. Holcan means warrior and brave, but also (Brinton, Maya Chronicles, 248) the head caller.
Nothing else in this line calls for explanation.

10. Analysis of line 3.
cakah for *cacah*, the commune.
tun for *than*, word.
chi for *cihi*, aorist of *cen*, to say, tell.
buc pet for *pach bet*.
mazcabcun ca for *mazcab*, prison, and *xanac*, to remain.
hol pet pet tun kak for *hol bet bet tan kak*. The literal translation is with the text.
caoxtun for *chuuc-tan*.
hunthun for *chunthan*, president.

11. Analysis of line 4.
Buluc katun, the army of Baliz.
Cathikel for *Cachiquel*.
cakah for *cacah*, the commune.
caoxtun for *chuuc-tan*.
yok, over, often must be translated as by.
Belon-Hunichob, the one established in Palenque.

CHAPTER XV.

1. Stephens, Incidents of Travel in Yucatan, II., 341.
2. Brinton, The Maya Chronicles, 25, 231.
3. Stephens, Incidents of Travel in Yucatan, II., 228.
4. Stephens, Incidents of Travel in Yucatan, II., 265.
5. Brasseur, Nations civilisées, II., 505.

CHAPTER XVI.

1. Crawford, The Indian Archipelago; Laing, View of the Origin and Migrations of the Polynesian Nation; Humboldt, Kawi-Sprache; Whitmee, The Ethnology of the Pacific; Prichard, Physical History of Mankind; Latham, The Varieties of Man; Baldwin, Ancient America, Appendix; Journal of the Polynesian Society.
2. Mariner, Tonga Islands, II., 109.
3. On the Origin of some American Indian Tribes, Canadian Naturalist, Vol. IX, No. 2, p. 74.
4. Canadian Naturalist, Vol. IX., No. 2, p. 68.
5. Mariner, Tonga Islands, II., 183.

CHAPTER XVII.

1. ap. Thomas, A Study of the Manuscript Troano, 229; Brasseur, Nations Civilisées, II., 51, 568.
2. Crawford, Indian Archipelago, I., 94.
3. Lang, View of the Polynesian Nation, 13.
4. Mariner, Tonga Islands, II., Appendix CIV.
5. Squier, Adventures on the Mosquito Shore, 232.
6. North Americans of Antiquity, 241.
7. Pickering, Races of Man, London, 113.
8. Crawford, Indian Archipelago, I., 366.
9. Schoolcraft, Hiawatha Legends.
10. Mr. Whitmee finds traces of Sanscrit in Malagasy.
11. Journal of the Polynesian Society, Vol. I., p. 190.
12. Zuniga, Historia de las Islas Philipinas.

APPENDIX II.

TABLE OF THE MOST COMMONLY RECURRING SYMBOLS.

Numbers marked by balls up to four and occasionally beyond that number; fives denoted by thick lines, the length generally of the cartouche. King, chief, lord, denoted by an inscribed semi-circle over a dot or ball, *ahau*.

Man, figure of, *uinic*,
Woman, figure or head of, *chup*,
Head, *pol* or *hol*,
Forehead, *chilek*,
Face or eye, *ich*,
Nose, *nu*,
Mouth, open, *chi*,
Mouth with food in, *mak*,
Tongue, *ak*,
Tooth, *toh* or *co*,
Ears plain or ornamented, *xicin*,
Beard, *meex*,
Breast, *tan*, *tzem*,
Back, *pach*,
Abdomen, *nak*,
Phallus, *kulel*,
Arm or hand, *kab*,
Foot, *oc*,
Dog, *pek*,
Wild cat, *ekxuc*,
Bird, *kox*,
Parrot, *xkan dzulop*,
Bird-god, *puch*,
Bird's beak, *xul*,
Bird's wing, *xic*,
Turtle shell, *ac*,
Bee, *cab*,
Tree, *che*,
Branch, *ak*,
Bean, *yib*,
Trefoil, *ka*,
Cloak, coat, *yub*,
Cap, hat, *ppoc*,
Shoe, *yab*,
Covering over, *buc*,
Sun's rays, *kin*,
Sky, *caan*,
Moon, *u*,
Cloud, *muyal*,
Rain, *chac*,
Fire, *kak*,
Stone, *tun*,
Building, *pak*,
Cross, *pak*,
Inverted cross or well, *chen*,
Stones crossed, *xic*,
Drop on stone, *thun*,
Cultivated ground, *pak*,
Writing, *dzib*,
Flint flakes in circle, *tok*,
Tied bundle, *bak*,
Upright bundle divided at top, *ca*,
Cavity, *hol*,
Comb, *ca*,
Wheel or circle, *pet*,
Mat, *pop*,
Jar, *ppul*,
Kettle, *mazcabcan*,
Bracket or union, *kax*,
Imperfect circles united by horizontal line, *tan*,
A thing placed over, *yok*,
Standing symbol at end, *xul*,
Plurality at foot of group, *ob*.

APPENDIX III.

COMPARATIVE VOCABULARY OF MAYA AND MALAY-POLYNESIAN WORDS.

Maya.	*English.*	*Malay-Polynesian.*
ahau,	king, chief,	how *Tonga*, aiki *Marquesas*, uea *Tarawan*, sau *Rotuma*, *Fiji*.
ahaual,	enemy,	caauay, *Tagala*.
ahcuxan,	life,	kauaghan, *Formosa*.
ak,	tongue,	aki *Ternati*, *Tidore*, gigi *Aru*.
akab,	night,	gaby *Tagala*, gabe *Bisayan*, sabi *Cagayan*, gubie *Bolanghitam*, hubbi *Sanguir*, cappasay *Pelew*.
al,	child,	ala *Wahai*, lea *Rotuma*, aro *Tagala*.
atan,	wife,	betina *Malay* (woman), wadhon *Java* (woman).
baat,	axe,	vasai *Batan*, badog *Sunda*, bandu *Madura*, matau *Fiji*, pedah *Sanguir*, peda *Sulu*, *Tidore*, beda *Aktiago*, *Matabello*, badi *Baju*, rede *Gah*.
bac,	bone,	bookoog *Sulu*, wuku *Macassar*, wukuna *Bugis*, buko *Sanguir*, bakas *Baju*, boko *Salayer*, obuku *Bouton*.
bak,	flesh,	paa *Tagala*, wat *Formosa*, wokuu *Gani*, wacuti *Awaiya*, mbithi *Fiji*.
bak,	to bind,	bookoohae *Sulu*.
balam,	tiger,	halimao *Lampung*, harimao *Malay*.
ban,	much,	baniak *Malay*, bete *Tarawan*, pipi *Tobi*, banyak *Madura*.
batab,	a chief,	patul *Batan*, fatu *Tahiti*, pakaiki *Mariannes*.
betah,	to make,	buat *Malay*, fy *Tonga*, faa *Tahiti*, whaihanga *Maori*.
bal,	thing,	boi *Tarawan*, apapa *Malay*.
binel,	to go,	pomray *Pelew*, li-pan *Bouton*, fanow *Matabello*, fano *Fakaafo*, uhana *Maori*.
botah,	to pay,	bayad *Sulu*, bayar *Tagala*, utu *Maori*.
bolon,	nine,	sambilan *Malay*, sambilante *Serang*.
buc,	to cover, covering,	poki, hipoki *Maori*.
ca,	when,	cani *Cagayan*, cā ano *Iloco*, cay lan *Tagala*.
ca,	and,	caan *Batan*.
ca,	we,	cami *Sulu*, *Tagala*, kita *Malay*, *Ponape*.
ca,	two,	agua *Tuham*, zua *Flores*, sua *Mangarei*, guo *Tobi*, ka-leh, *Java*.
caan,	sky, heaven,	hanit *Batan*, hani *Marquesas*, gagono *Java*.
cab,	earth,	gumi *Bali*, soupe *Easter*, apa *Tarawan*.
cacab,	town,	kawa *Tarawan*.
cah, cahal,	town,	koti *Malay*, kaan, *Tarawan*, kainga *Maori*.
cai,	fish,	ikan *Malay*, *Iloco*, juka *Macassar*, jukoh *Madura*, iko *Tonga*, ica *Maori*, oca *Bolanghitaru*, ika *Tobi*, *Fakaafo*, *Tarawan*, *Fiji*, ik *Mille*.

Maya.	*English.*	*Malay-Polynesian.*
can,	speech, to speak,	kata *Malay*, kaya *Fiji*, cang *Rotuma*, ngongo *Tarawan*, ki *Maori*.
can,	serpent,	nanipi *Bali*, neke *Maori*, koioim *Alfuros*, katoan *Sanguir*, katoun *Menado*.
can,	four,	oang *Pelew*, tan *Caroline*, oan *Tobi*.
cax,	fowl,	tikaokao *Maori*, cookiyoou *Pelew*, kakep *Mysol*.
caxan,	to seek, to find,	chitaghin *Batan*, kuah *Borneo*, kite *Maori*.
ceh,	deer,	oo-sah *Sulu*, kasak *Samang*.
chac, haa,	water,	chai *Sunda*, aki *Ratahan*, *Sanguir*, *Tidore*, *Galela*, yeh *Bali*, hoi *Timor*, aie *Sasak*, oee *Rotti*, akei *Menado*.
chac, caaxha,	rain,	gia *Teluti*, huya *Sulu*, oha Bolanghitam, ua *Tahiti*, ooha *Tonga*, usa *Rotuma*, utha *Fiji*.
chac,	red,	eja *Macassar*, pakaka, *Maori*, sak *Borneo*, kao *Liang*, *Morella*, *Lariki*, *Saparua*, *Teluti*, *Camarian*, shei *Mysol* kula, *Fiji*, *Fakaafo*.
che,	tree, wood,	cahuy *Tagala*, kayu, *Cagayan*, kago, *Iloco*, kayu *Malay*, cahui *Bisayan*, kahoi *Sulu*, kayu *Batan*, chuc, *Samang*, kaau *Marquesas*, kai, *Teor*, kaju, *Salayer*, gagi *Gani*, gah *Mysol*, kaya *Gah*, kao *Wahai*, kai *Tarawan*, kau *Fiji*.
chem,	boat, ship,	sacayan *Bisayan*, *Batan*, sasacayan *Iloco*, canoa *Tahiti*, sakaen *Menado*, *Sanguir*, sangga *Fiji*, konia *Maori*.
chi,	mouth,	changkam *Java*, *Bali*, *Madura*, sooka *Morella*, hihika *Liang*, hihico *Teluti*, siu-rare *Wahai*, su-ara *Batumerah*, su-mut *Gani*, ihi *Lariki*, so *Camarian*. haha *Marquesas*.
chiic,	arrow,	tkugh *Formosa*, n-gasau *Fiji*, caho *Tonga*.
chilek,	forehead,	alis *Malay*, lae *Tonga*, *Fakaafo*.
chupul,	goat,	cambing *Malay*, *Sulu*, *Tagala*, cochi Tonga.
chuplal,	girl,	ampelle, *Madagascar* (woman) felelara *Matabello*, (woman).
chuuc,	to seize,	coha *Tagala*, kau *Fiji*, kapo *Maori* coogoo *Tonga*.
chuy,	ashes,	chumi *Bugis* *Macassar*.
chuy,	to sew,	jahit *Malay*, tahi *Bisayan*, *Tagala*, tuitui *Maori*, tooi *Tonga*.
chuytab,	to hang,	whata *Maori*, ganton *Malay*.
cib,	wish, will,	kepagnai *Malay*, gamek *Samang*.
cill,	pleasure,	hari *Maori*, cayac *Batan*, suca, *Malay*, *Sulu*.
cimzah,	to kill,	tamate *Tonga*, kamate *Tarawan*, whakamate *Maori*, vakamate *Fiji*.
cimil,	to die,	kabis *Samang*, immit *Mille*, mbale *Fiji*, hemo *Maori*.
co,	tooth,	gigi *Malay*, *Bali*, *Madura*, *Bugis*, *Macassar*, yus *Samang*, gigi *Salayer*, *Baju*, ui *Tarawan*.
cuch,	to carry,	wa-hagi *Tobi*, kauhoa, kawe, hiki *Maori*, gowo *Java*, di-jayak *Sunda*, yoc *Samang*.
cuch,	a place,	koto *Fiji*, aguinan *Cagayan*.
cucut,	the body,	hata-co *Teluti*, kalakalath *Pelew*, tutut, *Gani* (belly) gete *Tonga*, (belly) hatua-ca *Liang*, (belly).
cul,	vase or cup	coali *Malay*, gooloo *Tonga*, quall *Pelew*, kuro *Fiji*.

Maya.	*English.*	*Malay-Polynesian.*
cutal,	to sit,	duduk *Malay*, cood *Sulu*, kuduk *Borneo*, tiko *Fiji*, tekateka *Tarawan*, tuturu *Maori*.
dza,	to give,	kasih *Malay*, kasik *Sulu*, tado, sako, *Java*, sukabake *Bali*, atu, *Tonga*, hoatu, *Sandwich*, *Maori*, wacito, kacito *Tobi*.
dzoc, dzoocol,	end, to end,	otinga, *Maori*, tow *Tonga*.
eck,	star,	chetu *Atui*, whetu *Maori*, hetu *Tahiti*, *Paumotuan*, hotu, *Sandwich*, hetika *Paumotuan*, hethu *Rotuma*, edju *Mille*, uic *Tobi*.
eek,	black,	etam *Malay*, ngeo, *Rotti*, ngoa *Batchian*, kokotu *Sahoe*, kass *Pelew*, kokotu *Tidore*, kitkuda *Gani*.
halach,	true,	uyur *Batan*, aual *Formosa*.
halal,	cane,	buluh, *Malay*, bulo *Bugis*, *Macassar*, hooli *Tonga*, cil *Tobi*.
haltun,	river,	kali, *Java*, *Bali*, walungan *Sunda*, weyl-hatei, *Morella*, waibatang *Amblau*, waifatan *W'ahai*, waililolun, *Teluti*, *Ahtiago*.
hani,	to eat,	acanen *Batan*, kana *Tarawan*, *Fiji*, kami *Maori*, kaman, *Borneo*, amu *Tahiti*, kmanna, *Formosa*.
hol,	hole, door,	hala *Tonga*, korua *Maori*, bolawah *Bajn*, olamatan *Wahai*, aleani *Awaiya*, ngora *Galela*, lawang *Sulu*, *Java*.
holcan	warrior, brave,	halga, *Tagala*, soregni *Malay*.
hun,	one.	sina *Timbora*, tong *Pelew*, nehi *Manatoto*, djuon, *Mille*.
ich,	face,	hihika *Liang*, gai *Tidore*, jauei *Borneo*.
ich,	eye,	socha, *Madura*, *Sunda*.
ich,	fruit,	asi, *Batan*, hua *Maori*, aihua *Lariki*, hua *Liang*, *Morella*, *Sandwich*.
ich,	in, within,	ing *Java*, ka *Bali*, ai *Madura*, i, kei *Maori*, gi *Tonga*.
ichan, ichambil	husband,	asauah *Tagala*, tane *Maori*, ohana *Tonga*, *Marquesas*, bulana *Gah*, gagijannee *Menado*, essah *Salibabo*, pulabau *Wahai*, bellin *Mille*.
ikg,	wind,	angin *Malay*, *etc.*, hau *Maori*, koyyoou *Pelew*, ang *Tarawan*, yang *Tobi*.
ilah,	to see,	liat *Malay*, lali *Mille*, lewa, serau *Fiji*, kele, rei *Rotuma*, ilaw, iloa *Tonga*.
ixim,	maize,	jagung *Malay*, *etc.*, kaanga *Maori*.
ixmehen,	daughter,	tamahine *Maori*, manania *Paumotuan*, tahine *Tonga*, lehani *Rotuma*,
kab,	hand,	camay *Tagala*, kimath *Pelew*, komud *Gani*, kaimuk *Tobi*, hiaphiap *Rotuma*.
kab,	arm,	camay *Tagala*, kimath *Pelew*, tamba *Fiji*.
kaba,	name,	tapa *Maori*, ikoa *Fakaafo*.
kabicheil,	arrow,	hofakbol *Rotuma*, jamparing *Java*, chopo, *Java* (bow), djub *Sulu*, (bow) jobijobi *Tidore*, (bow) acowfanna *Tonga*, (bow) kopera *Maori*, (bow and arrow).
kabim,	milk,	bannyu-susu. toyo-pawan *Java*, puwan *Madura*, waimah *Lampung*.
kach,	a fly,	kias *Borneo*, sisi *Tidore*, sisil *Morella*, *Baju*, seugeti *Massaratty*, kasisili *Salayer*, konghito *Bolanghitam* tekatcop *Mille*.

Maya.	*English.*	*Malay-Polynesian.*
kal,	twenty,	kalehdoso *Java*, calohaan *Bisayan*, olayuck *Pelew*, yaluh *Mysol*, meno-hallo *Galela*.
kan,	yellow,	kuning *Malay*, *Bali*, koni *Massaratty*, konin *Wahai*, kuni *Teor*, kunukunu *Gah*, kuning *Sulu*, *Baju*, *Java*, *Borneo*.
kantukin,	gold,	guinto *Tagala*, kanchono *Java*.
kat,	to wish, to ask,	chita, *Malay*, kuika, *Maori*.
katun,	a body of troops,	cow catanga *Tonga*, (the suite of a chief).
keban,	evil, bad,	jabat *Sulu*, jubak *Madura*, awon *Java*, kevi, covi *Tonga*, haufau *Marquesas*, kafetaia *Alfuros*, avet *Ahtiago*.
kin,	sun,	init *Iloco*, unu *Bolanghitam*, seasan *Mysol*, sunjinji *Java*, hangat *Wahai*, ingkong *Timbora*, singa *Fiji*.
kin,	day,	ini *Malay* seasan *Mysol*, dhina *Java*, unuveno *Bolanghitam*, cenang *Bisayan*, taginita *Galela*, ma-hana *Tahiti*, *Maori*.
koch,	to bear,	hatir *Tagala*, gowo *Java*, yoe, *Samang*, kawe, kauhoa *Maori*, wahagi *Tobi*.
kox,	bird,	cookiyoou *Pelew*, kawao *Samang*, kades *Bali*, tohek *Timuri*, siau *Borneo*, ayas *Malay*.
ku,	god,	akea *Sandwich*, aho *Tahiti*, hutua *Tonga*.
kuchul,	to come,	pangaling, *Tagala*, haere *Maori*, inokere *Tidore*, kule *Ahtiaga*, harre-mai *Tahiti*, *Sandwich*, iroua *Formosa*, alowei *Awaiya*, dirawoei *Java*.
kukum,	feather,	gogo *Tidore*, gan *Mysol*, huruni *Saparua*, huluna *Batumerah*, hulun *Wahai*, hokai *Maori*.
kuxil,	aversion,	sala *Tagala*, cailot *Batan*, mdalu *Borneo*, vakarusa *Fiji*, lili *Tonga*.
labal,	finish,	hili *Tonga*, balinaun *Cagayan*.
lai,	relative pronoun,	alin *Tagala*, lei *Borneo*, lelao *Samang*,.
lai,	demonstrative,	reyah *Madura*, yari *Tagala*.
lak,	companion,	aloha, *Sandwich*, aroha *Tahiti*.
lakpal,	boy, son,	anak laki laki *Malay*, alak *Formosa*, talacoy Pelew.
li,	leaf,	lau *Fakaafo*, allell, *Pelew*, leko, *Macassar*, lo *Tonga*, lino *Gah*, lan *Ahtiago*, ailow, *Liang*, *Morella*.
likil, likzah,	to raise, to rise,	langata *Fiji*, riaki, rangai *Maori*.
likin,	the east,	silangan *Tagala*, rawhiti *Maori*, alao *Bugis*, iraia *Macassar*.
lol,	flower,	lelun *Sanguir*, lahowy *Awaiya*, loen *Wahai*.
lukul,	to leave,	lacar *Tagala*, aloo *Tonga*, haerenga, *Maori*.
luum,	earth,	lemma *Java*, luu *Rotti*, linoe *Bugis*, lino *Macassar*, lupa, *Tagala*, leopah, *Sulu*, lope *Bisayan*.
ma,	no,	ima, *Tahiti*, mangga *Fiji*, ungah *Batan*, inke *Rotuma*.
mac,	who,	angou *Batan*, yang, *Malay*, ingkang *Java*, wai *Maori*.
mak,	to eat, to chew,	makan, *Malay*, magkaon *Bisayun*, munga *Pelew*, amu *Tahiti*, maa *Marquesas*, kmanna, *Formosa*, muka *Tobi*, mongah *Mille*, mamaca *Fiji*, ma *Tonga*.
mactzil,	wonder, miracle,	mihara *Maori*, manavahe *Tonga*, madading *Formosa*.

Maya.	*English.*	*Malay-Polynesian.*
mehen,	son,	manganac *Batan*, foha *Tonga*.
mentah,	to make,	mamarin *Batan*, manggawe *Biajuk*, mutitur *Pelew*.
menyah, meyah	to serve,	mogur *Tarawan*, nggara, *Fiji*, maagaad *Sulu*, mahi, mahinga *Maori*.
met, pet,	a wheel, a circle,	madeder *Batan*, potakataka *Maori*, buder *Malay*, moumouta *Fiji*.
muyal,	cloud,	mego, *Java*, mega, awan *Malay*, mega, *Bali*, *Madura*, *Sunda*, rang-mang *Bugis*, *Macassar*.
naa,	mother,	ena *Timur*, *Rotti*, indu *Bugis*, ina *Iloco*, inah *Sulu*, inahan, *Bisayan*, yna *Batan*, *Tagala*, yena *Cagayan*, inao *Morella*, *Batumerah*, inai *Alfuros*, neaia *Sulu*, neina *Wahai*, nina *Gah*, nin *Mysol*, *etc.*
nak,	abdomen,	ngaii *Borneo*, nan *Mysol*, tonina *Gah*, tena *Sulu*, nanaca *Liang*, nanau *Amblaw*, nangarohi *Galela*, yango *Fiji*.
nocoy,	cloud,	nangi *Tarawan*, kongu *Maori*, (cloudy).
noh, nohoch,	large,	naouticuti *Iloco*, nui *Tahiti*, *Sandwich*, *Marquesas*, *Maori*, naiki, naaik *Timor*.
nohkakil	smallpox,	chachar, *Java*, *Bali*, *Madura*, kachukluan *Java*, *Sunda*.
nohol,	south,	tanghali, *Tagala*, tonga, *Maori*.
nu,	nose,	nasika *Java*, enur, inu *Timur*, inore *Wahai*, ninura *Batumerah*, ne *Sulu*, nunu *Ternate*, un *Tidore*, nien *Wahai*, oanu *Bouton*, nieni *Massaratty*, nem *Cajeli*, *etc.*
nuc,	answer,	megnuot *Malay*, whakao *Maori*.
nuctah,	to understand,	matau *Maori*, manatoo *Tonga*, manoimah *Sulu*, mengarti *Malay*, inea *Rotuma*.
nucte,	old,	motua *Tonga*, matanga *Talaga*, mahaas *Sulu*, antichs *Malagasy*, mazui *Tobi*, mathua *Rotuma*, matua, makaua *Fiji*.
oc,	foot,	siki *Sulu*, cocor *Batan*, soko *Madura*, kaki *Malay*, yohu *Tidore*, aika *Liang*, *Morella*, ai *Larika*, yai, *Ahtiago*, oei *Bouton*.
ohel,	to understand,	iloa, *Tonga*.
ol,	mind,	alo *Fiji*, wairua *Maori*, loto *Tonga*, varua *Tahiti*, vaerua *Hervey*.
olam,	blood,	rah *Java*, *Bali*, *Lampung*, raw *Malagasy*, rahau *Timuri*, jera *Macassar*, lomos, lemoh *Mysol*, lawon *Baju*, lahim *Alfuros*, kawa, *Ahtiago*.
on,	we,	yamuen *Batan*, kami, *Sulu*, *Tagala*, naie *Malagasy*, am *Kotuma*.
otoch,	house,	tahu *Galela*, tewharre *Tahiti*, tallag *Formosa*, bata *Tarawan*, mbeta *Fiji*, pataka *Maori*, (hut).
ox,	three,	tiga *Malay*, othey *Pelew*, kuu *Uea*, hayen *Yengen*, kunete *Lifu*, ya *Tobi*.
pa,	to break,	patah *Malay*, punitin *Tagala*, bagbag *Sulu*, baba *Borneo*, pofa *Marquesas*, vavahi *Tahiti*, fachi *Tonga*, mbasu *Fiji*, pahu, papa *Maori*.
pach,	to seize,	pegan *Malay*, makon *Samang*, hopuk *Maori*, booge *Tonga*.

Maya.	*English.*	*Malay-Polynesian.*
pak,	building,	patu *Maori*, macca *Tonga*, patu *Tahiti*.
palil,	servant,	bulisic *Tagala*, buaak *Malay*, kawulo *Java*, kawula *Madura*, *Sunda*, boboola *Tonga*, parau *Maori*, mbombula *Fiji*.
paatah,	to watch,	mataaru *Maori*, bangon *Malay*, feaoo *Tonga*.
patan,	tribute,	fatongia *Tonga*, utang *Malay*, *Java*, *Sunda*, (debt).
pay,	coast,	baybay *Tagala*, fanga *Tonga*.
pay,	to call,	pangil *Malay*, tawag, *Tagala*, tawang *Sulu*, tavagan *Batan*, pia *Maori*, fecow *Tonga*.
pechac,	thunder,	bekilop *Malay*, whaitiri *Maori*, hotuk *Malagasy*, ba *Tarawan*, vijik *Tobi*, (lightning).
humchac,	thunder,	gunturu *Bugis*, *Macassar*, guntur *Malay*, gugoh *Lampung*, ngepa *Tobi*, onga *Rotuma*, (lightning).
pek,	dog,	patek, *Madura*, bausa *Rotti*, wasu *Teluti*, mog *Tarawan*.
pentac,	prisoner,	panjara Malay, *Sunda*, (prison), patandan *Madura*, (prison) benteng *Sunda*, (fort).
peten	country, island	pongoo *Batan*, motu *Atui*, *Fakaafo*; seems to be the Malay *padang*, a plain, Tongan *butu*, a part, a district, Maori, *wahanga*, a division.
pix,	knee,	poko-touri *Ticopia*, icici-bouka *Ombay*, bubuoniwai *Tarawan*.
pol, hol,	head,	olo *Tagala*, kapala *Malay*, hwulu *Sunda*, hulu *Lampung*, wulu *Bugis*, *Macassar*, ulu *Timuri*, siro *Java*, ulu *Salayar*, *Camarian*, ular *Borneo*, olum *Cajeli*, uru *Lariki*, *etc.*, ulin *Teor*, defolo *Tidore*, ulu *Fiji*, borrom *Mille*.
pol, hol,	hair,	bohoc *Tagala*, buoc *Batan*, ulu, fulafula *Fakaafo*, ira, burer *Tarawan*, leon *Rotti*, mala *Fiji*, bulo *Malay*, wullo, *Malagasy*, fulu *Tonga*, folo *Wahai*, peleah *Mysol* buloni *Cajeli*, bulwa *Bouton*, keulo *Teluti*,
polok,	blood,	marus, rah *Java*, rah *Bali*, *Lampung*, jera *Macassar*, arrassack *Pelew*, lalah *Saparua*, *Awaiya*, orah *Bouton*, poha *Sulu*, rara *Tarawan*.
pop, bac,	mat,	banig *Tagala*, pugi *Sulu*, pau *Borneo*, tepoh *Baju*, tupur *Salibabo*, sapie *Menado*, pai *Liang*, *Saparua*, lab *Ahtiago*, fira *Teor*, pail *Lariki*, paili *Camarian*, tapau *Maori*, tacapow *Tonga*, bawla *Tonga*.
ppoc,	hat,	tabago *Batan*, topi *Sulu*, toppi *Malay*, potae *Maori*, bulang *Borneo*, boolonga *Tonga*, fau *Fakaafo*.
ppuk,	cheek,	pipi *Malay*, paparinga *Maori*, fau *Rotuma*, papa *Tarawan*, umbi *Fiji*.
ppull,	jar,	pewell *Pelew*, beloo *Tonga*, mbilo *Fiji*, kwali *Malay*, kawali *Sulu*, wheoro *Maori*.
puchtun,	quarrelling, fighting,	pagaanay *Tagala*, mag-bantah *Sulu*, pagbabaca *Tagala*, pakanga, *Maori*, buoc *Tarawan*, powchia *Tonga*.
pump,	bow,	panah *Malay*, *Madura*, *Bugis*, *Macassar*, fun *Teor*, fean *Mysol*, fana *Tahiti*, banah *Ahtiago*, panat *Massaratty*, papite *Salibabo*, opana *Bouton*, jobijobi *Tidore*, acow-fanna *Tonga*.

Maya.	*English.*	*Malay-Polynesian.*
pul,	to carry,	pikul *Malay*, bawa *Sunda*, batok *Lampung*.
puzcical,	heart,	pozo *Tagala*.
taab,	salt,	uyah buja *Madura*, uyah *Java*, *Sunda*, *Lampung*, tasek *Bali*, tasic *Awaiya*, tohi *Tonga*, (salt water) *Camarian*, teisim *Alfuros*, tasi *Liang*, *Morella*, *etc.*, tote *Maori*, tintui *Fiji*.
tab,	to tie,	kabat *Malay*, babat *Tagala*, taui *Maori*, kape *Tarawan*.
tabzah,	to deceive,	daya, *Malay*, *Tagala*, kopeka *Maori*, tivava *Marquesas*, huavare *Tahiti*.
tal,	from,	dari *Malay*, *Madura*.
tamuk,	while, when,	amangu *Batan*, tainawhea *Maori*.
tan,	breast,	dada *Malay*, daghah *Sulu*, toot *Pelew*, tut *Tobi*.
tan,	middle,	tangah *Malay*, tengah *Sulu*.
tec,	quickly,	dali *Tagala*, ma-dali *Bisayan*, tuhaua *Maori*.
tembacil,	lightning,	fetatechile *Tonga*, kila *Bugis*, *Macassar*, kilat *Malay*, *Sunda*, *Lampung*, kilat tatit *Java*, bekilop *Malay*, (thunder) kuru *Fiji*, (thunder).
than,	speech,	taki, tataku *Maori*, taitui *Tarawan*, tukuna *Fiji*, titinup *Tobi*, cang *Rotuma*, talanoa *Tonga*.
ti,	to, by, for,	di *Malay*, *Sunda*, *Lampung*.
toc,	to burn,	tunu *Java*, *Bugis*, *Macassar*, *Tonga*, tono *Madura*, sagar *Sulu*, joting *Bali*, tahu, tikaka, toro, *Maori*, taa·*Tonga*.
toh,	just,	adil *Sulu*, atau *Tahiti*, tika *Maori*, tunu, tutunu *Tonga*.
tox,	to pour,	taro *Malay*, tahoro, *Maori*, titiri *Tahiti*.
tub,	saliva,	tefoo *Mysol*, duc *Bolanghitam*, idu *Java*, edu *Menado*, kivi *Galela*, tohulah *Saparua*, *etc.*, tehula *Liang*, *Morella*.
ttuy,	finger,	tujak *Borneo*, taga tagan *Matabello*, odeso *Gani*, limin-tagin *Teor*, djanthen *Mille*, ndusi *Fiji*, toohoo *Tonga*.
tul,	full,	turuki *Maori*.
tulpach,	to return,	toloy *Tagala*.
tulum,	a wall,	tara *Maori*, loolooa *Tonga*, lalonga, *Fiji*.
tun,	stone,	batu *Malay*, *Sulu*, bato *Bisayan*, *Tagala*, watu *Bali*, fatuk *Timuri*, fatu *Samoa*, bathu *Rotuma*, toka, *Maori*.
tux,	where,	dinu *Batan*, hadiin *Sulu*, di mana *Malay*, tea, tehea *Maori*.
tzen,	food,	kennon *Bisayan*, genanga *Tonga*, cangniang *Formosa*, ma-cunnan *Malay*, kakana *Fiji*, kokkon *Mille*, usima *Fiji*, tame, kame *Maori*.
tsol,	string,	tali *Malay*, taura *Maori*, taula *Fakaafo*, tari *Tobi*, ndale *Fiji*, kora *Tarawan*.
u,	moon,	buan *Tagala*, hu-lani *Batumerah*, hulan *Morella*, *Wahai*, wuan *Gah*, uarru *Java*, hulanita *Liang*, hiano *Teluti*, wura *Bolanghitan*, *etc.*, hula *Rotti*, vula *Fiji*.
uac,	six,	anang *Bugis*, enina *Malagasy*, loacha *Uea*, uan *Serang*, cha-lemen *Lifu*, hol *Caroline*, yawor *Tobi*.

Maya.	*English.*	*Malay-Polynesian.*
uaxac,	eight,	ooahho *Batan*, hasto *Java*, hawa *Paumotuan*, saya *Kayan*, oh *Kissa*, yawa *Tobi*.
uay,	here,	toye *Cagayan*, jah *Lampung*, eunai *Ainu*, diyak *Sunda*, heni *Tonga*, gagito *Borneo*, atia *Tobi*.
uinic,	man,	wong *Java*, lalaki *Bisayan*, *Cagayan*, *Iloco*, oosoog *Sulu*, hamme *Samang*, aima *Timuri*, muwani *Bali*, manusia *Teluti*, manesh *Sanguir*, kanaka *Sandwich*, *Mariannes*, tangata *Tonga*, *Hervey*, *Samoa*, *Maori*.
uinclil,	body,	yango *Fiji*, inawallah *Saparua*, sanawala *Awaiya*, nangarohi *Galela*, kalakalath *Pelew*.
uitz,	mountain,	vohits *Malagasy*, bukit *Malay*, *Bali*, buguid *Bisayan*, buked *Philippines*, eothiva, tuatua *Fiji*.
utz,	good,	ygui *Tagala*, baik *Malay*, butje, sahe *Java*, hadeh *Sunda*, bachek *Madura*, *Bali*, baji *Macassar*, bati *Lampung*, huhuatanga *Maori*, ia *Liang*, *Wahai*, *Morella*, yisung *Tobi*.
uuc,	seven,	uju *Biayuk*, hiku *Sandwich*, fuz *Caroline*, iko *Kissa*, yavic *Tobi*.
xanhi, xantal,	to remain,	tinggal *Malay*, hintay *Tagala*, toenga *Maori*.
xicin,	ear,	tayinga *Tagala*, taingah *Sulu*, tinacono *Teluti*.
xchup,	woman,	sawah *Sulu*, gefinch *Wahai*, ahehwa *Matabells*, sowom *Cajeli*, saua *Borneo*.
yax,	young,	jaja *Malagasy*, kuao *Maori*.
yax,	green,	ijau *Malay*, fuccao *Cagayan*, iju *Java*, ejo *Sunda*, ijao *Biajuk*, ijau *Borneo*.
yub,	clothing,	hiapo *Marquesas*, ofu *Samoa*, kapa *Sandwich*, cofoo *Tonga*, kovu *Fiji*.
yalcab,	finger,	goolamai *Sulu*, jari *Malay*, kukur *Wahai* erike *Baju*, raraga *Galela*, saranga, *Bouton*, karami *Salayer*, ngganggalo *Fiji*.
yum,	father,	yama *Cagayan*, amahan *Bisayan*, ama *Tagala*, *Sulu*, *Iloco*, *Batan*, *Lampung*, *Rotti*, *Timuri*, *etc.*, ammah *Batta*, amai *Alfuros*, amana *Bouton*, jama *Menado*.
[zah, zahal, zahacil,]	fear,	coket, takot *Malay*, asing *Bisayan*, koera, hihira *Maori*, mataku *Fakaafo*.
zinic,	ant,	sumut *Malay*, *Java*, samot *Bali*, singeh *Menado*, singa, singat *Teor*.
zaz, zazil,	light,	sagaa *Bisayan*, sogho *Batan*, silao, *Iloco*.
zi,	wood,	cahuy *Tagala*, cahui *Bisayan*, kayu *Malay*, *Batan*, *Cagayan*, cahoi *Sulu*, gagi *Gani*, gah *Mysol*, kai *Teor*, kao *Sulu*, *Wahai*.
zil,	to give,	kasih *Malay*, kasik *Sulu*, sareangi *Macassar*, horoa *Tahiti*, kacito, li *Tobi*.
zuhuy,	virgin,	sunti *Java*, jadda vavy *Malagasy*, kohaia *Maori*.

INDEX.

This Index does not include the words of the four inscriptions, as they are set forth in the respective analyses.

THE OLDEST WRITTEN RECORDS OF THE LEAGUE OF THE IROQUOIS.

BY REV. JOHN CAMPBELL, LL.D.

(*Read January 22nd, 1898.*)

The late Horatio Hale, a lamented member of the Institute, in his Iroquois Book of Rites, follows Lewis H. Morgan in placing the formation of the Great League in the middle of the fifteenth century. David Cusick, who wrote the History of the Six Nations, takes it back a thousand years before Columbus. That the confederacy was revived at the time suggested by Morgan, Hale, and others, in view of Algonquin pressure, is most reasonable to suppose. That any such confederation took place on American soil in the end of the fifth century, as Cusick states, is more than improbable, since there is no evidence that even the Mound-Builders, who later formed the most ancient population of Mexico proper, entered the continent before the eighth century. Some rocks and stones engraved with inscriptions in the Mound-Builder characters, commemorate Iroquois and Huron chiefs, but make no mention of a League. Neither is there any mention of such in the inscriptions of Siberia and Buddhist India, which were erected by the ancestors of the Iroquois and cognate tribes. But writing of essentially the same character, and yielding a still more archaic but decidedly genuine Japanese form of speech, is found throughout the Sinaitic Peninsula, and the country east of the river Jordan, up to the Hauran and beyond it. These venerable inscriptions mention repeatedly the *kumi no to*, or Band of the League, and one of them names as contemporaries Odatshehte and Dekanawidah, two of the League's founders. Many inscriptions also refer to another League founder, the terrible Atotarho of the Onondagas, who was the original Ben-Hadad, or in Hittite speech, Hadad-ezer, of the race of Hamath, or the mountain door. These men flourished before Israel went out of Canaan into Egypt.

The only attempt at deciphering the Sinaitic inscriptions known to me is that of the Rev. Charles Forster in his Sinai Photographed. The reverend author, regarding them as Hebrew records corresponding to the story of Israel's desert wanderings, assigns arbitrary phonetic values to the characters represented, and wastes much unappreciated learning upon them. The characters, however, are not Semitic but Turanian, and the originals of those that appear in the East on Parthian coins, and on the Lats of India, on the monoliths of Siberia and Mongolia, and on Mound-Builder stones in America; while their Western descendants appear in the inscriptions of Lycia and Phrygia, of Lemnos and non-Aryan Italy, of Celt-Iberia, and Pictland. The Turanian revelled in inscriptions, and, while it is true that the Teuton, whether German or Scandinavian, borrowed his characters, with change of phonetic value in the runic staff, most of the supposed Teutonic runic inscriptions are really records of an Iberic predecessor, alike of kin to the Basque of the Pyrenees and the Ugrians of the Baltic and the Urals. The so-called Etruscan document, found on a mummy now in the museum at Agram in Croatia, probably never saw Etruria, but was written in the land of Egypt, where once dwelt many thousands, it may be millions, of the users of old Turanian script. In point of language, the peculiar polysynthesis that characterizes the Basque appears first in Asia Minor, and thenceforth accompanies all the Western inscriptions to the very shores of Greenland. But in the East it is unknown. From Arabia Petræa to America eastward, in Susiana and Parthia, India, Siberia, and Japan, the language is Japanese, archaic and severely brief often, but classical and universal. He who can read an inscription of the nineteenth century B.C. in Arabia Petræa, can also read one of the same character in America in the seventeenth century A.D.

The characters of the Sinaitic inscriptions are singularly free from the hieroglyphic form to which the Turanian Hittites of far later centuries went back, and to which on this continent the Aztecs confined themselves. Yet, it is evident that the conventional characters of Sinai had a hieroglyphic origin. So far, these original Turanian hieroglyphics have not come to light. Time is required to modify a hieroglyphic system of writing into one of conventional symbols, yet the conventional Turanian can be proved as old as the nineteenth century B.C. How old, therefore, must have been the primitive hieroglyphic system, borrowed, no doubt, from Egypt, with change of phonetic value, which the Turanian simplified into the Sinaitic hieratic or demotic script! Still more wonderful is the fact that the scribes of Arabia Petræa, instead of carefully keeping their syllabic characters distinct and punctuating them with colons, as did their descendants both east and west, ran them together into compound characters, often very confusing and hard to decipher, as if for them and their readers their work was a mere child's play. It looks as if they had little room to work in, and accordingly adopted an ancient fashion of shorthand with which to puzzle posterity. Nevertheless, every stroke in the compound character stands for a well-known phonetic syllable, and on careful investigation yields its value and meaning. This will be made clear in the inscriptions I have chosen for illustration, so that I need not tire the reader with examples of it at this stage. As the inscriptions given are copied from Forster's Sinai Photographed, the numbers they bear in that work are appended.

The first is Forster's No. 36, and consists of six lines which, transliterated, yield the following:

No. I.

shi-ko-ba
ku da shi-ta shi-ba
shi ba ma da ba ku-shi-no
ku-ma dzu ta de ka-na-ta
ku dza no-ba shi da shi ku da shi ta ba
ku ma no to

Turning this into as near an approach to current Japanese as its archaic style will allow of, it yields the following legend:

shi kobe
dead chief

Kudashita shiba
Kudashita death places

shibume tobe Kushi no
soldier opposing Kushi of

Kumi dzuto Dekanata
League head Dekanata

kudzu Noba satashi Kudashita be
causes to descend Noba to aid Kudashita under

Kumi no to
League of band

Freely translated we read: "An opposing soldier of Kushi kills the deceased Chief Kudashita: Dekanata, the head of the League, causes the Band of the League, under Kudashita, descend to ally itself with Noba."

Here is the problem which this document presents. In the Wady Mokkateb, or written valley of the Sinaitic peninsula, is found an ancient inscription in virtually the same characters as those of the Yarmouth Stone and the West Newbury written rock, the former commemorating a Cayuga chief named Katorats, and the latter a Huron Tionon called Mehashi. With slight differences, naturally arising from great intervals of time and space, they yield the same Japanese speech, the Latin or classical tongue of the northern Turanians. Next, we have in the Sinaitic peninsula or its vicinity a *Kumi* or League, and its *Kumi-no-to*, or band of the League, an armed force at its command. The world has seen many leagues, from that of Chedorlaomer to the one which Henry of Navarre overthrew ; but this is a Turanian league in the midst of what in all historical time was a Semitic or sub-Semitic country. These leaguers were not Bedouins, Edomites, Nabatæans, nor Israelites ; neither were they Egyptians, although there are Egyptian inscriptions of great antiquity in the Sinaitic peninsula alongside of the Sinaitic proper. The syllabary and language of these ancient leaguers are the same as those of the Iroquois, who also were famous for their League. This is no mere coincidence, for Turanian leagues are of rare occurrence.

The inscription mentions three persons by name; Kudashita, the general of the band of the League; Dekanata, its head ; and Noba, with whom it allied itself when Kudashita fell. Kudashita in Japanese means "He has caused to yield or surrender." Has reliable history any such name? In my volumes on The Hittites, whom I regard as the ancestors of the Japanese and many other Turanian peoples, including our Iroquois, I have shown that a certain Achuzam was the eponym of the Zuzim of the Bible, the Gagama of the Assyrian inscriptions, and the Chicimecs of Mexico. He is not Kudashita, but in Genesis xxvi. 26, there appears a name of the same formation as Achuzam, namely Achuzzath, or, as King James' version reads it, Ahuzzath, who was a friend of Abimelech, the Philistine king of Gerar, and is mentioned along with Phichol, the chief captain of the Philistine army. Whether what I read as *ku* was anciently pronounced *aku* or not, I do not know. The Basques, who are of the same stock, would doubtless prefix a vowel, *a*, *e*, or *i*, and their ancestors may have done the same in early days, but it is not in the writing. Nevertheless, I am convinced that Kudashita is Achudzath, for that is the true transliteration of the Hebrew, and that he was a warrior, the friend of the Aryan Padishah, or, as the Hebrew translated the title, Abimelech of Gerar. He was also, by a common process of name corruption, the Odatshehte of the Oneidas, whom Dekanawidah, at the instigation of Hiawatha, gained over to the cause of the League.

The Oneidas are the Onneyote of old writers, but the interchange of liquids in the Turanian tongues enables one to pierce the disguise of the name, and see in it the Aleutan title, as well as the Olut or Eluteat, of the islands that touch Alaska, and that designate the Koriaks of Asia. In classical speech, Kudashita or Odatshehte, was an ancient Lydian. In his day, according to the inscription, the head of the League was Dekanata. Now, Mr. Hale says that the first name on the roll of the League of the Iroquois was that of the Canienga or Mohawk Tekarihoken, that Hiawatha came second, and that the name of his great colleague Dekanawidah nowhere appears. "He was a member of the first council; but he forbade his people to appoint a successor to him. 'Let the others have successors,' he said, proudly, 'for others can advise you like them. But I am the founder of your league, and no one else can do what I have done.'" Dekanawidah is not exactly the same as Dekanata, any more than Kudashita is the same as Odatshehte, but the collocation is remarkable. The Iroquois lengthened out names received by tradition. The old Hittite ancestor and deity, Zur-vune or Tsurvune, became, in Iroquois speech, Tharonhia-wakon. In the same way the original Dekanata was made Dekanawidah. Who Dekanata was, I do not yet know from any other source, but that he was the real head of the League, and that Kudashita fought at his command, is evident.

The defensive alliance entered into by Abraham and Isaac on the one hand, and Abimelech of Gerar on the other, had reference, as most alliances have, to warfare. We read in Genesis x. 14, and 1 Chronicles i. 12, that Philistim or the Philistines came out of Casluhim, a branch of Mizraim or Egypt. Hitzig has abundantly proved that these Philistines were Pelasgi, the ancient stock of the Aryan race, and the Egyptian monuments, equally with the Bible, inform us that they came out of Egypt, but there is as yet no record of when they went into that country from their early settlement at Gerar in the Negeb. The mention in Genesis of Phichol, the chief captain of Abimelech's army, along with Achudzath points to warfare, and the fact that the Philistines came some generations later out of Egypt, leads one to think that the land of the Pharaohs was the scene of their military operations. The present inhabitants of Gerar are the Azazimeh Arabs, who may have inherited the name, if nothing more, of the old Zuzim descended from Achuzam. At the time of Sarah's death, the Zocharite branch of the Hittite family was in possession of Hebron, and, long before, the Amalekites of the same stock were as far south as Kadesh. A great Hittite movement, similar to the barbarian invasions in Europe in the fifth century, converged from many points towards the fertile Nile valley, and resulted some time before the captivity of Joseph, in the replacement of the old dynasty of the Hor-shesu or Sekenen-ras by the foreign one of the

Hyksos, called also the Aadtous, who were the Adites of the Arabian historians. That the Philistines gave their military strength to this invasion is most probable, although historical data for asserting its reality are yet wanting.

Dekanata, as head of the League, sent Kudashita into the west to be the ally of Noba, and he was killed by an opposing soldier of Kushi. If Kushi be Cush or Ethiopia, we know nothing of its early history. It, however, could not be reached without ships, unless the men of Arabia Petræa passed through the whole length of Egypt. Had the inscription been found in Yemen in Arabia Felix, the identity of Kushi with Cush would have been incontrovertible. In the Delta was a nome that became the seat of a kingdom in Hyksos' day called Kasit, and its capital was Khesauu, termed by the Greek Xois. Its tutelary divinity was Amen-ra. Now, the second Amen-em-hat was named Nub-kau-ra, that is Nub (the son of), Kau (the son of) the Sun. The nearest Pharaoh in name to this Kau is Ka-kau, whom Brugsch places in the second dynasty of Thinite kings, continuing the old confusion of Manetho between This and Tanis or Zoan. Ka-kau is the Kaiechos of Manetho and the Choos of Eusebius, who was succeeded by a woman. But in Manetho's first dynasty, the fourth Pharaoh is Ouenephes, in whose time was a great famine, and who built the pyramids at Cochome, or according to the Armenian version of Eusebius, Cho, a place unknown, unless it be Khesauu or Khesun, otherwise Xois.

From the confusion of Manetho, worse confounded by each new Egyptologist, we turn to a brief chronicle, originally kept by the Kenite branch of the great Hittite family, but incorporated, with many indications of ignorance, in the Hebrew records. In 1 Chronicles iv. 8, we read: "And Coz begat Anub and Zobebah and the families of Acharchel, the son of Harum." The Turin papyrus mentions Anoob as a shepherd king, and Manetho mentions Archles. Zobebah is the Biophis of Eusebius, who immediately follows Choos of the second dynasty, and in whose reign it was decided that women should have the right to rule. She is also the Se-hotep-ab-Ra whom Amen-em-hat I. bracketed with himself on his cartouches. According to Manetho, the first Amenemes was killed by the guards of his bed chamber, and the same is related of Othoes, the first of the sixth dynasty. The founder of the sixth dynasty Brugsch calls Ati, and he makes him contemporary with a Teta or Hadad. It is remarkable that a person called Se-hotep-ab-Ra had charge of the temple of Anpu or Anubis during the reigns of the third Usertesen and Amen-em-hat, and was buried in the necropolis of Abydos, the chief seat of the Usertesens who sprang from Teta. The first Usertesen, who followed the first Amen-em-hat, opened the copper and turquoise mines of the Sinaitic peninsula, and his officers left Egyptian inscriptions there.

Ati, who seems to have taken to himself the name of Pepi, married the daughter of Khua and Nekebet. Now Nephthys, according to tradition, was the mother of Anubis or Anub, the brother of Zobebah. Nebtei is not the same word as Nekebet, but they are not dissimilar. "Coz begat Anub and Zobebah." Greek mythology, which touches all the world, here comes to our help, presenting Œnopion, king of Chios, as the son of Bacchus. This Bacchus or Iacchus is the Egyptian god Khons or Chonso, called, with the prefix of the article Pa-chons, the n being inserted for the sake of euphony. According to Diodorus Siculus, the father of Bacchus was Jupiter Ammon, and according to the Egyptians, he was the son of Amen and Maut. Looking for Nephthys or Nebtei, we find that the sister of Khufu, the Cheops of Herodotus, and the Ziph of the Kenite chronicler (1 Chronicles iv. 16), was Ziphah. This name, connected with *Zepheth*, pitch or naphtha, in Semitic, the Egyptians would naturally change to *nebtei*, as they changed the Semitic *zahab*, gold, to *nub*. All the ancient lists give two Khufus or Souphises, and most Egyptologists make Nef or Noub-Khufu the successor of Khufu proper. In the latter I am disposed to see the Anub, who was Ziph's nephew as the son of Ziphah, and thereby to rend asunder the scheme of untenable antiquity ascribed to the Egyptian dynasties.

A confirmation of the story of Zobebah is the Phrygian one of Cybebe or Cybele, told by Diodorus Siculus. This queen, called the daughter of Mæon or Manes, doubtless her grandfather Ammon, in mature years fell in love with a youth called at first Atys, afterwards Papas, the Ati or Pepi of the monuments. Atys was put to death, and in her time of grief she bore a posthumous child. Compare the story of the Kenite chronicler (1 Chronicles iv. 9), "And his mother (Zobebah) called his name Jabez, saying: 'Because I bare him with sorrow.'" This Jabez, or Yaabetz, is the Aahpeti of the monuments, and the Ægyptus of the Greeks; and, at the same time, the third Amen-em-hat. He is also the second Pepi or Apophis who reigned a hundred years, and in whose eighth year Joseph was exalted. His son was Ahmes, or more properly Mes-ah, his grandson Neb-pehti-ra, and his great grandson and successor Har-em-hebi, after whom came the new dynasty of the Thothmes-Rameses.

Amen, the tutelary deity of Xois, the husband of Maut and father of Khonso, the eponym of the Amen-em-hats, and Jupiter Ammon, the father of Bacchus and grandfather of Œnopion, is Ammon the son of the Lot of Genesis. Many years ago Sir Gardner Wilkinson said, "The names of the children of Ammon, as well as of Chemosh, their god, are too near to the Khem and Amun of Egypt to be accidental." Whether Ammon or Ben-Ammi was in Egypt or not we have no present means of knowing, but that his son Coz, the Kushi of the inscription, founded in the Delta a kingdom called after himself, is indubitable. It lay considerably to the west of the original Horite kingdom of Zoan or Tanis, the tutelary deity of which was Horus, so that there was no necessary collision between the two states, nor would invaders from the eastern desert need to pass through the occupied territory of the one to reach the other. There is every reason to believe that the Horite line, whose Pharaohs were called Sekenen-ras by the Egyptians, and Kukanos by the Hittites, was on the throne of Zoan in the time of Coz and his son Anub. It is also likely that Maut, the consort of Amen and mother of Khonso, belonged to that royal family, thus giving the line of Ammon claim to rule in Egypt.

We are now in a position to place the time of the ancient League. The following table may be trusted in general terms:

```
   Jehaleleel        Ammon   born circ. 1897 B.C.
   ______|_____        |
   |          |        |
  Ziph      Ziphah = Coz
                  |
          ________|________
          |               |
        Anub        Zobebah = Ati
                            |
                         Yaabetz   born circ. 1723 B.C.
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From the birth of Ammon to that of Yaabetz is a period of 174 years, or an average of 58 years for each generation. Isaac was Ammon's contemporary, but he was ninety-three years of age when he met Achudzath in Gerar, which would fall about the year 1804 B.C. This leaves about 81 years between the interview and the birth of Yaabetz. It follows that Achudzath was a young man when he visited the Philistine king, and an old one when he fell by the hand of a Xoite warrior. He was, therefore, a contemporary of Coz rather than of Anub, so that his death may have taken place in 1756 B.C., when Anub was about 25 years old. It remains to learn, if possible, why Achudzath was killed by a Cozite soldier when going to ally himself with Anub, the son of Coz.

Mr. Forster's No. 16 gives some news concerning Coz or Kushi. It is from the Wady Eufrea, and reads in one line:

No. II.	ma ma	ku shi	kibi	ma ko ko	ma no	dzu ta
or,	mi mi	Kushi	Kibi	mukoko	Aman	dzuta
	great great	*Kushi*	*Kibi*	*son-in-law*	*Ammon*	*successor*

Freely rendered it gives, "The very great Kushi, the son-in-law of Kibi, the successor of Ammon." Here Kibi represents Ziph or Khufu, the builder of the great pyramid, whose brother-in-law Coz was; but in Japanese *muko* is a son-in-law, and brother-in-law is *ane-muko* or *imoto-muko.* Literally *muko-ko* would mean the son of a son-in-law, which would complicate matters still more. Noba or Anub appears in Mr. Forster's No. 19 from the Wady Mokkateb, where the Achudzath inscription comes from. It is broken into two lines which read:

No. III. Kima ma ma no ba ma kidzu be no
no shi no ki dzu yo

This is:

Kemi	mi mi	Noba	makedzu	Beno-
Kemi	*great great*	*Anub*	*conquers*	*Beno*

-nesa	noki	dza	yo
of the	*enemy*	*head*	*from*

"The very great Anub conquers Chemi from the chief of the enemy of the Benones." Here Chemi does not stand for the whole of Egypt, but for Chemmis or Panopolis in the upper kingdom, whither the arms of Amen-em-hat extended. The Benones again are not the Punt or Phount, who were negroes of the race of Phut, the son of Ham, but a Hittite stock, the descendants of a Jephunneh, son of Ephron, great grandson of Zohar or Tsochar, and the father of a Caleb who became the Greek Æsculapius; for Yephunneh was Pæon, the father of that physician, and Tsochar was Teucer, from whom he descended through Ephron or Apollon. The Benones are the Tokari, often mentioned on Egyptian monuments, at times as enemies, at others as mercenaries in the pay of the Pharaohs. Their wise men had cultivated the art of medicine, so that Homer knew the Egyptian physicians of the race of Pæon. The fortunes of this family I have set forth in my last paper on the Tungus of Asia and the Denes of America. No name is more widespread in mythology and legendary history than that of the ancestral Tsochar, from the Trojan Teucer and the Greek Deucalion to the Tigil of Kamtschatka, and from the Polynesian Tangaloa to the

Tockill of Yucatan. But Anub was stronger than his descendants the Benones or early Huns, and drove them out of Chemmis.

Mr. Forster's 23rd may apply to any ruler of Xois, but probably relates to Anub. It is from the Wady Mokkateb, and is in five lines:

No. IV. kuta ba kisa ma be kuma ki ta
shi da shi ta.
kishi shi ma no ku shi no kisa ma
shiba da ki bi noto.
shi no shi de.

Put into intelligible form it is:

Kutaba Kisama be Kumi Kita
Kutaba Kisama under League Kita

satoshita
instructed

kiza shime no Kushi no Kisama
engraved proclamation of Kushi of Kisama

ezbada Kibi no to
refuses Kibi of band

sinetsi de
regard from

Here one or two words not recoverable from the Japanese are supplied by the Basque, a language of the same origin. These will be discussed in the analysis. The document reads: "Kutaba instructed the Hittite League under Kisama. To the engraved proclamation of Kushi, Kisama says no, out of regard to the band of Fibi." This Kisama or Kishima must have been a man of note, since the Hittite League was under him, yet he had regard to the forces of Kibi or Khufu who ruled in Memphis, and had himself mines in Arabia Petræa as inscriptions in the Wady Mayhurah testify. In Kishima we must recognize the Husham, Chusham, or Chesham, as it is written in Genesis xxxvi. 34, 35, who was the third king that reigned, not over the Edomites, for as yet they were not but in the land that afterwards was called Edom. He was a Temenite or Amalekite, and Eliphaz of that nation, the friend of Job, may have been his son. This name perhaps, was *Ki-shime*, "who keeps his temper."

He is mentioned in another inscription, Mr. Forster's 58 from Wady Hebran. It is very badly engraved and hard to decipher at first.

No. V. bu shi to shidzushi me shidzushitsumeshita koi
kishishima kumi me sh dzushi
ta me no obe kishishi ma bu shi
to a ta a ba hi ta

In readable order it becomes:

bushi to sadzushi meshi-dzushi tsumeshita koi
soldier band to send ambassador pressed desire
Kishima kumi me hidzushi
Kishima league amb ssador
Temeni obe Kishima bushi
Temeni lord Kishima soldier
to Ataa bahita
band Ataa pledged

Freely, it may be read: (To) the desire of the ambassador (who) pressed Kishima to send a band of soldiers, Kishima, the lord of Temeni, pledged the ambassador of the League a band of soldiers (for) Ataa."

What he would not do for the king of Xois, who was an Ammonite and a foreigner, Husham expressed his willingness to do for Ataa, Who was this? He was in some respects the greatest man of his day. the Ati of the Egyptian monuments, who led the Aadtous of the First Sallier Papyrus wrongly translated "the impure" or "the strangers." Othoes and Achthoes are names given him by Manetho. The Arabian historians call him Ad, and his posterity Adites, men of great stature and violence, relatives of the Amalekites, and conquerors of Egypt. The Kenite chronicler (1 Chronicles ii. 47) calls him Jahdai or Yahdai, perhaps the old Japanese *yatai*, the bold. He was the son of one Gazez in the Achuzamite or Zuzim division of the Hittites, who, in Abraham's time dwelt in the country later occupied by the Ammonites, where Chedorlaomer smote them. This Ati or Yahdai married Zobebah, the daughter of Coz, and, after much fighting, died, if all accounts be true, by treachery, leaving behind him an unborn son by her, in addition to six sons of man's estate, of whom the eldest, called by the chronicler Regem, was the famous Sargon, king of Agade. As George Smith makes Agade the same as Akkad, we may find in the name of Yahdai the origin of the Babylonian ancient name. The death of Yahdai must have taken place in 1724 or 1723 B.C., so that Brugsch's date of 3266 for his ascension to the throne as Ati, and that of 2456 for the same as Amen-em-hat I., are grossly at fault.

Other inscriptions contain the name of Yahdai. One is Mr. Forster's 102 from Wady Guene. Its legend is:

No. VI. ki-be-ku ku be ta be ki ke ra shi la ki
ma ya da ya

or: Kibeku kobe tabeki Kera sa alki
Kibeku head subduer Syria of pow

ma Yadaya.
ful Yahdai.

"The head of Kibeku, the conqueror of Syria, the powerful Yahdai." This inscription is of great interest, from the fact that it connects the name Kibeku with the Zuzimite division of the great Hittite family. This name in geographical nomenclature is the Gibeah of the Hebrew, which, ending with the letter *ayin*, would be pronounced Gibeag of Gibeg. On the 13th of September last, Mr. A. Cameron, president of the Summer School of Science for the Atlantic Provinces of Canada, wrote me from Yarmouth, N.S., as follows, referring first to my translation of the inscription on the famous Yarmouth stone: "About three weeks ago, another graven stone was found near the shore, about a mile southwest of where the first one was found. The inscription is in two lines. The upper line is the same as the old one. The lower line contains only three characters, YVH." I give the nearest equivalents in Roman letters, which, as Hittite writing, read Kubeka. Katorats, the chief whose name figures on these two Yarmouth stones was, equally with the Yahdai of the eighteenth century B.C., a Kibeku or Kubeka, in Iroquois parlance, a Kuwega or Cayuga, and his tribe gave name to Quebec, before phonetic decay had deprived the Iroquois of their labials. Peter Dooyentate Clarke, in his history of the Wyandotts or Hurons, places the Senecas in the neighbourhood of the Quebec Hurons but the name Quebec and the legend of the second Yarmouth stone shew that the Kubeka or Cayugas must have been to the east of them. Quebec is thus really one of the oldest town names in the world. That Kera denotes Syria is evident from the hieroglyphic Hittite inscriptions.

Yahdai appears once more in Mr. Forster's 74, with more important historical connections. It reads as follows:

No. VII. kishishima o no o no kita ma ra no ku kuno shi ki
kishi shi ma no ku ku ta ku la shi ta ya ta ya be

This is:

kiza shime on on Kita marane Kukuno saki
engraved proclamation good good Kita overcome Kukuno lord

kiza shime noku kudaku Lasada Yataya be
engraved proclamation enemy shivers Lasada Yadaya under

Put into English, it is:

"Written notice: The excellent Hittites overcome the Lord of Kukano. Written notice: Lasada, under Yahdai, shivers the enemy."

The Kukano are the Sekenen-ras of the Egyptians, the old Horite rulers of Zoan, descended from the Horite Akan or Yaakan, who was the Agenor of the Greeks. They had possessions in the Sinaitic peninsula, for in Numbers xxxiii. 31, 32, and in Deuteronomy x. 6, we read of Beeroth of the Bene-Jaakan, a name transferred in after years to Berytus in Phoenicia, for Bene-Jaakan gives the Phœnician name. The second letter in Yaakan is *ayin*, which has the value of g; hence the word would be transliterated Yagakan. It was out of this the Hittites made their Kukuno, or as elsewhere Kukano. Zoan, or, as Genesis xxxvi. 27, calls him, Zaavan, and 1 Chronicles i. 42, Zavan, was the elder brother of Akan or Yaakan. They were sons, along with Bilhan, the eldest, of Ezer, the son of Manahath, whom Osburn has compared with the Egyptian god Month, and who was the son of Shobal, the Horite, the Seb-ra of the Egyptians, his elder brother being Reaiah or Ra, the sun-god. Unless Manahath be Menes, this illustrious family has no early recognition on the Egyptian monuments, but Ezer is, in all probability, the Osiris whose body was dismembered by Typhon, who was Ziph or Khufu, and his grandson, the son of Yaakan, named Etam or Getam, is the Cadmus, son of Agenor, of the Greeks, and the Timæus of Manetho, in whose reign the Hyksos conquered Egypt.

To return to the general of Yahdai called Lasada. He is, no doubt, the Hyksos leader named by Manetho Salatis, but Arabian tradition calls him Lasouad, and ascribes to him the excavation of Lake Maras, the Mœris of the Greek writers. He is the Shuhite prince Laadah or Lagdah of 1 Chronicles, iv. 21, the ancestor of the Lydians of Asia Minor, the Eleut Koriaks of Siberia and Kamtchatka, the Aleutians, and the Oneidas. According to the Kenite chronicler, his son was Mareshah or the illustrious Reshah, the Maris or Mœris, and the Marsyas of the Greeks, who gave name to the great Egyptian reservoir. This Mareshah is the Latin god Mars, and, without the honorific prefix *ma*, the Ares of the Greeks, the Arioski of the Koriaks, and the Areskoui of the Iroquois. Another inscription from the same place, the Wady Mokkateb, unites Yahdai and Lasada in two distinct proclamations. It is Mr. Forster's 27 :—

No. VIII. kishishime taki ma da shi shi kushi
be kushi no kata ya da
kishishime ra shi no ya ta
la shi da shi no to

In connected form :

kiza shime daki Mada seshi Kushi
engraved notice receives Mada regent Kushi

be Kushi no kata Yada
under Kushi of conqueror Yahdai

kiza shime Rashi no aita
engraved notice Rashi of father

Lasada shi no ato
Lasada death of indication

These separate proclamations read: "Engraved notice: Mada, the regent under Coz, receives Yahdai the conqueror of Coz (Xois). Engraved notice: intimation of the death of Lasada, the father of Reshah.

Whether or not these two inscriptions should be connected it is hard to say. If they should, it would appear that Mada, the Moabite, who was regent in Xois, had welcomed Yahdai to the conquest of the Xoite kingdom, and that Laadah had perished in the warfare which thus terminated. Henceforth, according to the Phrygian story of Cybebe, Mareshah or Marsyas became the champion and faithful attendant of Zobebah, as Laadah had been of her husband Yahdai. Mr. Forster's 32, also from the Wady Mokkateb, furnishes information regarding Mada. This is it:

No. IX. kishiki ma kumimata be kubekurarashi
be ku mada kishi ya ko dzu yo.

It reads:

kiza ki ma kumi mito be Kubeku Rarashi
engraving does give league king under Kubeku Karashi

waka Mada Kishiya ko dzu yo
separates Mada Kisaye son succeeding from

In English: "The carving sets forth that the Kubeku, under the king of the League, separates Rarasa from Mada, the son and successor of Kisaye.

Without at present enquiring for the site of Rarasa and into the rival claims of Mada and the Kubeku to it, we turn to Mr. Forster's 89 from the Four Wadis. Its legend is:

No. X. kishi ya mo ya

be o mo ba ma ta dzu dzu nabe

This reads:

Kisaye Moa-
Kisaye Moa-

be omo Bamota dzudzu nabe
-b chief Bamoth head lord.

or : "Kisaye ruler of Moab, high lord of Bamoth." Mr. Forster's 88 is from the Wady Mokkateb, and is defective, yet gives a synchronism.

No. XI. kishishime . . ta ma da shishi beshi no ba
shi no shi da shi

In Japanese :

kiza shime . . ta Mada seshi besshi Noba
engraved notice . . ? Mada viceroy special Anub
sinetsi tachi
esteeming appoints

"Anub, esteeming Mada, appoints him regent extraordinary."

A very difficult inscription on page 96 of Mr. Forster's book, and which is not numbered like others, comes from Wady Nasab. It may be read :

No. XII. kishi ya nobeko behano o be ri do kuba o be
kishishime lasada kimi be be
ta bera no ma bekama

In Japanese :

Kisaye Nobe go bei no obe rido kobe obe.
Kisaye Anub of yes of lord justice head lord

kiza shime Lasada kemi be be-
proclaims Lasada inspector under mi-

-taberi no me be Kemi
ners of eye under inspector

In English :

"Kisaye, lord of the electors of Anub, chief lord of justice, proclaims Laadah superintendent of the subordinate inspectors of the miners."

Here we have Kisaye and Mada, father and son, acting in succession as prime ministers of Anub, the grandson of Ammon. It is natural to think that Kisaye may have been a son or grandson of Moab, having paternal estates, not in the land of Moab, but in the Delta of the Nile, contiguous to the kingdom of Xois, and which included the Bamoth of Inscription X The Moabites were evidently subject to the Ammonian line of Xois, and only achieved their independence, when, some time before Israel's exodus, they quitted Egypt and settled in the country east of Jordan which bears their name.

Mr. Forster's 75 from Wady Mokkateb exhibits the relations between the Xoite kingdom and the Hittite league :

No. XIII. ku ki yo ma re shi da nota be kumi noto tsu ta
kumi noto be ma no

In order:

kukiyo Maresha danda be Kumi no to tsuta
illustrious Mareshah tribute under League of Band brought

Kumi no to be Amon
League of Band under Ammon

In English:

"The illustrious Mareshah brought the band of the League under tribute (and) Ammon under the Band of the League."

This was the result of the marriage of the Hittite warrior King Yahdai to the Ammonite queen Zobebah, their son Yaabetz or Aahpeti combining the two stocks in his own person. It is worthy of note however, that the League was not brought under Ammon, but Ammon under the League, which is quite consistent with the practice of adoption in the League of the Iroquois in modern times.

A few inscriptions of the Hamathite or Onondaga family, to which the League founder Atotarho belonged, may complete the present series. Mr. Forster's 90 is from the Wady Guene, and deals with the first of the Hadads.

No. XIV. keshi shishi ko do beka da ta
be da ki ka nobe ta shi no

In Japanese:

gasshi seji-kota beka Adad
united world lord Hadad

Beda ki kanebeta shoni
Bedad noble Kanebeta son

"Hadad, lord of the whole earth, son of the metallurgist, the noble Bedad."

This is undoubtedly the Hadad son of Bedad of Genesis xxxvi. 35, 36, who succeeded Husham in the range of Hor, and smote Midian in what afterwards became Moab. The name of his city was Avith, that is to say Abydos in Egypt. His father Bedad or Beda he calls the metallurgist, as one who was among the first to work the mines of Arabia Petræa. The modern Japanese name for a metallurgist is *kane-fuki*, but the ancient Hittite term for smelting was *beta*. The remarkable thing, however, about the word *kanebeta* is that it is the original of the English *knife* and French *canif*, which were derived from the Basque *ganibet*, a knife, the meaning of which in old Hittite days was simply "smelted or manufactured metal." A member of this society, Dr. W. Canniff, may claim descent from Beda Kanebeta, a contemporary probably of the patriarch Abraham. Hadad is the mining monarch out of whom the Greeks made their Acetes of Colchis, and his adversary Husham is their Jason, whom, however, Hadad survived.

Mr. Forster's 61 is from the Wady Mokkateb.

No. XV. kishishi be no da ta shiba
ma no shi shi ta do shi ku no
kumi meme
ta do o shi shi da te

In order:

kiza shi Bendata shiba
engraving is Ben-Hadad kills

Amon sesshi todo seki-no
Ammon commanding officer hasten will

Kumi Emim
League Emim

todo oshi sadate
officer violent death to avenge

"The engraving sets forth that Ben-Hadad has killed the commanding officer of Ammon. The Emim of the League will hasten to avenge the officer's murder." This Ben-Hadad, so called, perhaps, because of his friendship for the Semitic speaking Sekenens and others, is the Hadad-ezer of his own Hittite language, and the Atotarho of the Iroquois tradition. With inversion of parts, the name is the same as the Parthian Tiri-dates and the Assyrian Esar-haddon. This early Hadad-ezer was the enemy of the Ammono-Hittite line, and favoured the Sekenens or Kukanos of the old Horite dynasty. The Emim of the inscription are the early inhabitants of Moab and Bashan, Genesis xiv. 5, for they really included the two branches of the Achashtarite division of the Hittites, namely the Chelubites and the Shuhites, to the former of which belonged the Rephaim and the Chanochites, Kaniengas or Mohawks, that included Hiawatha, the original founder of the League. The inscriptions, however, indicate that the Rephaim were of doubtful loyalty to the League, and appear to restrict the appellation Emim to the Shuhite branch of Ashteroth Kamaim, or of the two horns, in which Laadah and his son Mareshah were the chief figures.

Mr. Forster's 105 from the Wady Mokkateb illustrates the change of front of the Rephaim.

No. XVI. shiba raba kita be
keshi beki ka ta shiba shi
kishiki ma ku shi noba to
be da ta kita .
shi no shi

In order:

Shiba Raba Kita Be-
kill Raba Kita Be-

-keshi beki Kata shibashi
keshi lord Kata killer

kiza-ke ema Kushi Noba to-
carved lines gives Kushi Anub in-

-be Data Kita
-stead of Hadad Kita

sinetsi
esteem.

"The Raba Kita, having killed Kata, the lord of Bekeshi, the killers give notice that they prefer the Hadad Kita to Anub of Xois."

This defection in the League evidently took place while Anub was the leading figure in lower Egyptian history, and while he was in conflict with Hadad. The Bekeshi seem to have been the Paseachites, closely related to the Rephaim, and, in a measure, subject to them. Of the Paseachites came the Yoba Kita of the family of the patriarch Job, out of whose name, Hiob, arose the names of Iowa and Hiawatha, while the Canienga or Mohawk title was derived from his descendant Chanoch.

Another inscription, Mr. Forster's 99, indicates that the Rephaim became part of Ben-Hadad's army.

No. XVII. dzu dzu nesa be no da ta be
raba kita a to
guno ba ba ta shiba nesa shi no shi

That is:

Dzudzu-nesa Beno-Data be
followers of the Ben-Hadad under

Raba Kita ato
Raba Kita rear

gunba bata-shiba-nesa sinetsi
army horse soldiers of the esteems

"Of the followers under Ben-Hadad, he esteems the Raba Kita of the cavalry of the rear guard." In my paper on Siberian Inscriptions, printed in the Transactions of April, 1892, pp. 261–283, the names of the allied Raba and Yoba Kita will be found as set forth on monuments dating from the end of the fifth century A.D. onwards. They were the Libyans of the ancient Greek writers, and a remnant of them are the Lapps or Lappi-gunda of Northern Europe. Brugsch says: "To the west (of the Nile) dwelt the groups of tribes which bore the general name of Ribu or Libu, the ancestors of those Lybians, who, inhabiting the northern coast of Africa, extended their abodes eastward as far as the Canopic branch of the Nile. From the evidence of the monuments they belonged to a light-coloured race with blue eyes and blonde or red hair. It is a noteworthy phenomenon that, as early as the Fourth Dynasty, members of this race wandered into Egypt to display their dexterity as dancers, combatants and gymnasts in the public games." Now the Fourth Dynasty is that of Khufu, whom Brugsch places in 3733 B.C., while George Smith places the Babylonian Hammu-Rabi in 1500 B.C. But Hammu-Rabi is Beth-Rapha, son of Eshton of Mehir of Chelub of the Emim (1 Chronicles, iv. 12) from whom the Rephaim derived their name. The peculiar complexion of this Hittite stock arose from its intermarriage with the Zimrite, Sumerian, or Cymric Celtic stock. George Smith's date is much under the mark, but not so much as Brugsch's is over it, for the Rephaim were smitten by Chedorlaomer about 1913 B.C. The inscription seems to indicate that the Raba Kita cavalry were in Egypt before the end of the eighteenth century B.C., and that they probably quartered in the city of Abydos where the Hadads reigned.

The temptation is great to continue the translation of these inscriptions, of which there are over three thousand in the Ordnance Survey of the Sinaitic peninsula, but for present practical purposes the seventeen already given may suffice. We have in them a type of phonetic writing in conventional characters, in existence, no doubt, before the time of Abraham, since some of the inscriptions are contemporary records of the son of Ammon, and Khufu of the Great Pyramid, and one contains the equally contemporary story of the death of Achudzath, who had talked with Isaac at Gerar. They prove, at the same time, the great antiquity of letters, and the historicity of the Old Testament records, while they cut down the extravagant chronological schemes of writers on Egyptian and Babylonian history, who toss about centuries as things of little account. Did time and space permit, it could be proved from the inscriptions given, and many others that, from the time of the founding of Zoan down to that of the second Rameses and beyond it, there were several kingdoms in Egypt, and that although one Pharaoh at times like

Aahpeti and the Thothmes-Rameses occupied the position of king of kings, in a measure like that of the German Emperor, the subordinate kingdoms were practically independent. Of these kingdoms, the most ancient was that of the Horites of Zoan or Tanis in the Delta, whose rulers being expelled by the Hyksos in the end of the eighteenth century, took refuge in the neighbourhood of Thebes, whence they emerged in the beginning of the sixteenth century in the persons of the Thothmes-Rameses. Some time later than the beginning of the kingdom of Zoan, and probably about the same time, commenced the reign of the Ammonite line in Xois, and that of the Cherethite-Hittite-Khufu in Memphis. The first seems to have lasted till the time of the expulsion of the Hyksos by Thothmes II., but the latter dynasty was expelled during the reign of Aahpeti, in the end of the eighteenth or the beginning of the seventeenth century, and became the ruling family in Assyria. Three kingdoms, probably contemporaneous in their origin, were the Ammono-Hittite, or dynasty of the Amen-em-hats, which arose in the Sethroitic name of the Delta, and passed on to Memphis, and finally to Thebes, where it became extinct by the marriage of its heiress to Thothmes II.; the Hamathite dynasty of the Hadads or Usertesens at Abydos, who worshipped their great ancestor Chepher, and disappeared in the time of Rameses III.; and the Kenezite dynasty of the Mentuhoteps, which made a beginning about Philæ, and afterwards moved down the Nile to Tell-el-Amarna. The Setis, who served as commanders-in-chief for the Rameses and were connected with them by marriage, belonged to the latter dynasty, which disappeared with them. Thus there were at least six contemporary dynasties in Egypt during much of the early portion of its history, and there were great feudal families, like that of Mareshah or Mœris, that were little less than regal, whose names found their way into Manetho's Pharaonic lists.

But the task that I set out with was to shew that the League, which we call of the Iroquois, was an old Hittite League, dating back to the end of the nineteenth or the beginning of the eighteenth century B.C., and that at least three of its founders recorded in the Iroquois Book of Rites, have their record on the rocks of the Sinaitic peninsula. These are Odatshehte, Dekanawidah, and Atotarho, in the forms Achudzath, Dekanata, and Hadad-ezer. It remains to show that Job or Hiob, the original Hiawatha, gave name to a people at the same time. Mr. Forster's No. 5 proves this:

No. XVIII. ma ku dzu nabe yo be no kita be ha ma shino
kushi be

In order:

Maku dzu nabe Yobe no Kita bai-ma shone
Maku head lord Yobe of Kita elector son

Kusabe
Kusabe

In English: "Kusabe, chief lord of Maku, son of the elector of the Kita of Yobe."

This inscription is from Wady Sittere. I have been in doubt whether to call the *bai-ma*, or "giver of yea," an elector or a councillor. Kusabe appears again in Mr. Forster's 96 from Wady Mokkateb.

No. XIX. Kisa shi me shi noka ta be ta ba shita to do ku sabe

In order:

Kiza shime Sankata be tadashita todo Kusabe
engraved notice Sangata under righteous commander Kusabe

In English: "Written notice: the righteous commander Kusabe under Sangata." Sagata or Sangata is a name associated in India and Siberia, as well as in Sinai, with the Raba Khita, who held the Yoba Kita in subjection as the Ammonites held their brothers, the Moabites. Who the righteous Kusabe was I do not know, but a more complete reading of the Sinaitic inscriptions may clear up the difficulty. He may be a Hittite of the Yoba family named after Joseph, the prime minister of Aahpeti or Amen-em-hat III., and inheriting his righteousness with his name. Job's three friends were Hittites; Eliphaz the Temanite related to Husham; Bildad the Shuchite or Sakya related to Laadah and Mareshah; and Zophar the Naamathite, a Tsocharite or Tokari of the Beno Kita whom Anub the Ammonite drove out of Panopolis. None of them were League founders. Job or Hiob was Hiawatha of the Kaniengas or Mohawks; Âchudzath or Odatshehte was the Oneida or Eleut representative, and Bildad may have been his son; Dekanata or Dekanawidah is made a Kanienga or an Onondaga in Iroquois tradition, but was probably Techinnah, the father of Ir Nachash (1 Chronicles iv. 12), and must have been a very old man; Atotarho was Ben-Hadad or Hadad-Ezer of the Hamathites or Onondagas. There remain the Cayugas and the Senecas. Of both tribes the inscriptions furnish indications, and those of the Kubeku or Cayugas are numerous, but their Iroquois League founder Akahenyonk defies identification, unless he be Aznoth, the brother of Chesulloth or Chisloth, who were sons of the Kubeku Sheber (1 Chronicles ii. 48) after whom

Tabor in Canaan was named. There is an inscription, Mr. Forster's 13, from Redoua, which mentions Chesulloth, but not his brother Aznoth. It reads:

No. XX. mi mi kishilatu ta ku kushima do tsu ki no

In order:

mi mi Kesulatu daku Kusima to zoku no
great great Chesulloth receive Zuzim band tribes of

In English: The band of the tribes of the Zuzim receive the illustrious Chesulloth."

Now the Kubeku were the Zuzim, and Chesulloth was of them as was Aznoth, but when did they live? Sargon of Agade, the son of Yahdai, born long before Aahpeti of Egypt, marched to the Mediterranean, and overthrew Kastubili of Kazalla. If Kazalla be Chesulloth or Chisloth Tabor, it will bring the man so named and his brother Aznoth, near enough to the time of Achudzath and Dekanata as to make Aznoth the Akahenyonk of the Cayugas.

There remain the Senecas, whose representation in the League was double, including the chiefs Kanyadariyo and Shadekaronyes. The Senecas call themselves Nondewa, and are the Nandas of the Indian historians. Satakarni was a Nanda king in India, just as Shadekaronyes was an Iroquois Nondewa. They were the Mentu-hoteps of Philæ and Tell el Amarna, but who were the two League founders from among them I do not know. Indeed, it seems to me that tradition here is at fault, and that some later personages have been introduced, yet the archaic British name Catigern or Kentigern is just Satakarni, and he is made contemporary with Gwr-theyrn and Gwr-thefyr, or Vortigern and Vortimer, who are Sheber and Tirhanah of the Zuzimite Kubekus. Mr. Forster's 60 from the Four Wadis contains the names of Tirhanah and Sheber (I. Chronicles ii. 48.)

No. XXI. kisashime ti ra no tabera be shi kube ka no
da be
te be shi tsu ku ta

In order:

kiza shime Tirana Tabera be shi Kobe Kan-
carved notice Tirana Tabor under dead chief Kan

dobe
dobe

tebeshi tsukata
scribes governed

In English:

"Written notice: under Tirhanah and Tabor, (Sheber) the deceased chief Kentub superintended the scribes."

Sheber and Tirhanah were real personages, as were Gwr-Theyrn and Gwr-Thefyr, about whom British history is all astray chronologically, Why then may not Catigern, called the son of Gwr-Theyrn, not be as real, and the Shade-karonyes of Iroquois tradition? He was not, however, a Kubeku as they were, but a Nondewa or Nanda of the Mentuhoteps. In these ancient days the ancestors of our Iroquois were truly kings of men. Chief among them was Tekarihoken, whose name stands at the head of the League founders. The tradition about his being a Caniengz is at fault, for he must have been Sargon of Agade, the eldest son of Yahdai, and thus a Zuzimite Kubeku, or Cayuga. His original name Regem (I. Chron. ii. 47) is the Japanese *rikimi* strength, power, authority, but the Chaldean form Sar-ruykin gives Tekarihoken.

ANALYSIS OF INSCRIPTIONS.

No. I. *shi*, Japanese adjective, dead.

kobe, Japanese noun, head.

shi-ba, Japanese, noun, death, and *ba* J. place, used as a verb, like the Basque *ipi-ni* or *imi-ni*: to put death.

shibume, ancient compound of J. *shi*, dead, *bu* for *buchi* to strike, and *mi*, a person; a death striking person or soldier.

tobe, ancient form of J. *tome-ru*, to check, arrest.

no, J. postpos., of.

kumi, J. league, company.

dzuto, ancient comp. of J. *dzu*, head, and the *do* of *to-dori*, captain.

kudzu, for J. *kudashi*, cause to descend.

sata-shi, for J. for *satan-shi*, *saru*, to be an ally.

be, Basque, and universal ancient Hittite, postpos., under: not in modern J.

to, J. band, company.

No. II. *mi*, J. honorific prefix, great, reduplicated.

mukoko, explained in text.

dzuta, ancient form of J. *dzui-ju*, a follower.

No. III. *makedzu*, for J. *makashi*, to conquer.

noki, enemy from J. *nikumi*, Basque *nagatu*, to hate.

yo, original form of J. postpos., *yo-ri*, from.

nesa, in Benonesa, the Hittite genitive plural: see my Hittites, their Inscriptions and their History, Vol. I, pp. 68, seq.

No. IV. *satoshite*, past of J. *satoshi*, to instruct.

kiza, for J. *kiza-mi*, to engrave, engraving or carving.

shime, for J. *shime-shi*, to publish, proclaim.

ezbada or ezbala, in Basque now means "if it is not," its root being *ez*, not. Its origin seems to be "to place a no." There is no analogical word in J.

sinetsi, is also Basque "to esteem;" J. has *shinji*, to confide in.

de, J. postpos., on account of, the Basque *di*, *dik*.

No. V. *bushi*, J. a soldier.

sadzushi, for J. *sadzuke-ru*, to give, hand down.

meshi-dzushi, for J. *meshi*, to summon, and *tsukai*, a messenger or *tsuji*, an interpreter.

tsumeshita, for J. *tsume-ru*, to press, in past tense.

koi, J. and Basque, desire.

obe, for J. *omo*, chief and Basque *jabe*, lord.

bahita, for Basque *bahitu*, to pledge, which seems to be formed of *bai*, yes the J. *hei*, anciently fei.

No. VI. *takki*, for J. *tai-ji*, to subdue, formerly *tafu-gi*.

sa, Hittite genitive postpos. of the dzu or tsu of old J.

alkima, for J. *rikimi*, powerful. J. has no l, but Basque *al* is power, and *alik*, answers to J. *riki*.

No. VII. *on*, J. and B. good.

marane, see the Hittites, etc., Vol. I, p. 121. It is represented by the J. *amari*, to exceed, and by the B. *obore*, to be more than. It will thus mean "to get the better of."

saki, J. front, foremost.

neku, root of J. *niku-mi*, and B. *naga-tu*, to hate, detest.

kudaku, J. *kudaki*, *kudaku*, to shiver, crush, smash.

No. VIII. *daki*, J. to hold, embrace.

seshi, J. *sesshi*, to control, *sessho*, a regent.

kata, J. *kachi*, *katta*, to conquer.

aita, B. father, in J. *otots-san*.

ato, J. trace, indication; in B. *atz*.

No. IX. *ki*, J. part of verb to be or do.

ma, B. *ema*, *eman*, *ematez*, to give. It is the ending *mi*, *mu*, of J. verbs, which originally denoted giving.

mito, is the same as the J. *mi-kado*, and means "the sublime porte," for *to* means a door as well as *kado*.

waka, J. *waka-ri*, to separate.

ko, J. a child.

dzu, J. root of *dzu-sa*, a follower.

No. X. *ome*, J. great. Compare *obe* above.

dzudzu, J. *dzu*, head, with reduplication.

nabe, is root of Basque *nabusi*, *nausi*, master, answering to J. *nushi*, originally *nafushi*.

No. XI. *besshi*, J. special.

tachi, J. to stand, used for the transitive *tate-ru*, to make stand, or set up.

No. XII. *ge*, Basque genitive particle, in J. *ga*.

kei, the J. *hei*, originally *fei*, yes, the B. *bai*. The "lords of the yeas" were the councillors or electors.

rido, J. the way or principle of justice.

kemi, J. *kemmi*, inspector.

beta-beri, from J. *hetsu*, to separate, and *hori*, formerly *bori*, to excavate. As separation of metal from the ore was effected by smelting, *bete* came to mean this.

me, J. eye, B. *begi*.

No. XIII. *kukiyo*, J. *kukkiyo*, excellent, illustrious.

danda, B. payment by instalments, J. *denso*, a tax.

tsuta, root of J. *tsuta-yeru*, to introduce.

No. XIV. *gasshi*, J. to join together, unite.

seji-koto, J. affairs of the world.

beka, root of B. *bekoki*, forehead, front, the J. *muki*.

ki, J. honorific prefix, noble.

kane-beta, now J. *kane-fuki*, metal smelter, but see *beta-beri* above.

shoni, J. son, or rather, a little child, doubtless the original of the Germanic *Sohn*, etc., and of the English *son*.

No. XV. *shi*, J. verb to be.

shi-ba, places death.

todo, root of J. *todo-ri*, a commandant.

seki-no, J. to hasten, with the *n* of futurity common to J. and B.

oshi, J. violent death.

sadate, connects with J. verb *sada-meru*, to settle.

No. XVI. *beki*, variant of *beka*, in No. XIV.

shibashi, the person who places death. Agency in J. is denoted by *shi*.

ke, J. a line.

ema, B. to give.

tobe, in J. *kawari*, in place of. The B. has *lekhuan*, but an old form *to-be*, for *toki-be*, under the place, appears in inscriptions.

No. XVII. *dzudzu-nesa* is J. *dzui-ju*, follower, in the Hittite genitive plural.

ato, J. rear, behind.

gunka, J, *gun*, an army, *gun-po*, military tactics.

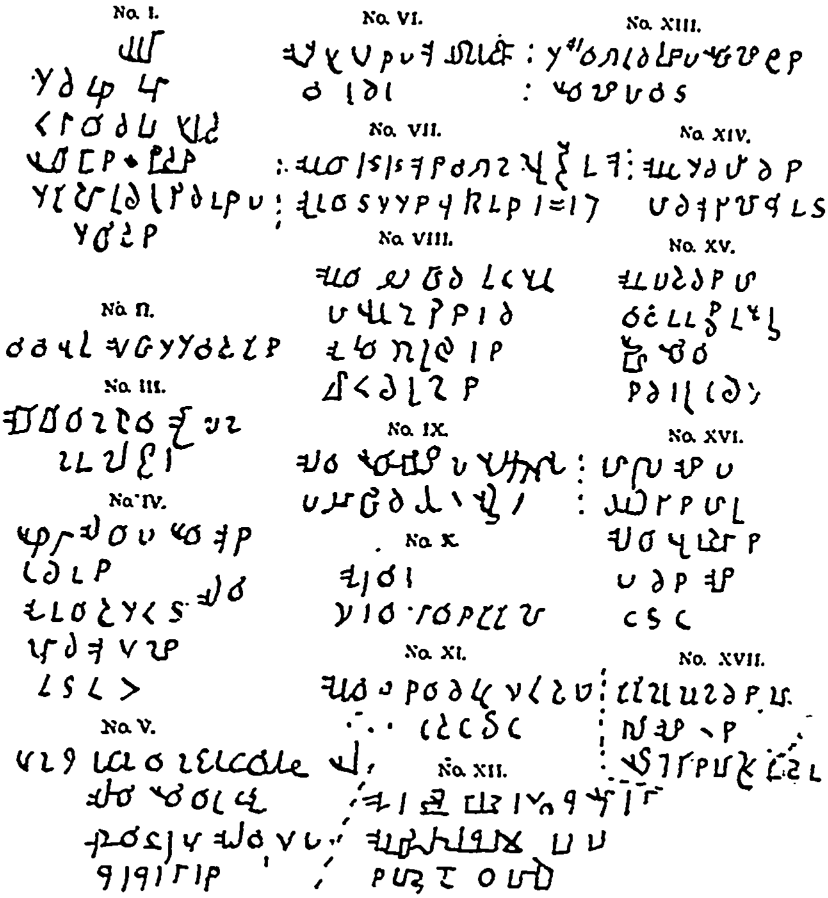
bata-shiba-nesa. In J. the present word for horse is *uma*, but a horse-dealer is *bakuro*, a horse boy *betto*, horse power *bariki*, a horse's hoof *batei*. Hence the old word for horse is *ba* and *bato* may be the horse company.

No. XVIII. *bai-ma* or *bai ema*, B. the giver of yea.

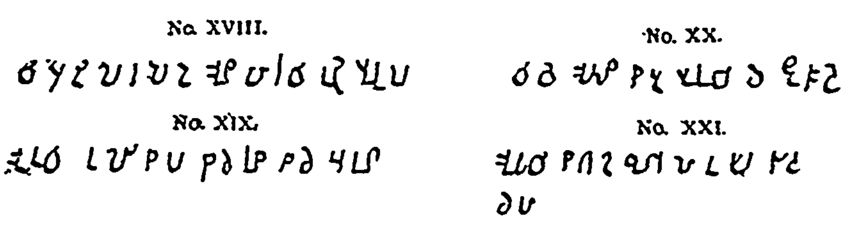
No. XIX. *tadashita*, J. *tadashii*, upright.

No. XX. *zoku*, J. family, clan, tribe.

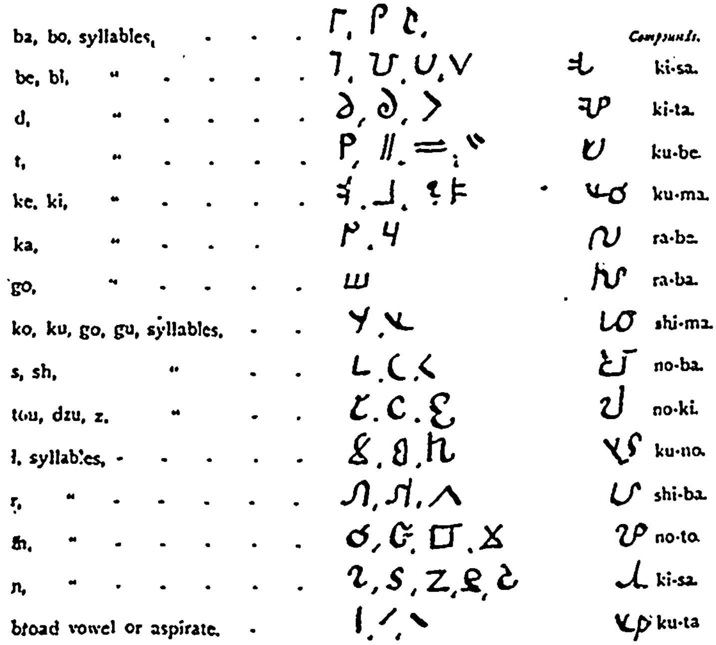
No. XXI. *tebeshi*, J. *te*, hand of writing, *hissha*, formerly *bissha*, writer.
tsukata, J. *tsukasa*, superintendent, director.



Inscriptions—Plate I.



Inscriptions—Plate II.



The Sinaitic Syllabary.

LANGUAGE AND RELIGION.

BY REV. JOHN MACLEAN, PH. D.

(Read May 6th, 1899.)

Language is the handmaid of religion. As the outward expression of religion is dependent upon language, we may by the study of the words and forms of expression obtain some conception of the religious ideas and ceremonies of a tribe or nation. As ancient religion was dependent for its expression on language, we can best understand it by understanding the ancient tongue, and without this knowledge we are compelled to accept the interpretations of scholars who are conversant with the form of speech. Archæology comes to our aid in understanding ancient religious beliefs and practices, but the chief place must be given to language. As there are various dialects of language, so there are dialects of religion of numerous kinds, whereby the learned and ignorant, the clergy and laity, men, women and children express their religious thoughts and feelings. As language changes from the period of childhood to that of manhood, so does religion. So closely are they related that language is influenced by religion, and deeply imbedded in the words spoken are the thoughts and forms of religion practised by the priests and people. Religion lies at the foundation of national unity and when a tribe or nation becomes definite, the language becomes definite, and we are able to see the relationship existing between language and religion. During the childhood of the human race the various tribes of men had no doubt religious rites as an expression of their thoughts about God and his relationship to his creatures, and some form of verbal communication had been used for handing down from father to son the creed which became a tie to bind them together. The study of language has enabled us to trace the objects of worship to their root-forms, thus revealing the meaning and thought that lay at the root of the worship, and the identity of the gods of different nations, though having apparently different names, has been proved by resolving them into the same root-word. Language expresses the inner life of a people, and by its help we may obtain with considerable accuracy a knowledge of their modes of life and thought, and religious beliefs and forms of worship

The seal of truth has been impressed upon language, and men are uttering deeper things than they know, and sometimes asserting great principles against themselves. Language has influenced opinions and beliefs and religion has influenced language. The stream of language has revealed in words, and roots of words, the arts, habits, life and religion of the prehistoric Aryan race.

As some ethnologists assert that there are no atheistic peoples, may we not also say that there are no atheistic languages? In the languages of numerous tribes there exist words for spirit, sin, sacrifice and God, the latter word not having the same meaning in all. Among the Cree Indians the word used for God is Kĭtcemûnĭto = Big Spirit, and among the Blackfeet Omûqkatos = The Great Sun, and Apĭstotokĭ = the Creator. Kinon = our Father as a term for God is the apparent result of missionary teaching. Missionaries are apt to believe that the languages are atheistic, because they do not find a word for God, having the same definite meaning as it conveys to the Christian mind and heart, just as they might say that the tribes have no religion because it is different from the Christian religion. But there are tribes such as are found in Australia which have no word for tree, fish or bird, yet they are not ignorant of these things. Worship is given by some of our Canadian Indians to the sun, and there are gods of greater and lesser degree. The languages reveal the names of these several deities, one of which seems to occupy the chief place, and though the chief deity differs from the supreme being of the Jews and Christians, we may call these peoples and languages theistic in the sense of having a chief deity. As there are no tribes without some kind of religion, so there are no agnostic languages. The religious ideas may be crude and the system very imperfect, yet there is some form of religion of whose meaning we learn by a study of the native tongues.

The polytheistic languages reveal a worship of single spirits as sun, storms and lightning, mountains and rivers; and ancestral spirits, who retain some cognizance of human affairs and exercise power for good or evil over men and things, are also worshipped. Max Müller assures us that the Semitic races had a number of names for Deity, as shown in the Phœnicians and Carthaginians, and in the monotheistic creeds of Jews, Mohammedans and Christians. The worship of the Semitic nations was a worship of God in history, as God affecting the destinies of individuals, races and nations. The names of Semitic deities expressed moral qualities generally, as the Strong, the Exalted, the Lord, the King, and seldom grew into divine personalities, definite in their outward appearance. Many ancient Semitic gods had a tendency to flow together and the transition to the worship of one god was easy. When we study the American Indian languages we find that the different stocks give different religious beliefs. The principal divinity among the Algonkin tribes is known under various names, as *Glooscap* among the Penobscots and Micmacs, *Nanabush* and *Manabosho* among the Delawares and Ojibwas, and *Napio* among the Blackfeet. The idea of a Supreme Being among these tribes is somewhat indefinite, whereby the term theistic as applied to them must be qualified as already mentioned. The definite deity is a mythical personage, good and bad. The grave Huron-Iroquois people have a different principal divinity, known as *Taronhiawagon*, the Holder of the Heavens, or *Raweniyo*, our Great Master, "a deity nobler in character and attributes than any of the Aryan divinities." Horatio Hale has shown by a study of the Siouan languages that the intensely religious Dakotas have a remarkable set of deities, the *Oonktayhe* or gods of vital energy, the *Takooshkanshkan* or moving god, who is "too subtle to be perceived by the senses," who "is everywhere present," who "exerts a controlling influence over instinct, intellect and passion," and the *Hayoka* or anti-natural god, with whom all things work by the rule of contrary, to whom joy seems grief, and misery brings joy, who shivers in summer and swelters in winter, to whom good is evil and evil good. The medicine men who are the physicians and priests of the native tribes of Canada, the healers of diseases and spiritual advisers and intercessors, have a sacred dialect of speech, epithets raised from material meaning to a spiritual significance, words expressing religious ideas, and a style of phraseology peculiar to themselves. In the sacred dialect there is revealed a worship of God in nature, symbolical expressions and names of deities hidden behind the veil of nature. Beside their worship of the Great Sun, there exists an earth-worship, the Earth being called *Our Mother*. As the Chinese say that heaven and earth are the father and mother of all things, and the Greek Demeter (Ceres), which is of distinctly Aryan origin, being none other than Gêmêter, *mother-earth*, so the Blackfeet associating the idea of masculine godhead with the sun, place the fruitful, all-nourishing earth, as a goddess. The Sun is addressed as *Kinon* our father, and the Earth as *Kikstsionon*, our mother.

The faculty of speech is a mysterious thing belonging to man as a supernatural being. We may assume that primitive man began his earthly career with vocal organs and the power of expression. A theory has been propounded that men or rather the precursors of men were at first incapable of speech, and that they acquired this capacity at different places. Professor Hovelacque the distinguished representative of linguistic science in France, after describing the impassable gulf which separates the Semitic and Indo-European languages, adds that the case of these languages is the case of a considerable number of linguistic systems and then says: "The consequence of this fact is important. If, as we have shown, the faculty of articulate speech is the proper and sole characteristic of man, and if the different linguistic systems which we know are irreducible, they must have come into existence separately, in regions entirely distinct. It follows that the precursor of man, the first to acquire the faculty of articulate language, has gained this faculty in different places at the same time, and has thus given birth to many human races originally distinct." The divisions of race into which the speechless descendants of these precursors of primitive man had separated before they acquired the faculty of language are laid down by Dr. Frederick Müller. The theory of a speechless race of human precursors or of human beings like ourselves without the faculty of speech raises difficulties greater than those which it is intended to remove. So far as we have been able to learn, primitive man began life with a voice. His vocal organs may not have been very flexible, but we may assume that they were sufficient to enable him to articulate words expressing his needs. Oral utterance was the form of expression used by primitive man, based upon his physical structure, intellectual endowments and social instincts. If he had been without a voice some other method of expression would have been found as in the case of deaf-mutes, sufficiently illustrated in the persons of Laura Bridgman and Helen Keller. There was a time when man was destitute of language, but possessed the faculty of speech, and were man again to be so situated that he had no language, he would recreate language, society and arts, and develop religion.

Gesture-language was one of the forms of speech of early man, coexistent with spoken language. It is a very expressive method of communication between persons who speak the same language aiding them in emphasizing and making clear their words and phrases, and is a useful form of speech for those who speak different languages. Primitive man would naturally and unconsciously use this as an aid to the simple language which he spoke. Drummond in his *Ascent of Man* suggested that this was the earliest form of speech, preceding spoken language, and sound-speech arose from a necessity of communication at a distance, the sound reaching farther than the sign, and being independent of light. Again it is said that speech is the product of a social state already considerably advanced, and the sounds being at first simply utterances accompanying gestures, finally became the signs of the gestures. Gesture-language is used extensively at the present time by the Canadian Indians and numerous tribes throughout the world. The excellent monograph on this subject by Garrick Mallory has revealed its significance and universal use. Itr present use by our native tribes reveals the fact that gesture-language will reach farther than spoken language. Having occasion to speak to a white man on the Blood Indian Reserve, I found that the distance between us ''as so great that I could not make him hear, though shouting loudly, and to add to the difficulty he was travelling from me at a rapid pace. There was an Indian standing close to me, and another beyond my friend, and coming toward him. My red companion with a few gestures secured the attention of the other Indian, and the two natives carried on a conversation in the sign-language, with the result that when the Indian met the white man and he delivered to him his message, my white friend returned to the place where I stood waiting for him. Sound-speech preceded gesture-speech and the latter remained as an aid to fuller and more emphatic expression. We can never know what the first sound-signs were like, but their choice and currency would depend on the success with which they conveyed the meaning intended. Some of these gestures may have served as effective germs of speech, but would finally give place to the highest form of speech, language in the form of symbols and abstract terms.

The distinctive human faculty is the power of speech and thought. Man is distinguished from the lower animals by the faculty of thinking by symbols. Every kind of animal possesses some sort of language which is expressive of animal sensations, and sense-impressions and reasonings. Possessing different sorts of minds, they are able to express their needs and feelings to their kind by vocal intonations, gestures, touch and perhaps smell. The study of the speech of monkeys has revealed the fact that they have three or four inflections of the same sound, each with a meaning of its own. They are able to speak in syllables, the word for food having five or six syllables. There is however a wide gulf between animal and human intelligence and language. Animals have not the human larynx, and the power of human thought ; man can learn the language of some animals, and imitate others, but animals are unable to learn the speech of men.

There must have been something in man which caused him first to use his mouth to give expression to the thought of his heart. To say that this was natural in the sense that speech was of human origin, is to deal with the beginning of things shrouded in impenetrable mystery in an easy way. If man alone of all animal creation possesses the godlike attitude, and a hand which distinguishes him as a superior being, may we not mark his vocal organs and the faculty of speech as not only characteristic of his superiority, but as the nearest of earthborn to his Maker? He carries about in his garment of flesh, intellectual and spiritual nature, evidences of his divine origin, and the faculty of speech is not the weakest argument that he is a son of God. His vocal organs and intellect will enable him to learn any language. The faculty of speech is the work of God. As he made man capable of seeing and hearing, he gave to him the faculty of speaking. Each living being was created with its special organs of voice and utterance, and these have been perpetuated with other specialities of its peculiar organization.

The social state of man required language as a means of communication, simple in structure for early man, and not a highly perfected language. Several theories have been propounded as to its origin as the imitation of sounds, the utterance of exclamations in moments of emotion resolved into elements of language, and the spontaneous expression of each distinct conception of the mind. Was language fully matured bestowed upon man in a miraculous manner, or was there given to him by God the power of perfecting language from simple elements? The analysis of languages reveals the fact that they pass through stages of development, that a linguistic system cannot be manufactured and that in general they can be resolved into roots in their earliest stages. There is no necessity for accepting language as an attribute of man, a ready-made gift of God, nor ascribing it to human origin. There lie as its foundation, roots, which form the secondary stage, succeeding the stage of naming objects, as they suggested something to the mind peculiar to themselves. These roots as meaningless words seem to have arisen from the first class of words, and became useful for joining words together, or they may have existed in the human mind as phonetic types implanted by God himself. By the joining of meaningless words, and of the meaning and meaningless together in their various stages according to unwritten laws, by the intelligent will of man influenced by his environment, we arrive at language in its true grammatical form, and language becomes a human art. We find in it the results of human intelligence and will, with God creating reason in man and laws of language. The first man began the work of making language by naming each one of the animals among whom he lived. He did not possess a ready-made grammar and dictionary, and even the names were not given to him, but there was bestowed upon him the power of naming, for he was more than a speaking machine, uttering words as a parrot. God treated him as an intelligent being, and endowed him with the faculty of language, and by His power aroused the faculty to act in accordance with the divine laws. The greatness of the task set before Adam in naming the animals may be seen in the fact that he had to give original names whilst the method usually followed by colonists and settlers is to give secondary names, such as they select from their previous knowledge. The work of the first man as the primitive language-former was sufficient to tax his highest powers, and awaken and keep active his sense of association between the external world and articulate sounds. The Jesuit Larramendi makes Basque the common source of all languages, the Abbè d'Iharce de Bidassouet says that Escuara was the language in which the Eternal Father conversed with the first of the Jews, an eminent Celtic scholar suggests that Celtic was the primitive tongue, whilst others have shown the affinities of the Celtic with Hebrew, making the former the older language, and some of the American Indian tribes speak of their language as the perfect language. The first language, however, is unknown to us, and will very likely remain a mystery.

The origin of all languages from a complete and perfect primeval language having a fully developed grammar and dictionary as the gift of God, accords with the idea that language is too great an achievement for the human mind, but there is no necessity for assuming the existence of such a primitive tongue, man being endowed with the faculty of speech and a creative faculty of language-making from germs or roots, so that in accordance with the laws of language, he could develop a flexible form of speech, or by neglecting the laws, beget decay, or arrest a language in one of its stages. The origin of stocks of languages although a much disputed question seems to arise from the tribe or people which first spoke the mother-tongue of each stock, having a common origin, and this tribe must have been isolated for a long time from other tribes sufficient to form a distinct grammar and vocabulary, and a peculiar mental and moral character. A language may become the mother of other languages, and these descendants preserve something in common by which philologists are able to trace them to the mother-tongue.

Languages are born, grow, decay and die like individuals, institutions, nations, races and religions. Just as the Hebrew has passed through three distinct phases, other tongues have developed and finally reached a period of decay, and some have become altogether extinct. Modern German has extinguished Polabish and old Prussian. Latin has absorbed Oscan and Umbrian, the Galatians, Normans and Lombards lost their tongue, Cornish is no longer spoken, the Hochelagan and other native tongues of Canada have become extinct, and many of the American Indian forms of speech are doomed by the increasing power of English and the advance of a superior race. The beginnings of a tongue may arise from individuals in infancy possessed of a creative faculty, who are separated in age and intelligence from others, and compelled by association to hold communication with each other; words are formed only intelligible to themselves, which by modifications serve all the purposes of their life. Children have possessed this language-forming faculty and have made a language of their own, sufficient for their needs, which required only time, continued association, and such conditions as would preserve their speech from the dominant influence of a superior tongue, to give it a place in the world as a new language. The study of child-language reveals a faculty of sound-speech, vowel-sounds, expressions made up of consonants, meaningless in themselves, syllables which as nouns stand for several things, and by a change of accent become verbs, and finally an arrangement of the vocabulary into sentences. The growth of a tongue seems to depend upon individuals who unconsciously, yet by an act of the will, introduce syllables and various changes by their creative faculty, then by imitation and finally through habit. The origin and growth of languages by individuals seem to indicate a primitive stage of purity, strength and richness, which is not found in later stages, when the descendants of the first speakers are only imitators.

There are eleven stocks of languages and great divisions of the American race in Canada and Newfoundland as follows: Eskimo, Beothuk, Algonkin, Iroquois, Sioux, Athapascan, Kootenay, Salish, Kwakiutl-Nootka, Tsimshian, and Haida. In British Columbia alone there are six linguistic stocks having twenty-nine dialects. The mental diversities of the native races, influenced by their environment, have contributed to the origin and growth of these languages. Political, social, literary and religious influences arrest languages in their growth, as seen in the formation of the three great families of speech, Turanian, Aryan, and Semitic, and in the Chinese, which is an example of a written language, arrested in an early period of its development, before the alphabet was reached. There are progressive and retrogressive movements evidencing growth and decay. There are evidences of corruption by loss of words, and replenishing from cognate dialects. Phonetic convenience works many changes. The Normans found the French tongue a barbarous jargon, but they gave it dignity and permanence by fixing it in writing, and employing it in legislation, poetry, and romance. Sanskrit, Russian, Greek, Latin, Welsh, and English are acknowledged to be descendants of a single Aryan form of speech, spoken at some time by a single tribe or nation, yet the languages sprung from the original Aryan tongue are mutually unintelligible. There are certain differences in words arising from changes to which the sounds of a language are liable, and from different names given to the same thing. The Blackfeet, Bloods, and Piegans speaking the same language, when separated gave different names to the same things introduced by the white settlers. The Cree dialects reveal phonetic changes by the introduction of letters expressive of sounds which run through the whole language. The Eastern Dénés have lost quite a number of inflections still existing in the verbs of Carrier, a dialect of the Déné. The Déné languages belonging to the Athapascan stock have changed considerably. A. G. Morice says: "Time, or some other cause, has greatly reduced in the Chippewayan, Hare and Loucheux idioms, the number of the modificative forms of the objective, locomotive, and instrumentative verbs. The ordinal adjectives, which still exist in Carrier, have equally disappeared with the tribes' migrations eastward. It is also worthy of remark that the Chilxohtin—a Western dialect—which has many terminological affinities with the Hare (Eastern) dialect, has similarly lost those terms." The organs of speech change so that there arises an inability to utter certain sounds, as we find the Blackfoot tongue has no sound of the letters b, d, l, r.

The physical characteristics of races change, while language is influenced very slightly by climate, food and labour. The flora and fauna of the territory inhabited, and the tribal customs introduce new words, yet affect little the internal structure. Political influences arrest language, so that wherever we find a mixed language, as the Blackfoot, there has invariably been a mixture of blood. Language is not merely the conventional instrument of thought, but it is to a great extent its creator, and the mould in which it is cast. The mould may be broken and races adopt the language of a conquering race, but there is no instance in which there is a complete transformation, so as to pass into a different type. Kinship in speech develops national unity, and exercises a strong influence on politics, as seen in the change of attitude of the British towards the people of Hindostan upon the discovery of Sanskrit. Civilization again begets an influence diffusing some forms of speech, and destroying others. Mythology likewise changes the modes of expression, as already shown. Christianity lays hold of floating terms and by reducing the tongue to writing, and creating a literature makes them permanent, and introduces changes in the social customs and characters of the tribe or people.

The languages of the world are divided into three great classes: The monosyllabic, of which the Chinese is the best representative; the agglutinative, represented by the peoples of Central Asia, the natives of Siberia, the Finns, the original inhabitants of Hindostan, and the American Indian race—all of these tribes and peoples living in the nomadic stage; and the flexible, belonging to the historic nations, which stand in the forefront of civilization. The structure and capabilities of a language depend entirely on the natural capacity of the people with whom it originated, and not upon the degree of culture. Barbarous tongues do not belong to savage races, as can be shewn by the structure of those spoken by the American Indian tribes. Constant warfare among native tribes, scarcity of food, internal troubles, and a nomadic life, have separated portions of tribes, and in a generation or two there are formed dialects. The adoption of prisoners of war has wrought changes, and made a mixed language, as in the case of the Blackfoot. On the American continent the great multiplication of languages and dialects arises from the breaking up and scattering of tribes. The configuration of a country begets dialects, as seen in Italy, and the English and Scotch shires. The dialects of the Cree language show the internal changes arising from separation. The letter *l* is incorporated in the dialect spoken at Moose Factory, while in other dialects the letters *n*, *y*, *th* or *r* are substituted for it. As an illustration of the influence of this dialectic change take the personal pronoun; Nela, kela, wela=I, thou, he, she, is the form in use at Moose Factory; nena, kena, wena, at Albany, Severn, and York Factory; neya, keya, weya, on the East Maine coast; netha, ketha, wetha, at English River; and nera, kera, wera, at Isle la Crosse. Although the Blackfeet, Bloods and Piegans have been separated for a brief period on reservations, changes are taking place towards the formation of dialects. There is a continuity in language which nothing can destroy, and in the lowest languages there is seen order and wisdom. The main distinction between languages is to be found in the inner mechanism or grammar.

Grammar is interesting in showing the modes by which the human mind proceeded at remote periods, and by different races, in working out the great problem of articulate speech. Modifications are introduced for the purpose of conveying more clearly and briefly the ideas, and these changes in structure are found in gender, plural, declensions, moods, and tenses of the verb and syntax. There does not exist a tribe without some kind of grammar, laws of structure, sometimes crude, yet sufficient to reveal regularity, beauty and strength. The most savage tribes without any literature possess languages of consistent grammatical structure sufficient for all the uses of effective native oratory. No matter how low in the scale of humanity a tribe has been found, it still possesses a complete and thoroughly organized language. Languages are not the result of mere chance, but are regulated by laws. Some of our native Canadian tribes possess in their dialects vehicles for thought more expressive and richer than some of the tongues of civilized peoples. The Déné language has no single term for "to be broken," but in lieu of the single Aryan term, this American tongue has no less than one hundred particularising substitutes, not one of which could be indifferently used for the other. These are expressive of the object employed to operate the breakage, the manner in which the object was affected, and the form of the object. These more than one hundred distinct verbs can be multiplied four or five times, according as the iterative, imitative, terminative, and other forms are used, whereby the signification is changed. The Sahaptin language spoken by the Nez Percé Indians, according to Hale, surpasses the Aryan and Semitic tongues in some of its forms. Its case-distinctions are much more profoundly reasoned and accurately classified than the Aryan, the verb surpasses both the Aryan and Semitic in the variety of its forms, and the precision and nicety of its distinctions, its tenses are as completely inflectional as Sanskrit, Greek, or German, and it possesses great power of agglutination. The Cree language is a beautiful and symmetrical tongue, possessing many forms of expression not found in those spoken by civilized nations. The paradigms of the verb cover more than two hundred and forty closely printed folio pages. The Blackfoot tongue is a guttural form of speech, symmetrical and euphonious, very expressive and abundant in grammatical forms. What has been said concerning these languages can be repeated for almost any dialect spoken by an American Indian tribe. Of the Mohawk tongue Max Müller says: "To my mind, the structure of such a language as the Mohawk is quite sufficient evidence that those who worked out such a work of art were powerful reasoners and accurate classifiers," and of the Algonkin speech, Professor Whitney remarks: "There are infinite possibilities and expressiveness in such a structure; and it would only need that some native American Greek race should arise to fill it full of thought and fancy, and to put it to the uses of a noble literature, and it would be rightly admired as rich and flexible, perhaps beyond anything else that the world knew." Indeed there is no shade of idea in respect to time, *place, and manner of action which the verbs of these languages cannot* express.

The existence of the laws of language by which order, beauty, strength and expressiveness are seen in the internal structure of every form of speech, the unknown operation of some of these laws, and the mysteries of speech and language which lie hidden from the human mind, manifest supreme intelligence. The discoveries made in this realm of knowledge corroborate the previous evidences of Divine wisdom. The languages of the world are another revelation of Him who made all things for Himself, and in them we find another argument for the existence of a wise, beneficent and loving God.

FAMOUS ALGONQUINS; ALGIC LEGENDS.

By James Cleland Hamilton, M.A., L.L.B.

(Read November 26th, 1898.)

Tribes composing the Algonkian nation. Their origin, places of habitation, language and customs. Mississauga chiefs. Chiefs Shinguakongse, Shingwauk and Pegwis. I-and-wah-wah, Kow-Croche, the peace-maker, Crowfoot, friend of the white man and of civilization. Poundmaker, Mikasto, Pontiac, The Blackbirds—The Mandan, A. J. Blackbird, Algic moral precepts, Makadebenessi, J. B. Assikinack, Upper Canada College Boys, Francis Assikinack, Kee-Jak, Gitchi Naigou and his pious daughter, "principal women" in treaties, Chiefs Sweet-Grass and Mistowasis, Mamongazida, Waub-Ojeeg, John M. Johnston and his family. Waub-Ojegg's battle song. Algic legends and Hiawatha myths. Moore's poem. Iroquoisan and Algonkian poetry compared.

"Peace hath her victories,
No less renown'd than war."

The Algonkian race forms a very considerable portion of the aborigines of Canada, who number in all about one hundred thousand souls.

Jacques Cartier and Champlain knew our nomad natives under two great divisions, the Iroquois or Six Nations, with their cognates, the Hurons, Neutrals and Tobacco tribes, and the Algonquins.

Algonkin, Algonquin, Altenkin, and Algic or Algique are other forms of the same word, as given by the early French.

Of the Algonquins proper, and bearing that name, there are about three thousand persons whose reserves are at Golden Lake and in North Renfrew in the Province of Ontario, and at Desert, Temiscamingue, the Districts of St. Maurice and Pontiac and elsewhere in Quebec. The Algonquins called themselves O-dush-quah-gummé, meaning people at the end of the water. But under the generic term Algonquin are included tribes found north of the great lakes from Labrador to the Rocky mountains and the river Athabasca, known as Chippewas, Ojibways or Saulteaux, Mississaugas, Odah-wahs or Ottawas, Adirondacs, Montagnais of Labrador, Montagnais du Saguenay, Abenaquis, Maskegons, Micmacs, Têtes de Brules of St. Maurice, Menomenées, Delawares, Potawahtamees, Crees, Bloods, Piegans and Blackfeet. The

Penobscots, Mohicans and some other extinct tribes in Eastern Canada and New England were also of the Algic stock.

"Their collective name," writes Professor Campbell, "was Wapanachki, or men of the East, a term which still designates the Abenaki tribe of Maine." "The principal tribe of this large family, from the earliest period to which traditions refer, was that of the Lenni Lenape or Delawares." "The Mississauguas, who held the site of Toronto and the coast of Ontario down to its outlet in the St. Lawrence, were likewise Linneeh." "The word Lenni signifies men."

Among all the Algonquins there ran a tradition that their ancestors migrated from the North-West. Mr. Lewis H. Morgan estimates that not less than a thousand years elapsed from the time when their forefathers passed from a common centre and their introduction to Europeans. The tribes so gradually moving surrounded the Iroquois territory, or as Mr. Parkman describes the situation,—"Like a great island in the midst of the Algonquins lay the country of tribes speaking the generic tongue of the Iroquois." The connection between the great Algonkian families is one of language, the different dialects spoken by them have been proven by analogy to have had one origin.(*a*)

The Algonkian tongue has a soft and pleasing sound, and has been compared to the Greek in its sweetness and mode of construction. Ideas are expressed in groups and word pictures are formed. The letters F, C, R, V and X are not in the alphabet proper of the Ottawas, Ojibways or Crees, but there is local dialectic variation. The Athabascan Crees turn the Lenapi L into R—the Wood Crees into *th*, the Hudson Bay Crees into *y*, the Plain Crees into *n*.

We find the national name in various forms on Canadian maps. Algoma is the land of the Algics, the great provincial reserve of more than one million acres in extent is properly called the Algonquin Park. The capital of Canada is named from one of these tribes. Winnipeg is a Cree word. Toronto is claimed by Dr. Oronhyatekha to be a word of his nation, the Mohawk, but Dr. Scadding and others derive it from the Mississauga idiom. Machquoteh, now honoured as the site of Upper Canada College, is certainly an Algic term, meaning a meadow.

Before the taking of Quebec in 1759, the red men sometimes held the balance of power. The Ottawas, Ojibways and Potawahtamees were

(*a*) "Ancient America," by John D. Baldwin, pp. 60, 65 and 135—"It may be suggested that the Salishans of British Columbia and Washington have been on the continent since the 13th century. The Algonquins must have preceded them some 600 years." Dr. John Campbell, "Can. Inst. Proceedings," 1884, Vol. 1. 15 and N. S. of 1897. 1. 39.

united in a loose confederacy under Pontiac. After his death and the capitulation of Montreal, the weight of the Algonkian power was with the British.(*b*)

The early voyageurs, traders and employees of the Companies fraternized with their red neighbours, learned their tongue and often became joined to them in ties of blood. The education so resulting was rather of the European into the native lore, than of the red man into the white man's learning, religion or customs. Sir Alexander Mackenzie remarked one hundred years ago that it requires less time for a civilized people to deviate into the customs of savage life than for savages to rise into a state of civilization.

From the red aborigine to the citizen with our artificial and complex civilization, there is an evolution that cannot be worked out in one generation. The scales of barbarism are sloughed off but the result is not an unmixed good. The appearance of white men, advancing in force with their lust for land, disturbs the conditions, the hunting ground becomes limited in space and in quantity of game. The tribes soon find it necessary to live at peace, not only with the whites, but with other tribes with whom they had for ages waged bloody feuds. Cultivation of the soil, to a small extent, had been practised by the squaws, now the men are urged to lay aside their weapons and to use the axe, the hoe and the plough, and eventually reaping and threshing machines. Such evidences result from a severe discipline, involving hunger, decimating disease and a contest with the inevitable. The famous bargain of 1870 added three millions of square miles to the area of the Dominion, now succeeding to the mild sway of the Hudson Bay Company with further Imperial authority. At this time the buffalo was disappearing and the old order was also passing away. Since the flag of Canada began to wave over the west, the farm instructor, school teacher, missionary and mounted police have been transforming the aborigines. Chiefs appear appareled in the red, councilmen in the blue, coats of their offices, as democratic leaders of their bands in the ways of peace. The Sun Dance, with its cruel rites, promises soon to be a forsaken custom even among the Blackfeet. The herding of cattle, raising of sheep, and breeding of swine promote domestic virtues. The scalping knife lies rusting in its sheath and the tomahawk is buried. Soon the blanketed Indian will be seen only in the most remote places and in photographs, and war-whoops will be heard only through the phonograph or in

(*b*)—"The Odahwah Language"—F. Assikinack, Can. Inst. Journal III. 481.
"Parkman's Conspiracy of Pontiac." 1. 125.
"Prehistoric Man," by Sir D. Wilson, 3rd Edition 2. 369.

Colonel Cody's Wild West Show. We will see that the red man and the pale-face are not far apart in human passions, pleasures and instincts. As the Jewish Samuel and Joseph had visions by night, so the young Indian sought through dreams to know the will of the Great Spirit. The sun was by some worshipped, the moon, the Pleiades, and other stars of our Western hemisphere were personified, and every Laurentian hill, lake and island had its Algic lore that lived in the imagination and memory as do the tales of fairies, pixies and warlocks in Wales and Ireland. We are accustomed to hear of Masonic and other mystic orders, but the Algic Wahbahnoowin was a pagan society of ancient origin and wide ramifications, whose priests turned to the east, the rising sun, for inspiration, and claimed supernatural powers. The society called Medaöwin had secret signs, rites and passwords.

Much has been written of the Iroquois and more southern Indians. Some noted Algonquins now claim our attention, loyal Canadians and brave men, of whom it may be said, "there were giants in those days."

MISSISSAUGA CHIEFS.—It is but right that the leading men of the Mississaugas, a branch of the Ojibways who, one hundred years ago, occupied the land on which we dwell, should be referred to. The present site of Toronto was included in an agreement made between Sir John Johnson and the Mississaugas, on September 23rd, 1787, confirmed by another, negotiated by Colonel William Claus, on behalf of the Crown, August 1st, 1805. The tract so peacefully handed over contained more than two hundred and fifty thousand acres. In the time of Champlain and the Jesuit-Huron missions, this was in the central territory of the Neutrals, or Attiwondaronk, allies of their northern neighbours, the Hurons. The Jesuit relation of 1641 estimated the Neutral population at 12,000, with forty villages scattered southward as far as Niagara, and westward to Detroit. The remains of their ancient stronghold, the Southwold Earthwork, with its moat and ditches, are yet to be seen between St. Thomas and Lake Erie. Iroquois torches had, a century and a half before Sir John Johnson's treaty, destroyed their villages, and their lands were now mostly occupied by Mohawks and Mississaugas. History does not tell us who were the predecessors of the Hurons and the Neutrals, but the archæologist and geologist come to our aid. They are not confined to records of the stylus and pen or the modern printer's art, but read the story of archaic ages in the rings of ancient trees and in the strata of the earth. They tell us that in the fair valleys of the Don and Humber were, not only contemporaries of the dwellers in Atlantis and of the Mound-builders, whose reindeer browsed on these hills, but, ages before them, were men who hunted the long-haired elephant on the banks of an ancient and larger Lake Ontario.

Returning to the period when Anglo-Saxon sway here began, we find that in the treaties of 1787 and 1805 the native owners were represented by Chechalk, Quenepenon, Wabukanyne, Acheton, Wabenose, Osenego, Kebebonecence, Okemapenesse, all chiefs or leading councillors, who appended their totems in much the same manner as the English barons attached their seals to King John's charter. Some of these names also appear in treaties made by Governor Simcoe. It seems a strange omission that none of the names of these old sovereigns of the soil are perpetuated in any part of the princely territory they once occupied.

Governor Simcoe came from his little capital at Newark, now Niagara, and spent part of the winter of 1793-94 in a tent near the Old Fort. He often met representatives of the Mississaugas but the treaties that he made at Niagara mostly concerned the Iroquois. The Governor at this time determined to make Toronto the capital. He went up the Don valley by a winding path under the shade of great oaks, elms and beeches and there, in sight of the favourite camping grounds of the Mississaugas, erected a summer residence the site of which is still defined. It was named Castle Frank in honour of his son. This house was long ago consumed by fire. Young Frank was a brave lad, who entered the army and fell in his country's cause at Badajoz in Spain. *(c)*

I regret being unable to single out any of the Mississaugas mentioned for deeds of prowess and other distinction, but there were many of the Algic stock of that time and since who won renown, some whose fame was confined to their locality and tribe, and some who were known throughout the nation.

SHINGUAKONGSE whose name signifies the "Little Pine," was the son of a Chippewa woman and British officer. When the father was removed from a western to a Lower Canada command, the mother stayed with her Ojibway relatives and kept the boy, educating him in Indian fashion. He early distinguished himself in the pursuit of Stoic virtues, and in his tenth year fasted twice, ten days in succession. He fasted to have fine dreams, that is, to have his head clear and his body enured to bear great exertion. He wished to know all that could be learned on earth and in heaven. His mother became wife of an Indian and her first-born sometimes suffered from neglect. Once as the boy lay on his

(c) The Duke de Liancourt, when visiting the Governor in 1795, wrote: "There have not been more than twelve houses hitherto built at York: they stand on the bay near the river Don. In a circumference of one hundred and fifty miles, the Indians are the only neighbours of York. They belong to the Mississaugas."

hard bed half naked and trembling with cold and hunger, he wept for a time, until, falling into a state between dreaming and waking, he fancied that a gentle voice said sympathisingly; "Thou poor Shinguakongse, thou art wretched, come to me!" He looked around him but could see nothing but a path hovering in the air which gleamed in the darkness and which, commencing at his bed, ran upwards through the door-way of his cabin. He knew it was a way on which he must walk. He went upon it and rose higher and higher into heaven. There he found a house from which a man came to meet him wrapped from head to foot in white garments like a priest. "I called thee, O Shinguakongse, to me, to shew thee something glorious. Look thither towards the rising sun." When Shinguakongse looked he perceived the entire field full of tepees and troops, among them the great tents of chiefs and a multitude of braves, warriors and leaders sitting together at the war council. . . "See," said the white robe, "hereafter thou wilt be as grand as those thou seest there in the field, and wilt become thyself a mighty hero." . . . The glorious reminiscence of this dream remained to the boy and he became one of the greatest chiefs of his race, the Ojibways on Lake Michigan (Mitchigaming) and on Lake Superior (Kitchi-Gami). After this dream he changed his name from "The Little Pine" to Sagadjiveosse, meaning "when the sun rises," and adored the sun from that time until in his later years he learned to revere the true Creator of the sun.

Shinguakongse was always faithful to his people. In January, 1837, he addressed the Governor, Sir Francis Head, in a long letter urging the government to build houses for his people as had been promised. At a great Indian gathering on Manitoulin Island in August following, Shinguakorgse represented his band of St. Mary's River and objected to a removal of the principal council fire to Manitoulin Island. When a grown lad his mother took him to see his father, then serving at Fort Detroit. The officer gazed with pleasure on the young savage. He was proud of his manly beauty, and wished to educate him as a white man and to procure him a commission in the British service. But no! Shinguakongse loved his mother, his tribe and the beautiful Northland too well, he would not forsake them. His father dismissed him with presents, and retained a paternal interest in him until his death.

In all wars Shinguakongse was on the British side. He was at Fort Malden and in the battle of Moraviantown. Had he been a white man, knighthood would have followed his achievements. He was made chief of his tribe and received many medals, which he never wore but distributed among the young warriors. He represented the Garden River

Indians, and was the first to sign the important treaty made by Mr. W. B. Robinson, at Sault Ste. Marie in September, 1850. He was offered medals and other honours by the Americans, which he declined. He had, with a large party of Canadian Indians, joined the force gathered for the attack on the Michigan stronghold at Macinac on July 17th, 1812. When the mode of attack was considered, Captain Roberts called on the Ojibway chief for his advice. He asked for time to consider, but the next morning he said, "I have dreamed, Captain." "I have dreamed too," the commander replied, "let us compare our dreams." Then Shinguakongse gave his dream or advice, which was shortly, that early the next morning while the fort was in fog and darkness, the Indians should paddle out in their canoes round the island, climb the heights and attack in the rear, while the British leader, with his troops with great noise of drum and guns attacked the Americans in the front. Captain Roberts answered: "Thou didst dream well, Shinguakongse, and I have dreamed also like thee; let us set to work quickly." The advice was taken, the dream was fulfilled. The post was the Gibraltar of what was then North-western Canada. It controlled the fur trade and the Upper Lakes. An attempt was made to retake Macinac two years later, but it remained a British post until given up when peace was declared in 1814.

When the war was over, he followed the British and came to Garden River, where a lob-tree of pine was erected before his lodge, on which flew the red Union Jack. He was long a leader of his people, and headed several expeditions into the Sioux country from Lake Superior to the Mississippi. He was then a pagan, and full of superstition. His medicine bags contained recipes for magic incantations, which he valued most highly. For these he had, at various times, paid in beaver and other skins, what was calculated by Mr. Kohl as amounting to $30,000. But, under the ministrations of Dr. McMurray, he became a Christian, and settled at the Indian village of Riviere au Desert, highly esteemed by his people and the English. As he lay in his illness, the red folk prepared and put up a second flag-staff before his house, with a new flag upon it; but he died, leaving a worthy family, one of whom, Augustin Shingwauk, gave his name to the Shingwauk Home. It was found that the old chief had, shortly before his death, destroyed all his papers and birch-barks, painted dreams, songs and dances. *(d.)*

Mr. J. G. Kohl, the German traveller and author, visited the north shore of Lake Superior in 1858, soon after the decease of Shinguakongse,

(d) "Kitchi-Gami," by J. G. Kohl, cap. 23. "The Canadian Indian," pp. 153, 343. "The Georgian Bay," p. 151.

and found him celebrated throughout that region for his prowess as a leader in Indian warfare, as an ally of the British, and as a wise councillor and chief.

The name of this chief, in the corrupted form Chinguacousy, is held by a township in the county of Peel.

Augustin Shingwauk lived at Garden River, near Sault Ste. Marie, Algoma, until his death on December 23rd, 1891. He was a true ideal of a race whose characteristics are rapidly receding from Canadian life. In height he was upwards of six feet, of fine physique and commanding presence. "His forensic eloquence often moved his white brothers to admiration of the wonderful natural gifts of the forest born chieftain." (*e*)

His picture, by Paul Kane, may be seen at the Canadian Institute. Mr. Kohl refers to him in 1858 as "a powerful and handsome man in the prime of life."

THE CREE CHIEF PEGWIS.—The three great tribes found in Manitoba and the Northwest Territories, are the Nehethowuck, known as Crees or Killistines, the Chippewas and the Blackfoot nation with their allies and kin the Bloods, Piegans and Sarcees. There are also many bands of Sioux or Dakotas, but they properly belong to more Southern regions. The Crees with the Chippewas were ancestral enemies of the Blackfeet, while the Sioux cherished a murderous feud against the Chippewas and their allied friends the Saulteaux. (*f*) The few whites were content, in early days, to let these savages hunt and destroy each other.

As late as 1866, the deadly hatred showed itself in Fort Garry. A band of Sioux from Minnesota was attacked by Saulteaux from Red Lake, and five of them were shot; the others fled. Prior to 1863, the home of the Sioux was in Minnesota and Dakota, at the head waters of the Mississippi and Red River of the North. They were systematically treated unjustly by the United States officials, until they left their reserve for the war path and inflicted terrible atrocities on the settlers of Minnesota. The military power of the United States did not succeed in subduing the savages until a territory as large as Nova Scotia had

(*e*) "The Canadian Indian," 1891, p. 153.

(*f*) The Crees called the Blackfeet *Ayatsuyniwak*, meaning foreign enemies. The Chippewayans called them *emnaslini*, wicked Crees, or wicked foreigners. The Crees, called Kinistenovah by the Blackfeet, style themselves modestly Neyowark, or Nehethowuck, signifying men. The Sioux were called *Pwan* by the Salteaux meaning *roast meat*, from the horrible custom of cooking the victims so indicated. From *Pwan* was derived *Pwatah*, and Assinipwatak, Sioux of the rocks, or Mountain Sioux, which was by the French made into Assinipoels, and then became Assiniboine. ("N.W. America," by Mgr. Taché, p. 123.)

LAND WAH-WAH.

(From a Toronto Photograph taken about 1860).

been depopulated. This Indian war cost the United States ten millions of dollars, and necessitated the maintenance of military posts, with garrisons of three thousand men, for some years. Some of these Sioux entered Canadian territory, and their reserves may be seen at Birtle, Regina, Moose Jaw, and Oak Lake, where they are taking kindly to civilization.

With such wolves on our borders, was it not strange that the little white flock of Manitoba did not suffer? In this we see the influence of the Hudson Bay Company, who always treated the Indian fairly and secured his friendship. Much credit is also due to the Manitoba loyal Indians and to Pegwis, chief of the Red River Crees.

Under the treaty made at the northwest angle of the Lake of the Woods in October, 1873, the Saulteaux became bound to live at peace with all men. The aged chief Kow-Croche was sent as mediator by the red men who entered into this important compact, to formulate terms of friendship with the Sioux in the Red River valley. The result was satisfactory and the ancient feud was buried. Next year the Dominion allotted lands for the first Sioux settlement on a reserve. (*g*)

In August, 1893, at St. Peter's Reserve, midway between the city of Winnipeg and the lake of that name, I met I-and-wah-wah or Thunderbolt, whose English name is John Prince. He is a man of fine proportions, with features very much resembling the late Sir John Macdonald. He was well aware of this resemblance, saying, "I was very sorry to hear of Sir John Macdonald's death. When we met at Ottawa, we looked, the one at the other, smiled and thought this is the man that looks like me." He was affable and polite, as he sat in the Superintendent's house, in the official blue coat of a councillor. At our request he told two Indian legends, simple tales, which had been recited at camp fires for many a score of years. (*h*). I-and-wah-wah occasionally took a whiff of his pipe, or chewed a piece of medicinal bark, apparently to help memory and imagination. He seemed to enjoy the telling, gesticulating and laughing as he proceeded. Then he became thoughtful when I asked him to tell of his grandfather Pegwis and of his relations with the Sioux. I informed him that Sir John Schultz, then Lieutenant-Governor of Manitoba, had told me of the sterling loyalty of Pegwis. He smoked a while, his wife who also had her pipe and took an occasional whiff, jogged his memory, and he said, (the good wife of

(*g*) "Morris' Treaties of Canada," 280.

(*h*) "Two Algonquin Legends," Journal of Am. Folk Lore, Vol. VI., 201.

the Indian superintendent interpreting), "I never went on the war path, but I often heard from our people of the contests between the Blackfeet and our nation, and of the Sioux massacres in Minnesota. Some of the Sioux came in early times, even before the Scotch people arrived, to smoke with Pegwis. Wah-ni-tii was their old chief. He had British medals, but grandfather suspected him even when smoking the pipe of peace. The Sioux wanted the Crees to join them against the British. Wah-ni-tii left our reserve and soon after killed all the Saulteaux he could catch on the plains.

"The next generation of Sioux were worse, sly as foxes and cruel as wolves. After the Minnesota massacres, ten of them came to see Pegwis, the bad chief Little Crow being with them. Grandfather was annoyed and angry with them. He died soon after of heart disease. Little Crow was shot and killed at St. Joe by Mr. Lampson. Grandfather always advised the Crees to be friendly with the whites." The name of Pegwis, or Pegowis, with his mark or totem attached, appears as representing the Red River Crees, on the treaty of July 18, 1817, between the Earl of Selkirk and the Chippewas and the Crees, whereby lands to the breadth of two miles on either side of the Red and Assiniboine rivers were ceded to King George III. The consideration to the Indians for their extensive territory was one hundred pounds of tobacco to be given to the chiefs of the Chippewas and a like amount to the Cree chiefs annually. The lands are now among the most valuable in Manitoba.

THE BLACKFOOT CHIEF CROWFOOT.—The Blackfeet were found west of the Crees of the Western plains, and south of the Saskatchewan. An English gentleman, who had sojourned among them some years ago, expressed great admiration for this people to Archbishop Taché, saying, "The Blackfeet are to other Indians what the English are to other people." "I bowed to express the high sense I had of his opinion, and leave to others to criticise as suits their fancy," writes the polite French churchman.(*i*)

The Blackfeet are now progressive and fast taking on civilization. They were slow to come under treaty, and it was very much through the influence of Crowfoot head chief of the South Blackfeet, that Governor Laird succeeded in concluding the important treaty of September 22nd, 1878, with Blackfeet, Bloods, Piegans, Sarcees and Stonies at the Blackfoot crossing of the Great Bow River.

(*i*) "Sketch of N.W. America," by Mgr. Taché, translated by General Cameron, p. 127. Here and in the Government Reports, *Blackfeet* is used in the plural. Adding *s* to the singular has been urged as preferable, and future historians may perhaps so persuade us. Meanwhile the prevailing nomenclature is followed.

CROWFOOT.

(From a photograph loaned by Senator Lougheed, of Calgary).

Crowfoot's speech at this meeting is a fine specimen of natural eloquence, and induced Old Sun and many other chiefs and leading men to follow with their allegiance.

How wonderful the change wrought among these wild but noble specimens of the race in the years that have passed since *1877*! Tribal customs, wisely tempered by Anglo-Saxon law honestly administered, form an admirable system of government which all respect. Christian Canada is proud of her Red Children, and aids their progress with no niggard hand. Works of irrigation have improved the pasture lands and facilitated the raising of cattle. Great hay stacks and well-filled granaries, comfortable houses, and barns such as white farmers would not despise, are seen in the valley of the Bow River and on the slopes of the Moose mountain. Among the Piegans, Chiefs "Old Moon" and "Thunder Chief" cut their hay with machines, while in 1892 "Running Crane" and Heavy Gun" owned their own reapers, and raised oats weighing 46 pounds to the bushel. "Heavy Gun" also tried his hand as a miner on St. Mary's river, delivering one hundred tons of coal at the McLeod Agency, the work being all done by Indians.

The Blackfeet also mine coal, the leaders in this industry being Chief Running Rabbit, a successor of Crowfoot, Calf Bull, and Many Bears, each of whom has driven a shaft into seams of coal. Some are successful agriculturists, raise hay in large quantity, which is carried to market by teams of two or four horses. Grain, but especially root crops, are grown. Wood is cut and sold, and many gain much of their support from tanning of hides which are sold to settlers around the reserves. The children are trained in local schools, and at industrial institutions, most of them under care of religious bodies, but all aided by grants from Government.

The English tongue is taught, and the scholars join in singing religious and patriotic songs. An organ or melodeon is often used to accompany, and the singing is particularly sweet and attractive. Many show skill in the use of musical instruments and boys' bands are not uncommon in the older reserves. Games such as attract sturdy white boys, including cricket and hockey, give vent to the exuberance of the young. On White Bear reserve the football is seldom at rest during spare time, and "on one occasion they got up a match among themselves, and were so taken up with the game that they played all night before either side would allow itself beaten and give up."(*j*)

(*j*) "Dominion Indian Report," 1897. p. 152.

Dominion Day and other Canadian national holidays, with their celebrations and pastimes take the place of the Sun-dance and Dog-feast.

It is thus that civilization with its comforts and pleasures advances. The meadow and the waving grain attract as did formerly the hunting field. Gitchi-Manitou flees into the darkness of the past before the white man's God. The consumer becomes the producer, adding an important industrial element to the Dominion.

This is a happy solution of Samson's riddle: "Out of the eater came forth meat, and out of the strong came forth sweetness."

Crowfoot, Esupomusikau, was son of chief Many Names. His mother was a Blood Indian. His name was gained through his intrepidity in battle with the Crow Indians, as Scipio was called Africanus after his conquests south of the Mediterranean.(*k*)

He led in a famous battle between the Crees and Blackfeet in 1866 at Three Ponds, between Red Deer and Battle River, and again at the last fight between these tribes a few years later near the present site of Lethbridge. His loyalty was tried but firm. In 1875 Sitting Bull and ten of his chiefs, who had destroyed Custer and his command, visited Crowfoot, but he declined to negotiate with them. He refused overtures from Riel when he proposed to capture the North-West for the Indians and the Metis.

"He was," writes the author of "Canadian Savage Folk," "a noble red man, worthy the respect and grief of a great nation, which delighted to honour him in life and now holds dear his memory."

Crowfoot was a noble looking man, tall and straight, with the eye of an eagle, and born to command. When he rode or walked abroad he was escorted by his retinue of headmen, and when in Council his coat of deer-skin and beadwork, his leg gear and moccasins were gorgeous indeed. Warned of the coming of the railway and of the white man's vices by good Father Lacombe, he ordered his people to keep to their reserves, and they are, as we have seen, still orderly and progressive. The author of "The Making of the Canadian West," refers to Crowfoot as "the redoubtable chief who promised to be loyal and kept his word. A stern, stoical man whose will was law for his tribe, and whose consistent loyalty was of great value to Canada during that troublous time."

(*k*) "Canadian Savage Folk," by John McLean, Ph.D., p. 375. "Dominion Report on Indian Affairs," 1892, XXIX.

CROWFOOT: BLACKFOOT CHIEF.
(Reduced from Dominion Indian Report of 1896).

Near Three Bulls' village is the modest monument put up by Canada over his grave. On one side is inscribed "Chief Crowfoot, died April 25th, 1890, aged 69 years." On the other side "Father of his people."(*l*)

POUNDMAKER. Not far from Crowfoot's grave, Poundmaker of rebellion fame is buried. He was on a visit from Battleford when he died. He was a Cree and passed his boyhood among the tents of his own people. When a youth he met Crowfoot who took a strong liking to him and induced him to live with the Blackfeet for several years. Crowfoot's teachings were for peace and against the hostile attitude that was an inheritance of Crees and Blackfeet. Poundmaker grew up tall and slender with high forehead, Grecian contour and free from any signs of coarseness or sensuality. His reserve of thirty square miles was south of Battle River, thirty miles west of Battleford. His independent spirit adhered to a nomadic mode of life; he did not take kindly to farming, and found much difficulty, as the buffalo disappeared, in bringing himself to an adherence to the new mode of life which he saw to be inevitable if his people were to be saved from annihilation.

When Governor Morris came to negotiate a treaty in 1876, he spoke in a manful way, saying, "We were glad to hear you tell us how we might live by our own work. When I commence to settle on the lands to make a living for myself and my children, I beg of you to assist me in every way possible. When I am at a loss how to proceed, I want the advice and assistance of the government." Poundmaker was attached to Lord Lorne's party when he visited the North-West in 1881, and the Governor General was favourably impressed with his appearance, intelligence and loyalty. There were, however, among the young braves of his reserve, many who loved the warpath and who were influenced by the messengers from Riel. This led to armed resistance at Cut Knife Hill and to the pillaging of Battleford. Poundmaker soon repented and surrendered to General Middleton on May 25th, 1885. At his trial he said, "Everything I could do was done to stop bloodshed. Had I wanted war I should not be here now, I should be on the prairie. You did not catch me, I gave myself up. You have me because I wanted justice." To the jury he spoke with passionate eloquence, concluding, "I can not help myself, but I am a man still and you can do with me what you will. I said I would not take long and now I am done." He was sentenced to Stoney

(*l*) Dr. McLean, the author referred to, favours me with the following further particulars,—"Crowfoot was well known to me; he had, according to the Indian customs, several wives. I have met only one Indian bachelor, and he was a Blood Indian dwarf. I never saw an old maid. Polygamy was extensively practised, and whilst I never encouraged it, I did not denounce it, as it was the result of their political and social customs, which would be rectified through advancing civilization. Crowfoot had several sons."

Mountain Penitentiary for three years. He had long black locks which fell to his shoulders and lent dignity to his appearance. At his earnest request these were spared. He spent half a year at work in the garden and grounds as a prisoner. The confinement worked sadly on his proud spirit and induced disease. His conduct was excellent and the Government opened the gates and allowed him to return to his people. "Poundmaker was," writes this historian, "a chief of great ability. He had the skin of a Cree Indian, the visage of a commander and the cool and strong judgment of a white man."(*m*) After Poundmaker's release he went to visit his old friend and foster parent, Crowfoot. He was received with great rejoicing but the excitement of keen joy was too much for him. A blood vessel burst and he died. "His name," says the same historian, "will always be associated with the rebellion in the North-West, but the nobler and truer side of his character will best be known by his intimate relations with his people, and his earnest struggles on their behalf." His name is given in Governor Morris' book as *Pondmaker*, but without authority for such change."(*n*)

MIKASTO, or RED CROW, chief of the Blood Indians, is a native statesman who stood next in rank to Crowfoot. He is tall and thin, with an aquiline nose, small, piercing eyes, a face beaming with intelligence, and of a mild disposition.

"He was," writes the author of "Canadian Savage Folk," "one of the bravest warriors and hunters. Sitting in his spacious lodge with the minor chiefs he discourses about the necessities of his tribe and lays plans for their progress in civilized life. In the old days I have often gazed with astonishment at the record of his brave deeds in the picture writing on his lodge. I have counted them, when grouped together, to the number of nearly three hundred."

"I have never heard of a single action unworthy of the dignity of a statesman who aspires to be an example of probity to his followers. . . . It is his striking personality which enables him to command implicit obedience to the customs and laws of the tribe. In the Council he presides with dignity, allowing the chiefs full liberty in discussing tribal affairs, and reserving his mature judgment in settling difficulties. As a firm administrator of law he has won the admiration of his people." And as Dr. McLean says in concluding his narrative—"May he reign in peace and spend many years on earth, a wise law-giver, teacher and friend of his race."(*o*)

(*m*) "Canadian Savage Folk." 388.

(*n*) "Treaties of Canada." by Gov. Morris, p. 219.

(*o*) "Canadian Savage Folk," by Dr. McLean, 413.

OTTAWA CHIEFS. Pontiac was a great chief of the Ottawas. He was about fifty years of age when Quebec was taken. His story has been so well told that it is unnecessary to do more than to refer to him here.(*p*)

THE BLACKBIRDS. There were several noted red men who bore the name of Blackbird. Catlin gives the story of the Mandan chief of this name, a proud and cruel potentate of the middle of last century. On his death he was placed on his favourite white steed, dressed in rich furs, feathers and war paint. A great grave was dug on a high bluff overlooking the Missouri River, into which was led the horse with his dead burden, and they were buried together.(*q*)

ANDREW J. BLACKBIRD. An Ottawa of this gens is well known as an educated man, who occupied the position of interpreter at Harbour Springs, Michigan, and was for a time postmaster there. He is author of an interesting volume, "History of the Ottawa and Chippewa Indians," replete with information as to his people, their legends, history, customs and language.(*r*)

MAKADEBENESSI. There were two brave men of the Ottawa tribe whose history it has been found difficult to separate so as to give to each the credit due for heroic deeds and loyalty. The descendants of both are cousins, as were the parents, and have Manitoulin Island as their home.

(*p*) "Parkman's Conspiracy of Pontiac." "Henry's Travel," part 1, ch. ix.

(*q*) "Geo. Catlin's Travels among American Indians," 2-5.

(*r*) Indian Moral Precepts. Andrew J. Blackbird gives twenty-one precepts, or moral commandments, of the Ottawas and Chippewas, the first five of which, with the sixteenth and the last one are as follows:—the others embrace the most of the decalogue.

(1) Thou shalt fear the Great Creator, who is the overruler of all things.

(2) Thou shalt not commit any crime, either by night or by day or in a covered place; for the Great Spirit is looking upon thee always, and thy crime shall be manifested in time, thou knowest not when, which shall be to thy disgrace and shame.

(3) Look up to the skies often, by day and by night, and see the sun, moon and stars which shine in the firmament, and think that the Great Spirit is looking upon thee continually.

(4) Thou shalt not mimic or mock the thunders or the cloud, for they were specially created to water the earth and to keep down all the evil monsters that are under the earth, which would eat up and devour the inhabitants if they were set at liberty.

(5) Thou shalt not mimic or mock any mountains or rivers, or any prominent formations of the earth, for it is the habitation of some deity or spirit, and thy life shall be continually in hazard if thou shouldst provoke the anger of these deities.

(16) Thou shalt disfigure thy face with charcoal and fast, at least ten days or more of each year, whilst thou art yet young, or before thou reachest twenty, that thou mayst dream of thy future destiny.

(21) Thou shalt be brave and not fear any death.

If thou shouldst observe all these commandments, when thou diest thy spirit shall go straightway to that happy land where all the good spirits are, and shall there continually dance with the beating of the drum of Tchi-baw-yaw-booz, the head spirit in the spirit land. But if thou shouldst not observe them, thy spirit shall be a vagabond of the earth always, and go hungry and will never be able to find this road, "Tchi-bay-kon," in which all the good spirits travel.—"Ottawa and Chippewa Indians of Michigan," by Andrew J. Blackbird, of Harbour Springs, late U.S. Interpreter. Babcock & Darling, Publishers. Cap. XIV.

At the treaty of Fort Wayne September 30th, 1809, a medal was given by General Harrison to the Black-Bird. An engraving of this is given at page 306 of Lossing's Pictorial History of the war of 1812. It is entitled the "Black Partridge Medal," by which name the Black-Bird was sometimes known. His Indian name was Maka-de-benessi or Black-Bird.

On the prairie, now included in the city of Chicago, there was a stockade built by Durantaye in 1685, and in 1804 called Fort Dearborn. Here John Kenzie from Quebec opened a trading post, and for twenty years was the only white man beyond the limits of the Fort. Captain Heald was in charge in 1812 when a band of Indians, mostly Potawahtomees surrounded Fort Dearborn, and it was soon apparent that the garrison could not hold their own. Makadebenessi, the Black-Bird, then appeared and warned them, saying to Mr. Griffith, the interpreter, in Indian fashion, "Linden birds have been singing in my ears to-day; be careful on the march you are going to take." He then gave to the officer the medal referred to, whether to prove his identity or for some other reason does not appear.

On August 15th the garrison marched out; but were soon cruelly attacked by the Indians as they passed along the shore. The Black-Bird restrained the red men as far as he could, and personally saved Mrs. Helm, step-daughter of Mr. Kenzie, from the scalping-knife. An engraved stone set in the wall of a warehouse near the banks of the Chicago river marks the site of the fort.

The garden of the late George M. Pullman's residence encloses the spot where Mrs. Helm was rescued by our hero. Here in 1893 Mr. Pullman erected in bronze a group representing the brave Black-Bird in the act of throwing up the arm of the savage whose tomahawk would in a moment have ended the woman's life. She lived to bless her brave benefactor, and Chicago honours him under the name of the Black-Bird, not knowing that in so doing our worthy Makadebenessi was the hero.

ASSIKINACK is the name of the next of the Black-Bird warriors to whom we refer. It signifies the Black-Bird with red wings, and sometimes appears as Assignac, Siginoc or Sackanough. Macinac was captured on June 2nd, 1763, when Sacs and Chippewas attacked and massecred the unwary garrison. Assikinack was there as a boy with his mother. He was again, under Shinguacongse, at Macinac when it was captured by the British in 1812. The Commissioner of Indian affairs at Washington furnished me with a copy of the petition of two

Ottawa chiefs dated at Washington, October 5th, 1811. One of these was Barstard, or Kimi-ne-tega-gan, the other "Black-Bird" or Siginoc, chiefs of the Ottawa Delegation.

Mr. F. Lamorandiere, of Cape Croker, writes, "I personally knew J. B. Assikinack, who was an old man when I was a boy of 10 years. He was one of the greatest orators of his time, born a leader of mén, quick in action and quick to learn. He was a chief both by birth and the choice of his people. Was born in Michigan; Grande Traverse, L'arbre Croche, Sagewong and St. Joseph, all claim his birth."

The Black-Bird's name appears in the relation of many border skirmishes, and in some important events during the war, but whether Makadebenessi or his cousin be referred to in each case it is now impossible to determine as they were both active British partisans.

The war over, Assikinack continued his allegiance to Britain, became Indian interpreter on the Manitoulin Islands, where he lived until his death on November 2nd, 1866, at the age of ninety-eight years. He was present as party or witness to several of the important treaties made with Algonquins by the British or Canadian Governments He had in his youth been addicted to intemperance. but after settling down to peaceful pursuits entirely overcame this vice. He also renounced heathenism for Christianity, and used his great eloquence to persuade his people tó follow the ways of virtue. On his baptism into the Roman Catholic faith he assumed the Christian names, Jean Baptiste. His good influence and example were widely felt and most valuable throughout the regions of the Georgian Bay and North Shore.(*s*)

(*s*) The author is indebted to the Reverend Daniel DuRanquet, the venerable missionary teacher of Wikwemikong, and to Mr. A. M. Ironside, of the Manitowaning Indian office, and to Mr. Frederic Lamorandiere, for inquiries made as to the Ottawa Black-Birds. Mr. Ironside suggests the name given to distinguish the hero of Fort Dearborn as he does not appear to have had a Christian name. It appears, however, that both of these warriors were sometimes called Assignack in Indian and Black-Bird in English story. Louis Odgik, a grand-nephew of the Chief, named in our narrative for distinction Makadebenessi, was the main informant of Mr. DuRanquet, whose interesting letter of May 27th, 1899, concludes as follows:

"The Chief of Chicago was called Assignak, after the starling, the bird which gives much trouble to farmers. Black-Bird is the translation of the Indian name, and I think the full name of that Chief. The place of his birth, Chicago, so says Louis Odgik. The time of his birth is not certain; his nephew father of Louis Odgik, was fifteen years at the beginning of the war (1812), his uncle might have been then from thirty-five to forty.

"The time of his death, eight or ten years before the birth of Louis Odgik, who is now sixty-four years old. His father, Bemunukinang, died in October, 1878, his sons say that the Chicago Chief Assignak, was yet strong and not over-aged at the time of his death, so they learned from their father.

"Before the war Chief Assignak had come on a visit to friends living about Makinac. He happened to be there when a British officer sent by the Government arrived and proposed to the Indians to join them in the war. They held a council and many answered their call. Assignak, thinking that his nephew, Bemunukinang, was too young (he was fifteen), wanted him to go home, but the boy felt greatly offended. 'No,' said he to his uncle, 'I will not leave you, wherever you go I will follow you.' So Michel Bemunukinang, Odgik's father, accompanied the Chief in all the campaigns of that war. They were at Niagara, about Detroit, and south of Detroit and at the river Aux Raisins. This is all I have been able to learn about your Assignak of Chicago. I remain, sir, yours truly, D. DuRanquet."

UPPER CANADA COLLEGE BOYS. In Mrs. Jameson's narrative of travels in Upper Canada in 1837, an account is given of a great assemblage of Indians on the Manitoulin Island. Here an important treaty was made with Chippewas, Ottawas and Potawahtomees. Assikinack, the interpreter, and Shinguakongse, the chief, were there and made addresses. The Black-Bird is, she states, a Christian, and extremely noted for his declared enmity to the dealers in fire water.

As most of the Indians brought their families with them to such gatherings, there were no doubt two youngsters there enjoying the fun. One of these was Charles Tebisco Keejak, a Chippewa lad, the other was Francis Assikinack, a son of the interpreter. Some three years after this, Mr. Jarvis, the superintendent, arranged that these two boys should come to Upper Canada College for their education. Keejak was a true son of the forest, supple of form, quick of sight and movement, skilled in use of bow and arrow and rifle. One morning he raced for a wager on a half-mile stretch down University Avenue against a British officer on a trotting horse, and got first to Queen street. He soon mastered the English language, and showed skill as a linguist. He then aided the late Rev. Dr. O'Meara in translating the New Testament into his native tongue, and was for a time interpreter to the Reverend R. Robinson, Congregational missionary to the Georgian Bay Indians. He was a scholarly man of fine features. He settled at Wobonash, near Owen Sound, where he died many years ago.

When Francis Assikinack entered college, he was a tall, slim boy of sixteen, and was diffident because of his inability to speak our tongue. He soon overcame this, was on the prize list in 1841 for good conduct and map-drawing. In 1843 he was in the first form and first in writing, general proficiency, Greek and geography. Francis left college after entering the sixth form, to go into a situation in the Government Indian Department. He had excellent testimonials from Mr. Barron, the Principal, and shewed a docile spirit by continuing his reading of history and the classics under the care of Bishop Charbonnel. While still at college he joined cheerfully with his classmates in their games and amusements, and distanced most competitors in feats of agility. He cared little for cricket or baseball. In winter he delighted in the making and storming of snow forts with noisy tumult of mimic war. He could shoot a robin on the wing with his bow and arrow and never missed the bullseye with his rifle. He stood six feet in his stockings, was of lithe form, jet black hair, nose somewhat aquiline, piercing dark eyes, and had small beautiful hands and feet. He is thus described by several "old

F. Assikinack

(From a photograph given by him to Mr. L. Heyden).

boys," who were classmates with him. His weakness was in mathematical studies, for which he had little taste. His classmates say that while they had their occasional caning, Francis never so suffered. The masters understood that the proud young Odahwah was doing his daily task conscientiously and treated him with sympathy and discretion. He was indeed proud of his origin and styled himself in official documents and in his literary productions, "a warrior of the Odahwahs," whom we call Ottawas. When acting as interpreter to the Indian department, Francis Assikinack read four able papers before the Canadian Institute, which may be found in their Journal of 1858 and 1860. In style of composition the articles are clear and eloquent. He discussed the origin and nomenclature of the Algonquins, their customs, funeral and marriage rites, feasts, modes of government, odadems or coats of arms, legends and myths. These papers are widely known and rank as valuable historical and ethnographic additions to Canadian literature.

Young Assikinack spent several years in the Indian office, generally at Toronto, and was witness to some important negotiations and treaties with Ontario Indians. His favorite associates were his former classmates in the college, with whom he conversed of his people, their history, legends and hopes for the future. He also related with flashing eye the valourous traditions of his race and among them the exploits of his heroic father. Of his people's prospects he once said, "Yes, we are going, it is true, but when we are gone our deeds will still fill many pages in the country's history. We have in Canada mingled in the white man's wars, first against him, then with him and against the common enemy."

He did not in his writings refer to Longfellow's *Hiawatha*, which had been recently published, but felt some disappointment or even resentment, that the songs and legends of his Algonkian forefathers had been set to the tune of an Onondaga pipe. He admitted however, that it is impossible to exactly localize the origin of legends of a nomadic race, even the Ottawas claim to have come from a region south of the great lakes long since the time of Columbus.

There were a sad romance and a sad ending to this promising young man's life. He became engaged to a young English lady of position and culture, and was congratulated on his happy prospects. After a time he fell ill and consulted a physician who found him suffering from a decline and could not conceal his anxiety, yet feared to speak the truth too rudely, for Francis was a favourite with all who knew him. A friend was sought, one who had been with him under Mr. Barron and Mr. Markland. To him Dr. Hodder said, "Yes, the Indian will die." On meeting his friend Alfred, Assikinack read his fate in his face, and said, "I see I must go." He soon manfully put his affairs in order, resigned his office and went home to his people on the Island of the Manito. "There is," he said, "a beautiful grove in my people's old camping ground. I will go and end my days there." He died on November 21st, 1863, and his last resting place is at Wikwemikong.

GITCHI NAIGOU, LE GRAND SABLE. On May 12th, 1781, Gitchi Naigou and other Chippewa chiefs, in consideration of £5,000 New York currency, surrendered to King George the Island of Michillimacinac, then called La Grosse Isle, and they promised to "preserve in their village a belt of wampum, to perpetuate, secure and be a lasting memorial of the said transaction."

Gitchi Naigou is connected in history with the taking of Macinac by the Chippewas and Sacs in 1763. He was absent when the Fort was taken, and when he arrived found many white prisoners. Entering a lodge where they were bound, he murdered seven of these helpless people, whose bodies were used in a horrid cannibal feast which followed, as related by Henry, the early trader.

Under the name of *LeGrand Sable*, Gitchi Naigou lived for many years after. When old and feeble he longed to go with his friends to the spring sugar camp, but his physical powers were unequal to the task. Then his daughter, Nadowaqua, came to his help, and carried him on her back fully ten miles to the maple woods on the banks of Lake Michigan. She was renowned for this pious feat. Mr. Schoolcraft gives the story, with an illustration of the devoted daughter bending under her living burden, saying she imitated the feat of Æneas bearing Anchises from the flames of Troy.(*t*)

It is seldom that the women were mentioned in Indian treaties, though they were not always excluded from the Council, but in three treaties made by the gallant Governor Simcoe at Navy Hall in 1792 the "principal women" are included along with Sachems and war chiefs.(*u*)

It would be interesting to sketch the character of other Algic chiefs who led their people and took part in inducing them to make terms with the advancing white man. Such was Sweet-Grass, the Cree, a brave and eloquent warrior whose influence was great in effecting the Fort Carleton treaties. He unfortunately died soon after from the accidental discharge of a pistol.(*v*)

(*t*) "Indian Tribes," 4, 49.

(*u*) "Blue Book Canadian Indian Treaties," Nos. 3, 3½ and 4.

(*v*) "What the great Chief Crowfoot was to the Blackfeet, so was Sweet-Grass to the Crees." Thus begins an interesting story, "The Conversion of Sweet-Grass," by W. A. Fraser in Canadian Magazine, Vol. 12, 403.

Mistowasis, supported by five Councillors, was party to the treaties of 1876, and lived until a recent day, seeing many of his people adopting the Christian religion and ways of life. His name is still attached to a reserve. The addresses of these and other chiefs at treaty making are remarkable for beauty of diction, sagacity and patriotic care for the future of their people.

We must conclude with a reference to a heroic character whose poetic spirit, transmitted through his descendants, has shed a lustre as of an autumn sunset, over our Northland.

WAUB-OJEEG, (the King Fisher). When Quebec was taken and the Marquis of Montcalm fell, Mamongazida (the Loon's-foot), a Chippewa chief, was by his side. He was the ruler of Chegoimiegon, bearing the totem of the Adik or American reindeer. After the capitulation, Mamongazida gave in his allegiance to Sir W. Johnson at Niagara and received the king's medal. Waub-Ojeeg was the second son of this chief, and was born under the British flag. As described by Schoolcraft he had a piercing black eye, stood six feet six in his moccasins, a Saul among the people, was spare and lightly built but of great strength, activity and endurance. He became chief, and for the twenty years prior to his death in 1793, was the ruling spirit of his tribe. He sometimes led their warriors against the Outagamies or Foxes, and the Sioux. He was a mighty hunter and claimed as his preserve all the country from Chegoimiegon or La Pointe, near Sault Ste. Marie, to the River Brûle, at Fort du Lac in Wisconsin, and all caught poaching there were liable to suffer death. His lodge at La Pointe, where were the Council fire and seat of Government of the Chippewas of Lake Superior, was always well supplied with meat of deer and bear. It was sixty feet long, and in its centre was a post rising above the roof, on top of which was the carved figure of an owl, which turned with the wind as a weather vane. It also indicated the presence of the lord of the soil, for when he was off on his hunts or other expeditions, the owl was removed.

Waub-Ojeeg was twice married; the eldest child of his second wife was Neëngai. John M. Johnston, a young Irish gentleman engaged in the fur trade, had occasion to meet the Chippewa chief in trading at Chegoimiegon, where the beautiful Neëngai was to be seen, and to see her was to love her. When he asked the chief for her hand, the old warrior, who was an affectionate father, demurred, saying, "Return, young man, with your load of skins to Montreal, and if there the women of the pale faces do not put my child out of your mind, return hither in the spring and we will talk farther; she is young and can wait."

The spring came and with it the young trader with unabated affection. The chief's daughter became Mrs. Johnston and lived very happily for thirty-six years at what is now the American Sault Ste. Marie, until Mr. Johnston's death.

The story is beautifully told in Mrs. Jameson's "Summer Rambles in Canada." Mr. Johnston was a native of County Antrim, his father having an estate at Craige, near the Giant's Causeway. He fell into the company of the half baronial class of the North-West fur traders. The free life and beauty of the Northland attracted his poetic fancy as the like scenes in Upper Canada early in the century aroused the inspiration of his fellow countryman, Thomas Moore. He found in Waub-Ojeeg, as Schoolcraft says, a sort of rajah, whom men were always ready to follow. Andrew J. Blackbird met Johnston at Macinac, and describes him as "a most noble looking and tall young man, who spoke perfectly the Indian language." He had four sons and four daughters to whose education he paid the utmost attention.

Of the daughters, one became wife of Rev. Dr. McMurray, who was then Anglican missionary at the Sault, and later Rector of Niagara; another was wife of Mr. Henry R. Schoolcraft, for many years American Indian agent at Macinac.

Waub-Ojeeg was in as high esteem for eloquence and poetry as for warlike daring. Mr. Johnston translated one of his war songs into English verse.

WAUB-OJEEG'S BATTLE SONG.

On that day when our heroes lay low, lay low,
On that day when our heroes lay low
I fought by their side, and thought, ere I died,
Just vengeance to take on the foe,
Just vengeance to take on the foe.

On that day, when our chieftains lay dead, lay dead,
On that day, when our chieftains lay dead,
I fought hand to hand at the head of my band,
And here on my breast have I bled, have I bled,
And here on my breast have I bled.

Our chiefs shall return no more, no more,
Our chiefs shall return no more—
Nor their brethren of war, who can show scar for scar,
Like women their fates shall deplore, deplore,
Like women their fates shall deplore.

Five winters in hunting we'll spend, we'll spend,
Five winters in hunting we'll spend,
Till our youth, grown to men, we'll to war lead again,
And our days like our fathers' will end, will end,
And our days like our fathers' will end.

This song was composed, more than one hundred years ago, for the expedition in which our hero led three hundred and forty warriors and overcame the Foxes and Sioux at the Falls of St. Croix, now in Polk County, Wisconsin. The battle decided the possession of St. Croix valley.(*w*)

Waub-Ojeeg's daughter inherited much of the poetic spirit of her father. Her Irish husband was also embued with romance, and, in turn, characteristic and beautiful sentiments seemed to be innate with their daughters. Mrs. Jameson gives several examples, tales or legends taken down by her from the lips of these talented ladies.

ALGIC LEGENDS AND HIAWATHA MYTHS.

Then when I have strayed a while
Through the Manitoulin Isle,
Breathing all its holy bloom,
Swift I mount me on the plume
Of my Wakon-Bird and fly.(*x*)

THOMAS MOORE.

Before Mr. Johnston's time, Alexander Henry traversed this region, met Algonquins of various tribes, was at the taking of Macinac by the Sacs and Chippewas, and for some time a prisoner among them. In 1767 he published some legends regarding Manabozhu, and other Indian stories. We may here note that the spirit of the Algic muse was of a very different character from that of their southern neighbours. Mr. Parkman compares the legendary lore of the Iroquois with that of the Algonquins. The former black as the midnight forests, awful in its gloomy strength, while the tales of the Algonquins were different in aspect, of necromancy and witchcraft, men transformed to beasts, and beasts transformed to men, animated trees and birds who spoke with human tongues. The credulous circle around the Ojibway lodge fire heard of sorcerers dwelling among lonely islands, of spell-bound lakes, of grisly wendigoes, of evil manitoes lurking in the dens and fastnesses of the woods, of heroes who by subtle strategy or magic art achieved triumphs over brute force. The God of Thunder, who made his home among the caverns beneath the cataract of Niagara, was a conception

(*w*) "Schoolcraft's Indian Tribes of United States," 5. 524.

(*x*) This verse is in the poem, "From the Banks of the St. Lawrence." In a note the Wakon-Bird is stated to be "of the same species as the Bird of Paradise, the Bird of the Great Spirit." In this poem Moore describes Niagara and, passing through the lake, sees:

"Where the blue hills of old Toronto shed
Their evening shadows o'er Ontario's bed."

As this was in 1804 what the Irish poet saw was the cliffs known now as Scarboro Heights, east o the infant city, and then covered with magnificent oak and pine trees.

which the deep imagination of the Iroquois might fitly engender. The Algonquins held a simpler faith and maintained that the thunder was a bird who built its nest on the pinnacle of towering mountains.(*y*) Mrs. Schoolcraft carried her store of poetic lore with her to Macinac, and her accomplished husband states that the legends he gave to the world were related to him by the Chippewas of Lake Superior.(*z*) Mr. Schoolcraft's industry was undoubted and he had an extensive personal knowledge of Indian life and character. His large illustrated work on American Indian tribes was published by the U.S. Government. Mr. Parkman, Dr. O'Meara and others criticized his mode of handling the subject, and charge him with grammatical errors. In his volume "The Hiawatha Legends," many fanciful stories of Manabozu occur, but not a fact or fiction about Hiawatha.

"Shooting the Thunder Bird," is practised by the Chippewas and Crees. At Broken Head River, Lake Winnipeg, a Saulteau Indian, with his daughter and nephew, were recently in their tent during a violent storm. "I will shoot the Thunder-Bird," said the man, directing his gun towards a dark cloud. But Jupiter Pluvius quickly resented the intrusion. As the gun flashed a bolt from the cloud followed its course, the Indian and his nephew fell dead. Compare the Iroquois description with Shelley's lines in "The Cloud :"

> "Sublime on the towers of my skiey bowers,
> Lightning, my pilot, sits,
> In a cavern under is fettered the Thunder,
> It struggles and howls at fits."

Mr. Longfellow follows in the wake of Schoolcraft, deriving the nomenclature and much of the substance of his Indian Edda from this source. Mr. Schoolcraft's two volumes of *Algic Researches* were published in 1839. Let us shortly consider how and why it is that, through the offices of the famous New England poet, and his striking versification, the Canadian and Algic character of these poetic legends is to some extent lost sight of. Horatio Hale writes : "Hiawatha was originally an Onondaga chief, noted for his magnanimous and peace loving disposition. Being driven from his nation and the home of the Onondagas in New York State, by the wiles and threats of a rival Atatorho, he fled eastward to the powerful tribe of the Caniengas or Mohawks. After various adventures he reached the headwaters of the Mohawk River. He was adopted by Mohawks and was made a high chief of the nation." "When by joint efforts the confederacy known as the League of the Iroquois

(*y*) "Conspiracy of Pontiac." Chap. 1.

(*z*) "Introduction to Hiawatha Legends."

was established, the affection of Hiawatha for the place of his birth revived. He returned eastward in his old age to the country of the Onondagas where he died." "Longfellow, using a large poetic license, has transported the hero, with his Iroquois, to the shores of Lake Superior, and has made him an Ojibway chief; but he has preserved the outlines of his character, and in some respects, of his history."*(aa)*

Mr. W. M. Beauchamp, late Secretary of the Anthropological section of the American Association for the advancement of science, discussing the history and career of Hiawatha, says,*(bb)* "When Longfellow's Hiawatha appeared I was prepared to greet an old friend, and was surprised at being introduced to an Ojibway instead of an Iroquois leader. The change, however, gave a broader field for his beautiful poem, a gain to all readers, but as he retained little beyond the name it may be needless to refer to that charming work. It preserves, however, the leading thought,

> "How he prayed, and how he fasted,
> How he lived and toiled and suffered,
> That the tribes of men might prosper,
> That he might advance his people."

Professor Campbell ascribes to the League an ancient Asiatic origin.

Dr. Brinton sets down this legend as a fanciful tale, based on old traditions. Dr. A. F. Chamberlain refers to "Manabozho or Nanabush, the demi-god and culture hero of the Chippewas and other kindred tribes, whose character and achievements Longfellow has mingled with those of the Iroquois patriot and statesman Hiawatha, to produce the majestic figure of his great epic."*(cc)*

The American poet may be said, in placing an Iroquois head on an Algic body, to have, in a manner, violated one of the main rules in Horace's Art of Poetry. Longfellow himself says that the legends are gathered,

> "From the forest and the prairie,
> From the Great Lakes of the North-land,
> From the land of the Ojibways,
> From the land of the Dakotahs."*(dd)*

(aa) "Am. Folk Lore Journal," Vol. iii, 182.

(bb) "Am. Folk Lore Journal," Vol. iv, 295.

(cc) "Am. Folk Lore Journal," iv, 193, and ix, 48, and note *a* ante.

(dd) The critical reader may trace the Algic, as distinguished from the more sombre Iroquois character described by Mr. Parkman, in the greater portion of the legends forming the "Song of Hiawatha." "Osseo, son of the Evening Star," is expressly stated by Mr. Schoolcraft to be an Algonkian tale. Among the beautiful songs rendered at the Wedding Feast by Chibiabos is the "Maiden's Lamentation for he lover, her Algonquin." "Paw-Pak-Keewis or the Storm Fool," is a Chippewa. Kwasind, the strong man, is stated by Schoolcralt to have been of Pauwating Village, now Sault Ste. Marie. He is the Ojibwa Hercules of the Epic. His strength was concentrated in the crown of his head, which was the

Among the legends of the Redmen of North America none are more numerous than those relating to the personage called variously, Manabozho, Nanahbosu or Nanabush, Schectac or Wesaketchak, Michabo and Messou; and our North country has many places sacred to him or connected with this mythical character by legend.(*ee*) He is regarded as the spirit of the northwest tempests, the personification of strength and wisdom. On the north shore of Lake Superior eastward from Thunder Bay Point, is his grave, according to a legend given by the late Peter Jacobs, while Alexander Henry in 1767 gave his burial place as an island on the east side of Michipocoten Bay called Nanibosu, held in much reverence by the natives. A mountain and point of land in that region also have his name. On a small rock on the Ottawa river are the prints of human footsteps and a round hole near by, the shape and size of a kettle. The Ottawas and Chippewas make offerings by throwing tobacco as they pass, saying they are tracks of Manabozho and the place where he dropped his kettle.

All the tribes referred to are, according to the late Sir Daniel Wilson, prehistoric, that is, had no written memoirs or records. The giving of one or more belts of wampum marked the consummation of each treaty, and these belts were carefully preserved. Young men of good memories were also chosen to act as custodians of tribal secrets and bearers of important messages, and the substance of treaties and historical matters was so preserved from generation to generation. The stories that old men, such as I-and-wah-wah, the Cree, can tell, were tales that had been recited for ages in the lodges and around prairie camp fires. Mrs. Jameson in her charming book referred to, gives some beautiful allegories, love and war songs, taken from the lips of the venerable

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vulnerable part of his body. Iagoo the boaster is "from the mythology of the Chippewas." It was doubtless in deference to New Jersey feelings that one of his stories is not told by Longfellow. One wing of a mosketoe, which Iagoo saw on a mush-keeg or great bog, was sufficient for a sail to his canoe, and the proboscis as big as his wife's shovel.

"Iagoo seems to hold the relative rank in Algic oral relation, which our written literature awards to Baron Munchausen, Jack Falstaff and Captain Lemuel Gulliver." His hunting stories are incredulous marvels. Pauguk, the personation of death, is Ojibway, as is the story of Mondamin descending from the sky, but the mythical origin of Indian corn was a legend common to the North American tribes. "Manabozho, the great incarnation of the North, an Algic legend," contains most of the stories attributed to Hiawatha, including the love of the arrow maker's daughter. His last journey was to the Northland, where he is understood to direct the storms which proceed from points west of the pole, while the legendary Hiawatha departed to find the Islands of the Blessed in the west, although the historical Hiawatha returned eastward in old age to end his days in his native country. *Shawondasee* is also, says Schoolcraft, vol. 2, 214, from Ojibway mythology. His sighs produced the balmy summer airs, the Indian Summer, and scattered the snowy hairs of the prairie dandelion. (Schoolcraft's "Algic Researches," Vols. 1 and 2, *Oneota*, pp. 32 and 83). And as to the character of Iroquois music and poetry and Hiawatha, see Archæological Report, Ontario, for 1898, pp. 66 and 85.

(*ee*) The term Nanahbosu is used by the Plain Crees from Manitoba to the Rocky Mountains. Wesaketchak is the name applied to the demi-god along the Red River of the North, and thence north to Hudson Bay. The Abenakis and Micmacs have their legendary Glooscap.

Mrs. Johnston, once the fair Neëngai, or her daughters, who inherited their talents from Waub-Ojeeg, and no doubt also from their high-spirited Irish father. Dr. R. Bell relieves the monotony of geological research in our Northland by gathering gems of Algic story and song. Dr. Brinton, Mr. Leland, Horatio Hale, Dr. Chamberlain and others have also found here a mine of interest and beautiful imagery. It forms the folk-lore of an ancient race in which are preserved the thoughts, theories and imaginings of many past ages. It proves the kinship of this brave people to the dwellers in other lands, with the like joys, sorrows and fate.

These legends are of the thunder and other powers and wonders of nature, of love, war and revenge, of the birds of the air, of the beasts of the chase, of the great sturgeon and other denizens of the waters, and are more various than the fables of Æsop. They tell of gray-haired winter leaning on his staff, of bright-eyed spring, his brow covered with flowers and breathing from his lips an air sweet as the wild rose, the beauty of the moon and the morning star, of the sunset and the Aurora, at once the emblem of promise and path of the spirits of the dead. They personify frost and hunger and tell of the magic canoe that will float to the happy hunting fields where at last plenty will abound.

When Fridtjof Nansen, in the stout little *Fram*, was on his way to pass three years in ice and snow, he looked out on his beautiful Norway and exclaimed, "You may shrug your shoulders as much as you like at the beauties of nature, but it is a fine thing for a people to have a fair land, be it never so poor." We have in our Algic land a territory that, for natural beauty, is not excelled by any on the face of the earth. Here are fertile valleys, tree clad hills, pellucid streams and mineral wealth in abundance. It is the paradise of hunters, the favorite haunt of the naturalist. The beautiful grosbeak flits about among the berries. The rossignol and song-sparrow enliven the woods and streams with their melody.

But let us not forget to add to the delight received from the senses and hope of the future, that satisfaction which should arise in his breast who feels that this too is a land of poetry, allegory and ancient story, that combine to make a charming background of Canadian history. We have considered the origin and traced the genesis of the lore and romance that crowns every hill and peoples with a fairy creation every vale, lake and island of our Algic land. So feeling, let us not allow the New England cuckoo to oust from her nest the Canadian song-sparrow.

A poet has called this land "Our Lady of the Snows." Beautiful indeed is she in her ermine mantle, her young head uplifted and her every step guarded by thousands of hardy liegemen, among whom the red men from the forest and prairie are to be reckoned at no insignificant figure. But I like best to look on this fair lady as she appears in autumnal garb in our wonderful Northland. The clematis and columbine make her fairy bower, gem-spangled moss her carpet. Tall pines and giant oaks are her sentinels, zephyrs fan her by day and at night beautiful Aurora flashes radiance. Hyacinths and golden-rod smile in her path. Ivy, blue bells and lilies of France unite to form her girdle. Her eyes are full of welcome, her hands are full of plenty, and bands of feathered songsters echo her praises.

PRIMITIVE NATURE STUDY.

BY ALEX. F. CHAMBERLAIN, PH.D.

(Read May 6th, 1899.)

IT is an all-too-common idea that the so-called "lower races" of man have little or no appreciation of the beauty and the majesty of Nature.

Höffding does not hesitate to declare that "Children and savages have, as a rule, no sense for the beauties of Nature" *(Psych.*, p. 266), and Ribot goes even further when he says: "In primitive poetry, man is in the foreground, Nature is only an accessory. Little of description, a few verses or epithets suffice to create it." *(Psych. des Emotions*, p. 336.)

Psychologists, generally, have seen fit to date the rise of real Nature-feeling from the middle of the eighteenth century, so far at least as the masses of the people are concerned, and to credit Rousseau with being the first to arouse such a sentiment *(Ribot*, p. 267). The ancient Greeks, however, and the Chinese had certainly a keen sense of natural grandeur and beauty, no less than that of the Hebrews, while, as Biese, who has written so excellently of the "Development of the Feeling for Nature," points out "the nature-lyric is primitive [uralt] and common to all peoples."

It is eminently fitting then, that a recent writer (Prof. Patten) should take occasion to observe concerning Rousseau, "the interpreter of Nature," as he has been called *(Ann. Am. Acad. Pol. and Soc. Sci.*, VIII., p. 455):

"Rousseau was a man of a more primitive type than the leaders of the preceding period of French thought. He had many of the characteristics of a savage and his concept of nature belonged to a much earlier epoch."

With this introduction, let us now turn to the consideration of the nature-lore of peoples who may be judged fairly to represent the thought and feeling of this "earlier epoch."

Fear has been by many philosophers and psychologists looked upon as the originator of religion and the sense of the sublime and wonderful. One recent writer observes:

"This awe of nature, even when not a kind of worship, is the child of our inheritances. Our ancestral savage could conceive of no other medium of communication from his God to himself than the material world in which he found himself. The power and force, the ruthlessness and inexorableness of the laws as he knew them, bodied forth with a flawless exactitude his ideas of what a God should be, based on the only two human qualities which he was able to understand—determination and physical force. And to this day these are the only attributes of a God which nature has to offer us through any of her phenomena. Viewed and studied either in the mass or in detail, we can learn from her workings nothing else than these. We look in vain for even the slightest indication of a single one of those human qualities which we have been accustomed to regard as akin to the Divine." (*Amer. Anthr.*, Vol. V., p. 248.)

This, I venture to say, whatever modicum of truth the modern philosopher can see in such a doctrine, is decidedly false and unjust as a general characterization of the attitude of those ancestors of ours who felt their kinship with "mother earth" and "father sky," worshipped the light, and with poetic imagination turned night into the fertile womb of being. Something else there is in man, as old at least as fear.

One of the most eminent men of science, again, does violence, unwittingly, no doubt, to the heart and the soul of primitive man, when he declares in exaggerated language:

"Nature tells the savage that the earth is flat, over which the sky is arched as a solid dome; then Nature tells the savage that the sun travels over the flat earth and under the sky of ice by day from east to west; then Nature tells the savage that the rain comes from the melting of the ice of the sky. Many, strange, foolish and false are the stories that Nature tells to the untutored savage. Nature is the Gulliver of Gullivers, the Munchausen of Munchausens. Nature teaches men to believe in wizards and ghosts; Nature fills the human mind with foolish superstitions and horrible beliefs. The opinions of natural man fill him with many fears, give him many pains, and cause him to commit many crimes. . . To the savage man Nature is ever a deceiver and a cheat." (Major Powell, in *Amer. Anthr.*, Vol. I., p. 312.)

Not so. Nature, from the beginning, has been a tireless teacher of the true, the good, the beautiful. Not all herself has she revealed to one age, to one people, but every race and every tribe can rightly say: "In Nature's infinite book of secrets a little I can read."

It is claimed too that primitive man is logical neither in his methods nor in his ideas, that as his body is often a collection of abnormal or brutish land-marks of far-reaching travel, so his mind is an arena where lawless thoughts and purposeless ideas struggle fiercely for unmeaning and insignificant mastery. Only the other day, Dr. Friedmann, a German student of the history of our race, made bold to say:

"The state of primitive thought is nothing more nor less than insanity, and has its parallel only in our asylums for mental diseases" (*Science*, N.S., Vol. IV., p. 352),—a view held to some extent by Tanzi, in his essay on "Folk-lore in Mental Pathology." (*Riv. di Filos. Sci.*, Vol. IX.)

This doctrine, too, we must reject as a libel upon humanity. Its advocates miss all the significance of the "golden mean." Reasoning by analogy, confusion of the real and the ideal, are to-day far too common and much too human to be regarded as evidences of an unsound mind. That the whole earth was ever populated by lunatics is a theory, which the arts, the inventions, the languages, the institutions of even the lowest races render absolutely untenable. No mere psycopath laid the foundations of astronomy, invented the boomerang, or changed the wild, rude grass into the all-bountiful maize.

Our scientific concepts of the universe may differ from the naïve philosophy of primitive man. The head of the race may have changed but the heart is in essence just the same. The words of Mrs. Stevenson, written of the Zuñis, will stand for myriads of savage and barbarous tribes of the present and of the past.

"The natural impulse of the human mind is to seek for truth and to account for the phenomena of nature, and thus philosophy grows. Mythologic philosophy is the fruit of the struggle for knowledge of cause. The reasoning of aboriginal people is by analogy, for at this stage of culture science is yet unborn. So the philosopher of early times is the myth-maker. The philosophy of primitive peoples is the progenitor of natural religion, and religion is invented through long processes of analogic reasoning. The Zuñian belongs to this stage of culture. He is conscious of the earth he treads upon, but he does not know its form; he knows something of what the earth contains beneath its surface, of the rivers, the mountains, the sun, moon and all celestial bodies of the solar system to be discerned without the optical inventions of man; he sees the lightning, hears the thunder, feels the wind and knows the value of rains and snows; he is acquainted with the beasts of the forests, the birds and insects of the air, the fishes of the rivers, and knows that these living things possess attributes not attainable by himself, and so he endows these animals with superior or supernatural qualities." (*Inter. Congr. Anthr.*, 1893, p. 317.)

Again:

"Our concepts of the universe are altogether different from those of primitive man; we understand phenomena through philosophical laws, while he accounts for them by analogy; we live in a world of reality, he in a world of mysticism and symbolism; he is deeply impressed by his natural environment, every object with him possessing a spiritual life, so that celestial bodies, mountains, rocks, the flora of the earth and the earth itself are to him quite different from what they are to us. The sturdy pine, delicate sapling, fragrant blossom, giant rock and tiny pebble play alike their part in the mystic world of aboriginal man," (p. 318.)

We can detect no symptom of world-wide insanity here, but rather the beginnings of the profoundest philosophy, the most consoling religion man shall ever come to know. Nature never hypnotized the race with lower aim than God when he intoxicated Spinoza. Too often have critics and historians forgotten the truth enunciated by Heinrich Heine: "Thought is the unseen nature, as nature is the unseen thought." Primitive man's view of nature is not that of the inmate of an asylum, but the view of a normal human being who deeply felt, though but dimly, at times, he perceived, the great thought of Goethe:

"In Nature we never see anything isolated, but everything in connection with something else which is before it, beside it, under it and over it."

In ignorance, no doubt, of the vast amount of primitive literature, accumulated by the patient toil and unwearying industry of the last quarter of a century of anthropological investigation, some writers have seen fit to vouchsafe to the uncivilized races but little power of description, a plenitude of monotony, and childish, rather than child-like imagination. How unjust this charge is, a moment's study of the original documents will show. Take the creation-myths alone—hours would not suffice to enumerate them even, much less to describe them.

What majesty there is in the simple story of creation as sung by the Dinkas, of the White Nile region in Africa!

> "Upon the day when God all things created,
> Created he the sun:
> The sun goes up and down, and comes again—
> Created he the moon;
> The moon goes up and down, and comes again—
> Created he the stars;
> The stars go up and down, and come again—
> Created he mankind;
> Man comes forth, goes to earth, returns no more."
>
> —(Ratzel, *Races of Mankind*, II., 354.)

The music of the spheres is there, we can almost hear "the circling planets in their course." To this race the great nature-hymn of Addison would be an old-time possession. At the other extremity stand complicated legends of enormous length, elaborate finish and beauty of expression, inconceivably brilliant and forceful description, wealth of quaint, naïve, yet seldom childish imagery, wonderful imagination and deep insight into the hidden things of nature and of man. Such a great primitive work of art has been preserved for all time by Mr. F. H. Cushing, in his "Zuñi Creation Myths." The perusal of this product of aboriginal genius is sufficient to make any man tread with unshod feet and bowed head, the holy ground from which such fruitage sprang. The glory of the seasons, the life of bird and beast and insect, the beauty of plant and flower, the noise of running waters, the rosy dawn, the quiet, holy night, the energy that dwells in all, the thought of man and God are there. You must, however, read it for yourselves. I can cite but a few brief extracts here. First listen to the song which the Beloved Twins sang to the despairing race of man, in one of its direst extremities (*13th Ann. Rep. Bur. of Ethnol.*, p. 406):

> "Look now, ye faithless and witless!
> The mothers who love not their offspring
> And cherish them not thro' all danger,
> Must lose them anon, as the wood-bird,
> Who sits not her nest, doth her broodlings
> Fear not, but cleave fast to your children,
> Though they strange-turn and frightful of seeming
> 'Tis the magic of water, and wildness
> Of heart, and will pass (as men's laughter
> Doth pass when the joy thought is sobered),
> As ye win your way forth from the waters." (p. 431.)

Another is the protest of the people—priests, when the children murmured, and they sought to hush them, telling them not to sadden the Mother-Corn by their complaints, as to the imperfection of the corn-rites. "What is this ye tell us?" said they. "These things be to the simple as the wind and other movings, speechless; but as to us they be signs even as erst the warnings of the underworld were signs to our fathers, the beloved, and ourselves, that we seek still further the middle, so are these things signs to us. Stay, therefore, your feet with patience, while we devise that ye be made content and happy." Then to one another they said, "It may well be Paiyatuma, the liquid voices his flute and the flutes of his players they tell of. Come now, we will await the time of our custom and then learn if perchance our hearts guess aright."

What becomes of the view of Höffding that savage peoples have no sense for the beauty of nature, no feeling of its grandeur and magnificense, no idea of its gentler aspects in the face of the following statement from the most eminent of German ethnographers?

"Even the savage, the most prejudiced creature in human shape, the man with the least field of vision, receives an impression from the rainbow, the bridge to the sky, from the roar of the sea, from the rustle of the woods, the bubbling of the spring. These phenomena are drawn into the range of superstitious conceptions, which in their turn are called forth by nearer causes.

"Are they images of souls, which the Ainu place on promontories where an awkward current prevails in order to pray for a good passage or a lucky haul? Savages know how meteoric stones fall, and have retained experiences of them in their traditions; the stone hatchets found in the soil they call thunderbolts. The boat with the corpse is launched on the waves; the dark forest is overlaid with taboo; in every brook a spirit is imagined. Poetry here entwines its roots with religion; it appears a highly superfluous question to ask if these races have a sense of Nature." (*Ratzel*, Vol. I., p. 49.)

Again:

"Many myths are nothing but picturesque descriptions of natural events and personifications of natural forces. These bridge over the interval to science, for in them mythology becomes like science, the way and the method towards the knowledge of the causes of phenomena.

"The original object falls into the background, the images become independent figures whose quarrels and tricks have an interest of their own. Therewith we have the fable, especially the widespread beast-fable.

"Here the immediate operations of Nature are indulged with a wider play. Just as the sacred mountains and forests, the sacred sea and its cliffs, protest against any denial of the sentiments of Nature among the races that have no literature, so do their myths and hymns testify to the deep impression made by Nature. The connection of many a little poem with the songs of birds is obvious. Light and darkness, day and night, arouse feelings of pleasure and discomfort; white, red and green embody benevolent natural forces and dæmons; black, those that are dreaded. Sunrise and sunset, storm, rainbow, the glow of evening, are most adapted to find a lyric echo where sun and fire are objects of adoration.

"What light and darkness are for the eye, sound and silence are for the ear. The rumble of thunder, the muffled roar of beasts of prey, contrasted with the clear ripple of the spring, the plash of the waves, and the song of birds. In a series of pictures, copious though limited by the constraint of customary expression, the poetry and pictorial art of the natural races continue to express this. On one side of the mysterious Papuan bull-roarer, the object of religious devotion, is depicted the resting moth, on the other the whirring moth: what a simple and impressive picture language!" (p. 70.)

Of the Eskimo, Dr. Brinton tells us (*Ess. of Amer.*, p. 289):

"Some of their poetical productions reveal a true and deep appreciation of the marvellous, the impressive and the beautiful scenes which their land and climate present. Prominent features in their tales and chants are the flashing variegated aurora, whose shooting streamers they fable to be the souls of departed heroes; the milky way, gleaming in the still Arctic night, which they regard as the bridge by which the souls of the good and brave mount to the place of joy; the vast, glittering, soundless snow-fields, and the mighty, crashing glacier, splintering from his shoreward cliffs the ice mountains which float down to the great ocean."

As an example of Eskimo appreciation of natural scenery, Dr. Brinton selects a song (from Kink's collection), dealing with the play of the clouds about Mt. Koonak (four thousand feet high), at Arsut, near Frederickshaab:

"I look toward the south to greet Mt. Koonak,
To greet Mt. Koonak there to the south;
I watch the clouds that gather round him;
I contemplate their shining brightness:
They spread abroad upon great Koonak,
They climb up his sea-ward flanks:

See how they shift and change,
Watch them there to the south,
How the one makes beautiful the other;
How they mount his southern slopes,
Hiding him from the stormy sea,
Each lending beauty to the other."

And yet the Eskimo have, very generally, been esteemed the lowest, perhaps, of all human races.

Another Eskimo lyric of nature was recorded by Dr. Franz Boas, while with the natives of Cumberland Sound. It is a "Summer Song," and was "composed by Oxaitoq, who, believing himself offended by some people, left the village and went on a long hunting trip inland. In the solitude of the mountains he gave vent to his feelings by this song" (*Journal of Amer. Folk Lore*, X., p. 114):

"Ajaja! It is pleasant, it is pleasant at last, the great world when it is summer at last.
Ajaja! It is pleasant, it is pleasant at last, the great world, when our caribous begin to come.
Ajaja! When the little brooks make a great noise, make a great noise, in our country in summer.
Ajaja! When the great water has spread over the ice, I cannot walk to the rock across there.
Ajaja! I feel sorry for them, I feel sorry for them, the gulls, for they cannot speak.
Ajaja! I feel sorry for them, I feel sorry for them, the ravens, for they cannot speak.

. . . .

I cannot obtain that kind of food, but I got the little sculpins quickly.
The old bad fox has found a smooth slope (of sand or snow), has found a smooth slope (in which to make his hole)."

As Dr. G. Brinton has remarked, "The priests were also close observers of nature, and were the first to discover its simple laws" (*L.C.* p. 43.) In all lands and among all peoples, their leisure, their seclusion, their meditation, their dances, rites and ceremonies, their prayers and prophecies, their poetry and symbolism, have often brought them much nearer to nature than the common folk. The worship of the dawn, the cult of the tree of life, "the rain-making" of the medicine man, the care of plant and animal oracles, the promotion of agriculture, hunting and fishing, and other duties that fell to the lot of the primitive priest, to say nothing of the determination of the feasts and festivals of the year, as social and religious institutions began to develop, demanded no mean acquaintance with the animate and inanimate phenomena of nature. Many of the names by which "medicine men" and priests are known among the lower race evidence the wisdom and the nature-lore they were supposed to possess. The Delaware Indians termed them "Snakes," and the natives of Chiapas gave the name of "serpents" to "one of their highest orders of the initiated." A synonym for "priest" with the Mayas of Yucatan, was *balam*, literally "jaguar," elsewhere they are likened to the owl and the prairie wolf (coyote). All this is summed up in the attributes of the "medicine man" of the Indians of Central Brazil, "who knows everything, is able to do everything, who can metamorphose himself into any creature or thing existing, who understands all languages and all sounds of forest, air, sea and sky." (Brinton, *L.C*, p. 351.)

Though the shamans of primitive peoples, like the priesthood of to-day among civilized races, are responsible for some of the veriest artificialities and trivialities of religion, they have, however, atoned for these a thousand times by the love of nature which their songs and dances have kept alive in the masses of the tribe and the true nature-feeling which constantly reveals itself in their prayers and invocations. The highest grace, beauty, truth of sentiment and expression are often to be met with among peoples whose social and political institutions still carry the *impedimenta* of barbarism or even of savagery. Following is a "house-song" of the Navajos, sung by an old shaman facing the east, just after sunset. (*Am. Anthr.*, VI., 353.)

"Rising Sun! when you shall shine,
Make this house happy,
Beautify it with your beams,
Make this house happy.
God of Dawn! your white blessings spread:
Make this house happy.
Guard the doorway from all evil;
Make this house happy.
White Corn! (the spirit of), abide herein,
Make this house happy.
Soft Wealth! (skins, blankets, etc.), may this hut cover much,
Make this house happy.
Male (heavy) Rain! your virtues send,
Make this house happy.
Corn Pollen! bestow content,
Make this house happy.
May peace around this family dwell,
Make this house happy."

Mr. Stephen further tells us: "After singing to the east, other songs are sung to the south, west and north. These are all in strains very similar to the first one, but as the Navajo assigns different groups of deities to each of the cardinal points, he petitions for different blessings from the different directions. Thus to the west he sings to a mountain deity that the yellow light of sunset may imbue his dwelling with its beautiful influence; that the spirit of yellow corn may sit in his hut;

that it may cover much 'hard' wealth, such as weapons, utensils, and silver and shell ornaments; that the 'young rain' (meaning mild showers) may fall around his dwelling. The heavy rain is regarded as the male rain, and the gentle showers as the female, and both kinds of moisture are deemed necessary to fertilize.

"Altogether thirty-two of these songs are sung, and their singing is so timed that the last one ushers in the first gray streaks of dawn, and the visitors (who have been enjoying the singing), then gather in their horses and ride home." (*Ibid.* pp. 353-354.)

Another prayer of a Navajo shaman has been recorded, and is thus described by Rev. S. D. Peet, whose *résumé* I quote. (*Inter. Congr. Anthr.*, 1893, pp. 196, 197.)

"This prayer might be called the journey of a soul after a body. It is a prayer which must be repeated at one time without cessation, and with great care to observe every part in its order. It contains a series of word-pictures, pictures of the unseen world under the material figures. In it the suppliant calls upon the divinities of the four mountains to come to him. There is a place of emergence referring to the story of the emerging of the people from under the earth.

"This place is guarded by Smooth Wind, but one of the war gods, Nagaynezni, with a black wind, a slayer of the alien gods, and Tobajischeni, the second of the war gods, a kinsman to the waters, with a blue wand, open the way for him. The passage is now through the chambers or houses of the clouds, the black cloud, the blue cloud, the yellow and the white clouds. The gods with the black wand and the blue wand lead the way. His passage is next through the chambers of the houses of the mists, the black mist, the blue mist, the white mist and the yellow mist. He arrives at the red river's crossing, an imaginary locality in one of the lower worlds. He then approaches the chambers of the mountains. First is the chamber of the black mountain, where the door is guarded by the red bear. Next the chamber of the blue mountains, which is guarded by the red serpent. The third is the yellow mountain where the red coyote guards the door. The fourth is the chamber of the white mountain where the red hawk guards the door. He comes to the entry of the red-floored lodge, which is the house of the woman, the chief of the witches. He enters and reaches the edge of the lodge, then the fire-place of the lodge, then the middle of the lodge, and finally the back of the lodge. Here he finds the spiritual body, which is held in the power of the woman chieftain. The feet, limbs, body, mind, dust, saliva, hair, are all recognized. The war god places the stone knife and the talking feather in his hand, turns around as the sun moves and says: "Woman chieftain, my grandson is restored to me. Seek not to find him; say not a word. We start back with my grandson; he is restored to me." They then go back to the middle of the lodge, to the edge of the lodge, through the entry of the lodge, the war gods, one with his black wand before, the other with his blue wand behind him; back through the chambers of the mountains, past the red hawk, the red coyote, the red serpent and the red bear. They cross the red rivers, they climb up through the white mist, yellow mist, blue mist and black mist, through the white cloud, the yellow cloud, the blue cloud and black cloud, to the house of white water, whose door is of daylight. Rainbows run in every direction and make the house shine with bright colors. They finally come to the medicine lodge, where the ceremonies and dances are conducted by gods, in the shape of the powers of nature, radiating white streaks, beautifully decorated with necklaces made of turquoise, coral and rare shells, embroidered dresses and many beautiful things.

"The poetry contained in this mountain chant is most remarkable and equals in some respect the poetry of Dante himself. The imagery is drawn from the mountain scenery, is filled with bright colors, and contains pictures of all the wild things of nature, strangely blended with thoughts of the supernatural beings.

"This wonderful chant is symbolized by the sand paintings which form an important part in one of the secret ceremonies of the Navajos."

Another great promoter of nature-lore among primitive peoples, equal often in power and effectiveness, is to be found in the secret societies in general, where rites and ceremonies, songs and sayings, abound in evidences of nature-observation and nature-feeling.

Dr. Washington Matthews, in his account of "Navájo Gambling Songs," says of those connected with the game of *Késitcè*, played only during the dark winter nights: "One old man, in reply to my question as to the number of songs sung in this game, replied that there were four thousand. Of course, this was an exaggeration, and intended to be understood as such; but the statement was designed to convey some idea of the great number that existed. Another Indian, an inveterate old gambler, who had made *Késitcè* 'the study of his life,' said that there was not a thing that walked or flew or crept or crawled in all the world (as known to the Navájos, of course) that had not at least one appropriate song in the game, and that many had more than one song. He further stated that it took him four years to learn all he knew." (*Amer. Anthr.*, Vol. II., p. 1.)

Dr. Matthews notes also: "The perfect uniformity with which they (songs) were repeated in most cases (by persons from widely distant parts of the country) and the close approach to uniformity in all other cases, was wonderful."

The game of *Kêsitcè* (hiding a stone in a moccasin) was originally invented and played by the primeval animals to settle the question whether it should be dark forever (as the night-animals desired it), or whether the sun should shine forever (as the day-animals wished). Around a huge fire they gambled until morning dawned and the animals fled to their several homes—the undecided game leaving the day and night alternating as at present, which seems to have been the original condition of things. Many of the animals bear on their bodies and limbs to-day marks whi date from the grand game of *Kêsitcè*: "The bear had lent his moccasins to be used in the game. They were therefore, partly buried in the ground. In his haste to be off, he put them on wrong—the right moccasin on the left foot, and *vice versâ*; this is why the bear's feet are now misshapen. His coat was then as black as midnight, but he dwelt on top of a high mountain and was so late in getting back to his lair that the red beams of the rising sun shone upon him, imparting their ruddy hue to the tips of his hairs, and thus it is that the bear's hair is tipped with red to this day.

"The home of the wood-rat, *létso*, was a long way off, and he ran so far and so fast to get there that he raised great blisters on his feet, and this accounts for the callosities we see now on the soles of the rat."

These are typical "observation-myths," of which, no doubt, hundreds could be obtained from this and other groups of songs.

Time forbids the citation here of more than the "Magpie Song":

> "The magpie! the magpie! Here underneath
> In the white of his wings are the footsteps of morning.
> It dawns! it dawns!"

and "the Badger Song":

> "Badger is lying down, badger is lying down,
>
> . . . .
>
> '*Waurr*,' [imit. of growl], he says, lying down;
> With a white streak down his forehead, lying down."

The poetic and onomatopœic names of the animals, the imitation by the singers of their characteristic noises and movements make an intensely interesting nature-study drama.

The totem-societies and animal-cults of many primitive tribes, in which the smallest and even the most insignificant actions of animals, birds, etc., are imitated in dance and ceremony with unvarying accuracy, and in which theparticipants are often masked and dressed to represent such animals, require even more detailed knowledge of animal life, habits and instincts, as recent studies of the animal-worship of the Pueblo Indians have abundantly shown.

The synonymy of animal-nomenclature and plant-designation in the songs and sayings which sometimes belong to the folk-speech, as well as to the language of the shaman or the initiate is worth careful study, and a dictionary of such names and nick-names would be fruitful both for psychology and for nature-study. In the "Magic Songs" of the Finns there is a surprising richness of these descriptive names. The *Bear* is called: The corpulent; hulking fellow; broad-forehead; claw-footed one; evil soot; scanty-haired one; shaggy; little shock; dark gray-haired one; tangled ball; little hay-stack; lovely shaggy coat; splendid coat of hair; blue stumpy-tail; honey-lover; honey-paws; cunning one; horror of the land. The *Cat* is greybeard; the *Dog*, woolly tail; the *Pig*, downward carried snout; the *Seal*, round boy. The *Wolf* has many names: *Dog*, woolly-tail, hairy foot, hairy-nose, windy-throat, gad-about, crafty one, etc. The *Snake* is denounced as: Crafty one; dread one; evil one; evil pagan; useless wretch; worm; worm of the earth; autumn worm; winter worm; Tuoni's (god of death) grub, —the *Viper* is striped back. The *Lizard* is styled: Hüsi's (devil) eye; fresh water herring on land; water-sprat; courtyard sweepings; ground sweepings; sweepings of Monala (god of death). The *Raven* is: Devourer; bird of three Lempos (devils); the *Pike*, water-monster: the *Wasp*, evil bird. The *Oak* is named God's tree; the *Fir*, bushy top, honey-moist, honey-top (*Folk-Lore*, Vol. I., pp. 30-36, 37-45, 331-336, 342-344.)

In the secret languages of the angakok among the Eskimo and the shamans or sorcerers of North Siberian tribes, many much more complicated and suggestive names are employed to keep the knowledge of the creature invoked or besung from the ears of the people, riddles and like subterfuges being frequently resorted to to refrain from direct divulgence. Primitive poetry, like that of the Arabs and other Oriental peoples, abounds in synonyms, and innumerable names are lavished upon things animate and inanimate, all perceptible qualities being exploited, and then the rich imagination of the bard given free rein. Here many points of contact with the slang of the criminal and lower classes, whose profusion of synonyms is well-known, may be noted, also certain striking resemblances to the languages invented by children, concerning one of which Mr. Newell observes: "A group of children invented the *cat language*, so-called because its object was to admit of free intercourse with cats, to whom it was mostly talked, and by whom it was presumed to be comprehended. In this tongue the cat was naturally the chief subject of nomenclature; all feline positions were observed and named, and the language was rich in such epithets, as Arabic contains a vast number of expressions for *lion*." (*Songs and Games*, p. 25.)

The participation of animals, birds and insects, in fact all animate and inanimate things in the creation of man, each giving him some mark or quality, each endowing him with a special characteristic or a useful organ, is a frequent occurrence in primitive myths, paralleled only in interest and significance by the many transformation legends and evolution stories by which man is evolved in some fashion from lower animals, a form of belief very widespread among the lower races, who couple with it often the myth that in the first days of earth all beings—men, animals and even trees spoke one common language, which, when the great culture-hero departed, was all-too-soon misunderstood and forgotten.

In the names they give to plants and animals, the lower races of men have crystallized much evidence of interest in, and appreciation for, the ways and means of nature. What could be more expressive than the Fanti name for "a small plant like the *Forget-me not*, with pale blue flowers, which grows very quickly and spreads"—*tutu muroko kohwe èpù*, "Run, I am going to see the sea!" (*Journ. Anthrop. Inst.*, *1896*, p. 141). Or the Arabic name, current in Central Africa, of the *Macrodypterix longipennis*, "father of four wings," because "as it chases the mice, it looks as though it had a couple of satellites in attendance!" With what fitness the Winnebago Indians style fire-flies *wa-ru-ha*, "the movers!" And it is interesting to learn that: "Certain roots, for example Indian potatoes (probably a species of *Ipomœa*), and Indian turnips (*Psoralea esculenta*), used by the Indians as food, are not dug during the summer months, the time when the fire-flies happen to be seen. The Indians say the roots are 'moving' at this time, and should be left unmolested." (*Schweinfurth*, Vol. I., p. 357; *Journ. Amer. Folk-Lore*, Vol. IX., p. 54.)

The inventions of primitive peoples and their arts,—mechanical devices, use of fire, stone-working, pottery, the subjugation and domestication of plants and animals, the textile and related industries, travel and transportation, etc., reveal a wide and deep acquaintance with the characteristics of animate and inanimate nature, as may be read in Prof. O. T. Mason's interesting volume on the "Origins of Invention," and the thorough-going researches of Prof. W. H. Holmes and Prof. A. C. Haddon on the "Evolution of Art" and "Ornamentation." The chief facts can be read there; a point or two of illustration must suffice at present.

Of the 150 species of indigenous plants in the environment of the Moki Indians, of Arizona, Dr. Fewkes tells us they have become acquainted with 144 as follows: "Agriculture and forage (not cultivated), 11; arts, 16; architecture, 4; domestic life, 10; dress and adornment, 6; folklore, 10; food. 40; medicine (folk and empirical), 29; religion, 18." (x. 43.) The Moki national flower is the *Castilleia linariæfolia*, called *wupàmansi*, "great girl flower, because of its being worn by the young maidens of the tribe."

Concerning the Micmacs of Nova Scotia, Rev. S. T. Rand, who knew them passing well, observes (*Leg. of Micm.*, p. 40): "But they are also versed in other subjects. They have studied Botany from Nature's volume. They know the names of all the trees and shrubs, and useful plants and roots in their country. They have studied their natures, habits and uses. They have killed, dissected and examined all the animals of North America, from the *nestugepegajit* to the *gulwakchech* (from the buffalo to the mouse). They have, in like manner, examined the birds and the fish. They are, therefore, somewhat acquainted with natural history."

The exactness and range of knowledge of natural phenomena by primitive peoples, have long been moot subjects for discussion.

Dr. Boas and other writers, who have treated of the 'decorative art" of the Indians of the northwest coast-of America, have remarked the variety of symbolic expression and the wide range of natural objects covered. Prof. Haddon says of the art products of the South Pacific Islanders: "The diversity of animals is also noteworthy. Nearly every great group of animals is represented in native art, and often so faithfully, that it is possible for the naturalist to give the animals their scientific names." (*Evol. of Art*, p. 15.)

In invention-origins, the world of nature lies very close indeed to man. Says Prof. Mason in the brilliant essay in which he tells what the earth, the first university, has done and is doing for man: "Among the animals, there is scarcely one that has not obtruded itself into the imaginations of men and stimulated the inventive faculty. The bears were the first cave-dwellers; the beavers are old-time lumberers; the foxes excavated earth before there were men; the squirrels hid away food for the future, and so did many birds, and the last named were also excellent architects and builders; the hawks taught men to catch fish, the spiders and caterpillars to spin (and make nets), the hornet to make paper, and the cray fish to work in clay." (*Amer. Anthr.*, Vol. VII., p. 144). It might be added that the first bridge was a fallen tree, the first elevator a climbing vine, the first fish-hook a thorn, the first cup a leaf, a fruit-rind or a shell, the first knife a stone. The mythology and folk-lore of invention are full of data of nature-study, its variety is inexhaustible, its range is infinite. Take house-building for example. The Chinese, who, alone of civilized nations, with a great literature, are evolutionists in their tale of human history from its low beginnings, report that the first men, from observation of the birds, built nests-houses in trees; the Ojibwa says that after the great Deluge had subsided, Manabozho, the culture-hero of the Algonkins, learned to build the first hut by observing how the muskrats constructed their houses In the opinion of the Navájos of Arizona and New Mexico: "The gods are said to have made the first hogan in the form of a dome; from east to west it was spanned with rays of morning and evening sunlight, and from north to south with the arching beams of the rainbow. The Navájo still maintains the form of this mythic hut, and the peculiar virtues deemed inherent in the primal elements and the blessings of the gods who made the first dwelling, are still invoked in their 'house-songs.'" (*Amer. Anthr.*, Vol. VI., p. 351.)

Need we wonder that every Navajo "house-warming" is a model lesson in nature study.

Folkard in his volume on "Plant Lore, Legends and Lyrics," Fergusson in his "Tree Worship," Hartland in his "Legend of Perseus," and Frazer, in his "Golden Bough," have shewn the vast influence which vegetative life has exerted over all human institutions. Here we shall limit ourselves to the consideration of plant-symbolism in proverb and in folk-speech.

In Polynesia the tree is a source of the most sacred figures and turns of speech.

In Polynesian words for God the idea of *life* is prominent. Throughout Eastern Polynesia the term for God is *atua* (*akua*), which, according to Mr. Gill, is derived from *atu*, "core, kernel":

"As applied to a 'master' or 'lord,' the term suggests that his favour and protection are essential to the life and prosperity of the serf. By an obvious analogy, the welfare of mankind is derived from the divine Atu' or 'Lord,' who is *the Core and Kernel of humanity*. In the nearly related word 'Atua,' *God*, the final *a* is passive in form but intensive in signification, as if to indicate that He is 'the *very* Core of Life' of man. A person who, at a critical moment has lost courage, is said to be 'topa i te io,' *i.e.*, *forsaken by his god*,—that divine something which imparts courage to fight or to endure." (*Myths and Songs of S. Pacific*, pp. 33-34).

This view of the meaning of *atua* is strongly supported by the analogy of *io*.

"The word 'io,' commonly used for 'god,' properly means 'pith' or 'core' of a tree: What the core is to the tree, the god was believed to be to the man. In other words, the gods were *the life* of mankind. Even when a worshipper of Motoro was slain in fair fight, it was supposed that the enraged divinity would, by some special misfortune or disease, put an end to the offender. Most appropriately and beautifully do the natives transfer the name *Io ora*, or *The living god*, to Jehovah, as *His worshippers never die!*" (p. 28.)

We learn further (p. 10):

An analogy was believed to exist between the pith of a tree and the umbilical cord at birth. Hence the expressions, 'ara io,' *i.e.*, 'pathway of the pith,' or simply 'io,' *i.e.*, 'pith,' as still used for 'God.'

Among the phrases and terms due to the atmosphere of vegetation in which the Polynesians live are, according to Mr. Gill:

Rauiki Nui, "ocean," lit. "the-vast-outspread-plantain-leaf." (p. 18.)

Pua ua mai, "*Bud forth* or *blossom*," as of a tree. Used in speaking of the beginning of the world. (p. 21.)

Mei tupua roa mai. "In the phrase 'mei *tupua* roa mai' (the essential part of which is 'tupua'), the sense is '*from the very beginning*,' *i.e.*, from the time when things first began to '*tupu*,' 'grow' or 'happen.'" (p. 34.)

E rimua ua atu. "The word 'rimu' means *moss*; 'rimua,' '*moss-grown*, the final *a*, as in the word 'Atua,' being intensive. Thus it comes to pass that '*eternity*' or '*for-ever*' is expressed by the phrase 'e *rimua* ua atu'—the essential part of which is 'rimua.' The idea is of a lofty tree covered all over with moss, the growth of untold ages. So that the phrase might be rendered, '*until covered with the moss of ages,*' *i.e.*, for ever and ever." (p. 34.)

"A still more interesting plural is '*rau*,' 'leaf.' Thus we may speak of 'te *rau* tangata o te Atua,' *i.e.*, a 'people *numerous as the leaves of a tree*, worshipping such and such a god.' The figure is of a vast tree, the growth of ages. The huge trunk represents the god, the branches the lesser divinities, the leaves the worshippers—ever dropping off by death and ever being renewed by fresh births. This is constantly applied to the servants of the true God: Jehovah being the trunk and branches, believers the leaves." (p. 323.)

"The last instance of plurals is '*maru*,' 'shadow' or 'shade.' Thus the natives daily speak of 'te *maru* tangata o te Atua,' *i.e.*, '*the people who sit under the shadow of God.*' The old idea was still of an ancient tree overshadowing the marae filled with worshippers. The noblest trees affording the best shade were planted in their idol groves, not a twig of which might be plucked. As applied to Christian worshippers gathering Sabbath after Sabbath under the shadow of the Almighty (Ps. xc. 1), the figure is extremely beautiful." (p. 323.)

"In allusion to the myth of the *bua* tree, a person who has been very ill and yet has recovered will even now playfully say, 'Yes, I have set a foot upon a branch of the *bua* tree, and *yet* have been sent back (by God) to life." (p. 165.)

The calendars of savage and barbarous peoples are full of interest from the point of view of nature-study, the names of the seasons and the months (where such exist), evincing not seldom penetrating knowledge of environment keen observation of atmospheric and celestial phenomena, deep acquaintance with processes of vegetable life, and the instincts and habits of animals, birds, fishes, insects, etc.

For our Aryan ancestors *spring* was "the time of the springing of young shoots out of the ground" (English spring), "the lengthening of the days" (German *Lenz*), "the time of increasing brightness" (Latin *ver*); *Summer* was "the warming up season," "the time of burning heat" (Latin *æstas*); *Autumn* was "the season of increase" (Latin *autumnus*), "the harvesting time" (German *Herbst*), "the time of the falling leaves" (English *fall*); *Winter* was "the white season" (English *winter*), "the snowy (stormy) season" (Latin *hiems*). These terms can be paralleled in the speech of hundreds of primitive tribes and they cover a wide range of thought and imagination. This is readily seen if we study for a moment the words for, say, "spring" and "winter" in certain American Indian languages.

In the Nootka language, of Vancouver Island, "spring" is "the sprouting season"; with the Kootenays of South-eastern British Columbia, "the time when the snow leaves", with the Ojibwa, of the region about the Great Lakes, "the time when the water is good (*i.e.*, for navigation)." To the Nootkas "winter" is "the season when everything is clean"; to the Kootenays it is the "time of snow and rain"; to the Athapascans the time when "the snow is on"; to the Klamaths of Oregon, "the season of fogs." The Nanticoke Indians of Virginia call *summer* "the great (long) light," and *autumn*, "the little (short) light." Some primitive peoples (*e.g.*, many of the tribes of North America) count their *years* by *winters*, while others (like the ancient Iranians, Hindus, Armenians, of our own race) count them by *summers*, both methods surviving with the poets who so often retain or re-coin the thought and word of primitive man. A volume might be written on the lore and symbolism of the seasons,—three sometimes, and not four, as with us and with other peoples in whose thought the winds of the cardinal points ruled the round of the year,—and the modifications which changing environment, social phenomena, and poetic imagination have brought about in their original designations.

We, whose almost colorless month-names—since we abandoned the naïve expressive terms of our Saxon forefathers—have been taken over bodily from Latin, do not possess, in this part of our vocabulary, the rich nature-feeling of the primitive races of men, who used all their art and skill in naming the various "moons" into which the cycle of the year was divided. Two only of the Roman month-names tell of nature-study—*Aprilis*, "the month of the opening earth," and *Maia*, "the month of growing things,"—but the month-names of many of the lower races immortalize the greening earth, the singing, nesting and breeding of birds, the travels, rests and activities of animals, the blossoming of plants and the ripening of fruit, the murmur of the waters, the war of the elements, the fetters of snow and ice, the presence of the gods.

Of the month-names of the Carrier (Déné) Indians of British Columbia five refer to the coming and going of fish (carp, salmon, trout, white-fish), while their neighbours, the Tsé'kehne, have commemorated the arrival of the golden eagle and the wild goose, the taking of the goslings to water, the coming of the black bear, the rutting of the buffalo, and the "growing thin of animals." The Haidas derive three of their month-names from the arrival of various species of geese, note the coming and going of the bear and two varieties of salmon, and have, besides, two months named from the ripening of berries and one from the blossoming of flowers. The Shushwap, of British Columbia, have a grass-month, a root-digging month, two berry months, two salmon-months, and a month named from the travelling of deer. Their immediate neighbours, the Kootenays, have no fewer than four months named from the ripening of berries, and notice, besides, the appearance of the black bear with its young, the rutting of the white-tail deer, the falling of the leaves, the rising of the rivers, the breaking open of the ground.

The Ojibwa name one month from fish (sucker), three from berries (strawberry, raspberry, blueberry), one from wild-rice, one from flowers, one from falling leaves, and one from the appearance of the crust on the snow. Their neighbours to the northwest, the Crees, name six of their months from observation of birds,—(May, June, July, August being respectively "month when the birds lay their eggs"; "month when the young break out of the shell"; "month of moulting"; "month when the young birds take to flight,") one from the frogs, and one from the rutting of animals. The Delaware Indians remember in their month-names the coming of the chipmunks out of their holes, the croaking of the frogs, the arrival of the shad, reddening of the deer, the abundance of honey-bees, the turning gray of the deer, the falling of the leaves, and the crackling of the trees with the winter's cold. With the Dakotas three months are named from the ripening of berries and fruits, two from rice, while one notes the arrival of the raccoon, another the rutting of deer, a third the shedding of their horns, and a fourth the prevalence of sore eyes. The Onondagas, one of the Iroquois tribes, name no fewer than four of their months from the length of daylight, three from the condition of the leaves of plants and trees, two from the condition of the fur of the deer, and two from the presence of cold weather.

Of the eighteen months in the calendar of the Quiché Indians of Guatemala, ten have more or less distinct reference to plants and plant-life, while the Tzentals, a cognate people, derive thirteen of their month-names from the same source. The Mayas, of Yucatan, and the Indians of Chiápas, each have named five of their eighteen months from observation of the condition of the weather. What a range of nature study we have here! The beginnings of all the sciences have been trenched upon. Some of the month-names are commemorative of man more than nature. The Haidas used to call December "the moon when it was too cold to sit down to relieve one's self"; the Tsilkoh'tins (Déné) termed November "the month of entering the subterranean huts," and March "the month of leaving the subterranean huts"; to the Shushwaps December was "the month of remaining at home"; and with the semi-civilized peoples of Mexico and Central America the recognition of man's activities, rites and ceremonies tended more and more, as with the ancient Romans, to obscure or to supersede the older month-names, which had originated from direct observation of nature animate and inanimate. Of course, with primitive peoples, the line of demarkation between moon and moon is not fixed like the laws of the Medes and Persians. What Mr. Riggs says of the Dakotas will stand for other tribes as well: "The Dakotas have often very warm debates, especially towards the close of the winter, about what moon it is. The raccoons do not always make their appearance at the same time every winter (February); and the causes which produce sore eyes are not developed precisely at the same time in each successive spring (March). All these variations make room for strong arguments in a Dakota tent for or against *Wicata-wi* (February) or *Istawicayazan-wi* (March)."

Much of the best nature-study of primitive peoples is no doubt contained in such debates and in the legends and poems recited about the lodge-fire or at the summer camp. But many tribes have felt that there are certain times of the years when nature and the gods are indisposed towards the mythopœic and the mythophoric art. With the Omaha Indians winter is the favourite season for story-telling, there being "a superstition which prevents the telling of stories in the summer season, as the snakes may hear and do mischief,"—the children, however, "carry the songs out among the summer blossoms, and the snakes do them no harm." (*Journ. Amer. Folk-Lore*, I., p. 120).

Of *day* and *night* little can be said here. *Day* is quite often "sun," *night* quite often "sleep,"—*morning*, "little sun," *afternoon* "big sun," with primitive peoples in their measurement of time. Occasionally we meet with a strange or naïve poetical turn of phrase, as *e.g.*, when the Tlingit of Alaska style *morning* ts'o tat, "blue night," or when the Tupis, of Brazil, call *evening*, "time of sadness." It is worth noting also—a relic of the old custom survives in our *fortnight*, *sennight*, German *Fastnacht*, *Weihnachten*—that our Aryan ancestors counted by "nights" and not by "days." This is probably why all the great Indo-European languages have a common word for *night*, but differ considerably in their terms for *day*. The profound influence of night with its moon and myriad stars is noticeable everywhere, though in extremely varying fashion.

The conquering of night and the bringing of day are tasks which the heroes of folk-tale and myth accomplish in a thousand differing ways. It is, however, a very common belief among primitive peoples that in the beginning it was altogether night or continual day, and it is a most interesting fact that so many of the lower races, the American Indians especially, fable that the present alternation of light and darkness is due to some chance-game of the gods, some celestial gambling in which day and night were the stakes, the result being usually a compromise. In the bringing of light or the keeping of darkness, the culture-animals and birds largely figure.

It was eternal night, say the Polynesians, until sky was riven asunder from earth and the broad daylight streamed through. Mankind, according to the legends of many primitive peoples, dwelt in the beginning in gloomy caves, or subterranean worlds, whence by sudden emergence, or by slow passage from stage to stage they reached the realm of light.

The dawn-myths and the dawn-lore of all races of men are of intense interest and even among savage races often of incomparable beauty. The morning-red, the first beams of the returning sun, have been glorified by untold thousands of folk-poets of whom no remembrance but the word they coined now survives. The Quiché Indians of Guatemala say for "it is beginning to dawn," *ca xaquin vuch*, *i.e.*, "now the opossum spreads his legs"; the Delaware *machka jappan* is the exact equivalent of the familiar "the sky is ruddy in the East"; the Algonkian *pita-ban* "the ruddy light is coming this way," really sums up the lines of Horatio in Hamlet:

> "Look, the morn in russet mantle clad,
> Walks o'er the dew of yon high eastern hill."

Very primitive peoples speak as we do of "the dawn of intelligence," for all over the world light and knowledge have been deemed to be like or even one and the same thing.

The Omaha Indians have expressed this idea very beautifully indeed in their puberty-lore.

Some of the sterner and more exciting of the operations of Nature have appealed to the primitive mind, even when least expected. Of the Mojos Indians of Bolivia, Herndon (*Amazons*, Vol. II., p. 237) tells us:

"The Mojos Indians have a natural fondness for painting the human figures and representing birds and animals, particularly the common chicken and the cow. The latter seems to have made a deep impression upon them at first sight. They often paint the cow fighting or chasing a man. These Indians describe the novel sights. I have not seen a single painting of an Indian or an animal which originally belonged on this pampa. The white man, the cow and chicken cock are their favourite studies. On the white walls of their houses, inside and out, such figures appear as a decoration. In the rooms of the government houses the best artist displayed his talent, and those drawings on the walls of the market place are admired by all who go there. So much taste and caution have the boys and little children, that none of them are known to disfigure any of these paintings in the public market-place.

"The Indians of Cuzco have had some of the most beautiful, large and costly paintings hung before them in the churches of that ancient city. The Church encourages this taste; yet we saw nothing there like what we find among these people who have never had lessons set them, and the natural scenery here is less calculated to draw upon the imagination. The whole country is a dead level: the view only extends to the horizon, the sky above, and one continued sheet of herd-grass below.

"The Mojos Indian makes a scene for himself, and describes it with coloured paints. On a windy day he strikes light and puts fire to the dry prairie-grass. As the wind carries the fire swiftly along, and the sheets of blaze shoot up under the heavy cloud of smoke, the Indian sketches the effect produced upon the cattle, who toss their tails into the air, and rush in fear with heads erect at the top of their speed in an opposite direction to that from which the wind comes. He decorates the inside wall of his house with this scene, which is a common one on these prairie lands."

Nor are primitive peoples unobservant of the gentler, serener aspects of Nature. Poets of all races and all ages have sung of the

> "Stars of morning, dewdrops which the sun
> Impearls on every leaf and every flower,"

and it would be strange indeed if the languages and legends of the uncivilized races of men had nothing to say of the dew. Classical myths tell of the rosy-fingered Eos, goddess of Dawn, weeping over the loss of Memnon, her son,—the dewdrops on the grass are her unremitting tears, and from them are born all the flowers upon earth. The natives of the Samoan Islands, in the South Pacific, call the dew-drops the tears which the Heaven-God, father of all things, nightly lets fall upon the bosom of Earth, mother of all, from whom he was torn asunder in the long ago. Among the deities of the Mayas, of Yucatan, were *ah ppua*, "the Master of Dew," and *Itzamna*, "the Dew or Moisture of the

Morning," who seems to have been "the chief of all the (benevolent and) beneficent gods," the creator of all things, and the general culture-hero of the race.

In the creation-myths of the Zuñi Indians we meet with *Paiyatuma*, "the God of Dew," at whose touch the all-nourishing corn received its form and proportion (Cushing, *L. C.*, p. 393), and "an ancient people of the Dew," who are termed "Drinkers of the Dew of Grasses," because, in their long search for water they "drank dew from their father (Paiyatuma), like deer on the mountain" (p. 398). Very poetic indeed is the concept of the Dew-God "touching the plants with the refreshing breath of his flute" (p. 395), as he came at dawn from the East-land. It was Paiyatuma who taught the Zuñis "the customs and song of the planting (of corn)," and when his work was accomplished he disappeared from the sight of men in "the gray mists of the morning" (p. 447). Such thorough-going recognition of the power and function of dew is most remarkable.

The health-giving, health-restoring properties of morning dew were known to primitive peoples ages before Father Kneipp's brigades of barefoot enthusiasts trod the grass at sunrise in the city parks. Among savage and barbarous races the first and most efficacious lustration of the new-born child is often its bath of morning dew, and in peasant Europe "going to meet the dew" is one of the last of the old May-Day observances to survive, the belief having not yet died out entirely that "washing the face in May-dew," will render one beautiful all the year round. The use of dew as "holy water," Dr. Brinton points out, was in vogue among the Mayas, the sacred objects in the temple and the worshippers being sprinkled with "dew gathered at dawn from the leaves." (*Myths of New World*, p. 148.)

As an example of the way in which primitive peoples carry out curious lines of thought to unexpected conclusions, we might cite the word *tchitchtok*, in the language of the Klamath Indians of Oregon, "curly-haired," because the ringlets "recall the round shape of the dew-drops." In certain primitive tongues (*e.g.*, Yoruba, *iri*, "dew, mist") the same word signifies at once "dew *and* mist," and this suggests one of the earliest forms of the nebular hypothesis in the cosmologies of the lower races. According to a myth of the Apache Indians, recorded by Capt. J. G. Bourke (*Journ. of Amer. Folk-Lore*, III., p. 109), after the world had been created by the elemental gods, Ika-esh-kin, "the Child of the Dawn," came and "threw out water upon the world; it became a fog, and, descending upon the land, made all to grow, and fruits, trees, etc., came forth in the four quarters of the earth." Mist, haze and fog play a most important rôle in the remarkable creation-legend of the Zuñis, obtained by Mr. Cushing. "In the beginning of the new-made," we are told, "Awonawilona (the Maker and Container of All, the All-father Father) conceived within himself and thought outward in space, whereby mists of increase, steams potent of growth, were evolved and uplifted" (p. 379). Later on the "warm breath of Mother-Earth blew the white flecks of foam off the primeval waters, so that, meeting the cold breath of the Sky-Father, they fell down in gentle mist and spray, whence came all life" (p. 380.) Out of the mist of the beginning all things that are have really been developed by a sytem of Evolution which Mr. Cushing thus outlines: "The universe is supposed to have been generated from haze (*shi-wai-a*) provided by Light (of the All-Container, Sun-Father) out of Darkness. The observed analogy of this in nature is the appearance of haze (both heat and steam) preceding growth in spring-time; the appearance of the world, of growing and living things, through mist seemingly rising out of the darkness each morning. In harmony with this conception of the universe is the correlative one, that every being (as to soul at least) passes through many successive stages of becoming, always beginning as a *shi-u-na hâ-i* (haze being), and passing through the Raw or Soft (*K'yá-pi-na*), the Formative (*K'yái-yu-na*), Variable (*thlim'-ni-na*), Fixed or Done (*ak'-na*), and Finished or Dead (*â-shi'-k'ya*) states; whilst the condition of the Surpassing Beings (gods) may be any of these at will (*i'-thlim-na*, or *thlim'-nah-na*, etc.) There are many analogies of this observed by the Zuñi, likening as he does the generation of being to that of fire with the fire-drill and stick. The most obvious of these is the appearance, in volumes, of 'smoke-steam' or haze just previously to ignition, and its immediate disappearance with ignition. Further, the succession of beings in the becoming of a perfect being may be regarded as an orderly personification of growth phenomena as observed in plants and seeds, for example, in corn, which is characterized by no fewer than thirteen mystic names, according to its stages of growth." (*Journ. Amer. Folk-Lore*, V., p. 50.)

Out of the "hazy steam-growing world" of *Shi-u-na*, come newborn babes to men, and into the "mist-enshrouded world" of *Shi-po-lo-a* sink the aged in their second childhood.

Of the "Mountain Chant," Rev. S. D. Peet thus speaks (*Loc. cit.*, p. 197):

"This chant describes the adventures of a Navajo hunter who was taken captive. He wandered about the mountains in his efforts to escape and get back to his home. It describes the wonderful adventures, which can be compared only to the journey of Virgil through

Tartarus, or Dante and Beatrice through the infernal regions. The rocks open by magic power, and he passes in and out again. Trees rise heaven high and land him on top of the mountains. Mountains sink and rise again, chambers appear. The wind storms and tornados come with rushing noise, the air is filled with logs and uprooted trees, but the tempest recognizes him and subsides. Serpents show signs of great anger, shake their rattles violently, thrust out their tongues, but they do not bite.

"After passing dangers of this kind, they come to the houses, the homes of the lightning gods, where the birds flash lightning from their claws. They come to the house of the butterflies, filled with butterflies and rainbows; also to the house of the squirrels, which is built of black water, with a door of red sunbeams; the house of the porcupine gods, where the door is of wind; a house of rock crystal with a door of all sorts of plants; a house of cherries with a door of lightning; a house made of dew-drops, on leaf mountain, whose door is made of plants of different kinds; through the place of emergence, along the coyote race-course, past the two hanging gourds, by the brown pinnacle and the breeze under a tree, until he sees his lodge and the trails that lead to it, and the broad field beautified with corn. Here two other divinities, Haschayon and Haschayalti, who were peaceful and beneficent gods of the Navajos, appear, one with a white wand, and the other with a blue, and lead him through the trails and across the fields to the entry of his lodge made of the daylight. They then pass through the edge of the lodge to the fire-place, to the middle of the lodge and the back of the lodge, where they all sit down on the floor of the lodge, where the feet, limbs, body, mind, dust, saliva, hair, are lying. The shaman exclaims: 'I have returned to my feet, my limbs, body, mind, dust, saliva, hair; and my feet are restored to me, my limbs, my body, my mind, are restored to me. The world before me, behind me, below me, above me, all things around me, are restored in beauty. My voice is restored in beauty. It is restored in beauty, in beauty, in beauty, in beauty.'

"Mother Nature"—what a world of meaning lies in that simple phrase! The poets and philosophers of all times and all races have seen fit to call "mother" the life that throbs in all existent things, the mysterious force whose "perpetual presence" fills the universe and gives birth to all that therein is of motion, act, thought, love. Even the most savage peoples have something of this feeling, and with some of the lower races air, sea, earth, mountain, river and forest, sun, moon and star, are baptized again and again with mother-names, making primitive lyrics and myths registers of the universalism of motherhood, in which are canonized the sympathetic, the gentle, the life-giving phenomena of nature, whose likeness to "the eternal womanly" appealed in endless variety to the fertile imaginations of the earliest tribes of man. In this interpretation of the "realm of orderly mystery" as Huxley so felicitously termed the phenomena of life, some of the best and most inspiring thoughts of primitive religions find their origin.

No aspect of nature seems unregarded. Countless peoples have adored "Mother Earth," "Mother Sea"; ancient Peruvians worshipped "Mother Moon," the Yuchi Indians "Mother Sun"; to the Armenian peasant Mount Ararat is "Mother of the World," and the Hindu has his "Mother Ganges"; in Bengalese folk-tales "Mother Forest" appears, and "Mother Corn" is known alike to the Tusayan Indians and to the Pawnees. That in the rites and ceremonies of these mother-worshipping races evidence of a sympathetic attitude towards, and a keen observation of, nature abounds goes without saying. And the aesthetic element in this province of early nature-study is often very large. Hear, *e.g.*, what Mrs. Stevenson says of the cultivation of corn by the Zuñis, one of the Pueblos tribes (*Loc. cit.*, p. 316):

"Every colour and shade of corn may be found, these primitive agriculturists having observed the greatest care in the development of varieties. The reds range from the richest cardinal to the faintest blush of pink, and a similar variety of shades runs through the blues, yellows and purples. They have pure white and black, and the variation in the original ears is remarkable. Almost the same variety of colour is found among the beans. All their care of propagation has a religious significance."

But this influence of religion upon the attitude of primitive peoples towards nature is by no means confined to the plant-world. There is much truth in the observation of Mr. E. Goadby that "the diminutiveness of the Hindu cow may be as much due to the legislation which has made it sacred as to the climate of Hindustan." (*Nature*, I., 648.)

Agriculture, indeed, is responsible for some of the noblest thoughts of primitive religion springing from the observation of plant-life.

I know of nothing nobler in all primitive literature, few things nobler in all literature, than the song which Paiyatuma, the Zuñi god of dew, addresses to the awed watchers who have noted his coming from the East, and his forming of the corn (p. 395):

"Lo ye children of men and the Mother,
Ye brothers of seed,
Elder younger,
Behold the *seed of all seeds!*
The grass-seeds ye planted in secret,
Were seen of the stars and the regions,

Are shown in the forms of their tassels !
The plumes that ye planted beside them,
Were felt in the far-away places,
Are shown in the forms of their leaf-blades !
But the seed that ye see growing from them,
Is the gift of my seven bright maidens,
The stars of the house of my children !
Look well, that ye cherish their persons,
Nor change ye the gift of their being,--
As fertile of flesh for all men
To the bearing of children for men,--
Lest ye lose them, to seek them in vain !
Be ye brothers, ye people, and people :
Be ye happy, ye priests of the Corn !
Lo ! the seed of all seed-plants is born !"

"Nature's crown is love," said Goethe, in those pæans which he raised to the mother and soul of all things, and with primitive peoples, no less than with our own race, the prelude to adolescence and manhood is a season of deep and intimate communion with Nature. Miss Alice Fletcher, writing of "Love Songs among the Omaha Indians," observes (pp. 156-7):

"As the tribal organization reduced the personality of a man to the minimum, any evidence of the activity of the vital principle of individuality becomes exceedingly valuable wherever found, and these love songs present such evidence.

"In them we discern the freer use of tonality, for tonality permitted a greater play of personal feeling than could be obtained through strong rhythms, however complicated; their flowing cadences voiced a longing that had made the youth conscious of his own individuality, of his distinctness from the mass of men in his gens.

"This dawning consciousness of his individuality in the longing for something not his own—an ideal, if you will—vindicated the stirring of the principle of personal freedom to choose and to act.

"Although there is a marked subjectivity in the music, there is also a concentration of feeling and purpose, and at the same time a reaching-out toward nature, a taking into his confidence of the woods, the birds, and the sunlight, in the joy of his own experience. The few words in these songs convey the one poetic sentiment: 'With the day I come to you'; or 'Behold me, as the day dawns.'"

Nor is the night forgotten. In the Matagalpan language, of Nicaragua, the lover can say to his sweetheart: *Maniji yalaca aycu caridi.* "Thou art beautiful as the moon."

The following brief song, composed in this language by a youth of Cacaopera, contains a sentiment familiar to all (Brinton, *Essays of an Americanist*, p. 408):

"In this beautiful field,
Where many birds sing,
There lives a girl,
For whom I am dying."

The highest l mit of primitive love and nature lyrics is reached in the songs of the ancient Mexicans and Peruvians, who were true lovers of nature and no mear poets.

Even the Minnesänger or the best lyrical poets of to-day could hardly excel the idea embodied in this Aztec song:

"On a certain mountain side,
Where they pluck flowers,
I saw a pretty maiden
Who plucked from me my heart.
Whither thou goest,
There go I."

Following is "The Song of the Salmon Fishing," sung to C. E. S. Wood, in 1877, by a niece of a chief of the Tlinkit Indians of Alaska. (*Century*, Vol. 24, p. 338):

"Why is the young man sorrowful?
Oh! why is the young man sad?
Ah-Ka. His maiden has left him.
The long suns have come.
The ice now is melting;
Now comes the salmon,
He leaps in the river,
In the moon's gentle twilight
He throws up a bow—
A bow of bright silver.
Lusty and strong he darts through the water,
He sports with his mate;
He springs from the water.
All the dark season
He has lain hidden.
Now he comes rushing,
And ripples the river.
Purple and gold, and red and bright silver,
Shine on his sides and flash in his sportings,
How he thrashes the net!
How he wrenches the spear!
But the red of his sides
Is stained with a redder:
The maid of the young man leans o'er the salmon.
White laugh her teeth,
Clear rings her laughter;
Which passes canoes all busy and happy,
Which outstrips the noise of the many mixed voices,
And pierces the heart of her sorrowful lover.
She has forgot him,

She joys with another.
All for another she chases the salmon,
Ah-Ka. Your sweetheart has left you.
So do they jeer him,
Ah-Ka—your sweetheart is here at the fishing!
Ah-Ka—how like you this gay salmon season?"

In a love-tale of the Wabanaki Indians, of Maine and New Brunswick, occurs the following beautiful song (Reade in Proc. Roy. Soc. Can., 1887, p. 6):

"Come, my loved one, let us go up that shining mountain, and sit together on that shining mountain; there we will watch the beautiful sun go down from the shining mountain.
There we will sit until the beautiful night-traveller (*i.e.*, evening star) arises above the shining mountain: we will watch him, as he climbs to the beautiful skies.
We will also watch the little stars following their chief.
We will also watch the northern lights playing their game of ball in their cold, shiny country.
There we will sit on the beautiful mountain, and listen to the thunder beating his drum.
We will see the lightning when she lights her pipe.
We will see the great whirlwind running a race with squall.
There we will sit, 'till every living creature feels like sleeping.
There we will hear the great owl singing his usual song, *teeg-lee-goo-weul-tique* ('go to sleep all'), and see all the animals obey his song.
There we will sit on that beautiful mountain, and watch the little stars in their sleepless flight. They do not mind the song, *teeg-lee-goo-weul-tique*: neither will we mind it, but sit more closely together and think of nothing but ourselves, on the beautiful mountain.
Again the *teeg-lee-goo-weul-tique* will be heard, and the night-traveller will come closer to warn us that all are dreaming except ourselves and the little stars. They and their chief are coursing along, and our minds go with them. Then the owl sleeps; no more is heard *teeg-lee-goo-weul-tique*: the lightning ceases smoking; the thunder ceases beating his drum; and though we feel inclined to sleep, yet will we sit on the beautiful mountain."

Of the Passamaquoddies, in whose language this lyric was composed, Mrs. W. W. Brown says that they "surpass all their kindred tribes in the strength and development of their poetic faculty. 'Hill, dale and shady nook, and liquid lapse of murmuring stream' bear in their names, and the legends associated with them, the evidence of their imaginative creativeness." (Reade, *Loc. cit.*, p. 4.)

We have now compassed the world of primitive man. We have been with him, at dawn, and when the evening shadows fell, on lonely mountain-top and wave-beat shore; in burning desert and in icy northern waste: in Asiatic jungle and in European swamp; by Egyptian stream and in Brazilian forest; in bleak Fuegia and in the tropic islands of the sea—and what thought comes home to us from all our wanderings? What but the one eternal fact which the heart of man in all ages, in all lands, has believed in and trusted, though his head has often dared to doubt!

Rightly understood, the nature-creed of primitive man is my creed and your creed, the creed of every sane, healthy, thoroughly human soul, who has thought since the race began and done no violence to the inspired instincts of his oldest, deepest being—the immanence of God:

"God dwells in all,
From life's minute beginnings up at last
To man."

The nature-myths, lore and legends of the primitive races of the globe, their poetry, speech, arts, institutions, wherever these have felt the touch of plant and animal, of sun and moon and stars, of earth and sea and sky, of changing seasons, of calm and storm, of summer rain and winter snow, of heat and cold, of light and dark, alike reveal the existence behind the appearances and the changes, the rest and the motion, the silence and the stir, the coming and the going, of all things, of some controlling influence to which is due the evolution of nature and the development of man.

If we must look to nature-study for one article of a religion that shall abide, we find it expressed by that great lover of Nature, the Oriental mystic poet Jelaleddin, who, more than six centuries ago, put into the mouth of the Being behind all the phenomena of life and death, these reverent words:

"The sunbeam am I and the sun itself;
To the sunbeam say I: stay; and to the sun: depart
I am the morning-gleam, the ev'ning breeze am I,
I am the forest's murmur, I am the surging of the sea.
The mast am I, the helm, the helmsman and the ship,
The reef of coral, too, on which 'tis wrecked,
I am the fowler and the bird, I am the net.
I am the picture, mirror, sound, the echo, too.
I am the tree of life, the parrot sitting on it;
Silence and thought am I, the tongue and speech.
The breathing of the flute I am, I am man's spirit, too,
The spark within the stone I am, the metal's golden flash.
I am intoxication, the grape, the wine-press and the must,
The toper am I and the tavern, the crystal goblet, too.
I am the candle and the butterfly that circles round it.
The rose and she whom it intoxicates, the nightingale.
The doctor am I, the disease, the poison and the antidote.
I am the sweet and bitter, the honey and the gall!
War, peace, am I, forum and victory,
The town and its defender, the stormer and the wall.

I am the lime, the keep, the master and the sketch,
The gable and the corner-stone, the tree and its decay.
I am the stag, the lion, the lamb, too, and the wolf,
The shepherd am I, who brings all things into one fold.
The chain of beings I am, I am the ring of worlds,
I am the leader of creation's steps, the rise am I, the fall,
I am what is and what is not.... I am the soul in all."

Another lesson, too, we may perhaps learn from our rapid review of the attitude towards nature of primitive man. The Aztecs of old Mexico thought, like the ancient Greeks (some of them, at least) that man was of the same immortal substance as the gods; that when the universe shall perish, even the gods will pass out of existence. And everywhere in the world we find some traces of a belief in immortality, in some form or shape, a desire to be forever. This hunger for existence, this longing to be through endless time a conscious part of all-embracing nature, this hope to preserve personality is the second great article in the faith of primitive man. It may be going too far, when Dr. Brinton tells us:

"To the *primitive man, as we know him, the sense of individual power*, that which metaphysicians call 'free will,' was very present. The strong, the mighty, was what excited his admiration above all else. His ideal was the man who could do what he wished or willed to do. The savage acknowledges no theoretic limit to the will any more than does the religious enthusiast. It can move mountains and consume rivers It can act at indefinite distances and its force is measureless. In the religion of ancient Egypt, the highest gods could be made to serve the will of a man did he but use the proper formula of command." (*Science*, IV., 1896, p. 488.)

But, in the best sense, some such ideal is the dearest hope of the race. *To feel and to know that human energy, human act, human thought*, human aspiration are as eternal as the earth, the sea, the sky, the stars, as God himself, that the activities and the genius of man, the productions of his deepest soul, his innermost being, diffuse themselves throughout the entire universe, and, like the poet's concept of the world-travelled Ulysses, "become a part of all they meet"—is a race-old wished-for goal. It is the primitive correlate of the bidding of the great founder of Christianity: "Be ye perfect even as your Father in Heaven is perfect."

If you will permit me so to express it, the study of the nature-lore of primitive man, suggests, nay establishes, as the two great foundation stones of religion the knowledge of the immanence of God and the hope of the permanence of man.

THE MAGNETIC INFLUENCE OF THE SUN ON THE EARTH AND ON COMETS.

By Arthur Harvey, Esq.

(Read February 18th, 1899.)

The connection between Solar eruptions and Terrestrial magnetism is a very fascinating study, of which the results are as yet incomplete, but they show that the sun is in magnetic as in other respects the ruler of the Earth, and I think I am able to prove that this power extends to comets also.

Mr. Elvins' paper on the Sun-spot of September last renders preliminary remarks needless, so I will merely supplement it by calling attention to a yellowish grey globe, which, in a very imperfect way, represents the sun.

I have painted upon it spots, drawn from my own observations, and in due proportion to the size of the sphere. These particular spots were not all upon the sun at the same time, but the sun may frequently be seen as much bespotted as this model. Their position, with reference to the sun's equator, is that in which they were observed, and in which these phenomena usually occur.

For the faculæ, shown in white, I have the authority of the Italian records published by Tacchini. They conform thereto in size and in latitude. There are as many meridians on the model as it takes the sun days to rotate, and I have placed the faculæ upon them, one for each day's observations. It is, to my regret, impossible to give the slightest idea of the beauty of these shining ridges of white brilliance. Nothing on earth compares with them, except the silver-tipped edges of cumulus clouds when illuminated by the sun. These faculæ are those of February, 1898.

The red patches are meant to represent the prominences, as recorded at Rome and at Catania (*Memorie della Società degli Spettroscopisti Italiani*). They are only seen upon the edges or "limbs" of the sun, therefore, to obtain an idea of the number in play at once, I took all that were seen on the east and west limbs during one semi-rotation in March, 1897, giving the proper meridian and the recorded latitude and size to each. If it is difficult to properly represent the faculæ, much more so is it to mimic the protuberances and the jets of flame they emit. When the sun is totally eclipsed, they are seen around the black disc of the moon, of a glowing carmine color, but the blaze of the sun quenches them as effectually as the light of the Aurora, and the red does not shew at any other time. To the extent of making them visible, and the most conspicuous of all the marks, the model is deceptive. Perhaps indeed they should not be red at all; this color may be the result of their illumination by the red glare of the chromosphere, as in a theatre smoke is made to appear now red, now green, as red or green light is reflected on it.

To complete the model I should have thrown around it a mantle of filmy gauze, like the scarfs of our skirt-dancers, if without profanation I may compare grand things with trifling ones. But to supplement this and other defects, I have the pleasure to shew you a painting of the features around the eclipsed sun, due to the artistic skill of Mrs. M. E. Dignum. The particular eclipse illustrated is that of 1896, as witnessed at Orlowskoje, on the Amur, by the Russian Expedition. Mr. M. Wittram, who was detailed to make naked eye observations, says the chromosphere was of a sealing-wax red, the prominences of a brilliant carmine, outside which was a ring of orange glow.* I could not shew this chromosphere upon the model without obscuring the other features, and in the picture I have had to show it as quite surrounding the moon. In reality, however, it is so thin a layer that it was only seen on one side of the moon at a time, though during another eclipse, when the moon is further off and only just obscures the sun, it might be seen as in the painting. The orange glow should probably be more extended, in parts, but I did not advise its being so represented, because I have only found one observer who mentions this, Lieut. Boutcheff. He says: "Around the black disc was a clear orange ring of irregular form, with several prominences, averaging one-third of the radius of the sun. One of the prominences, divided into two parts, was 1½ diameters of the sun in extent." If that is what an ordinary observer sees, a total sun-eclipse is an even more glorious object than this beautiful painting shows.

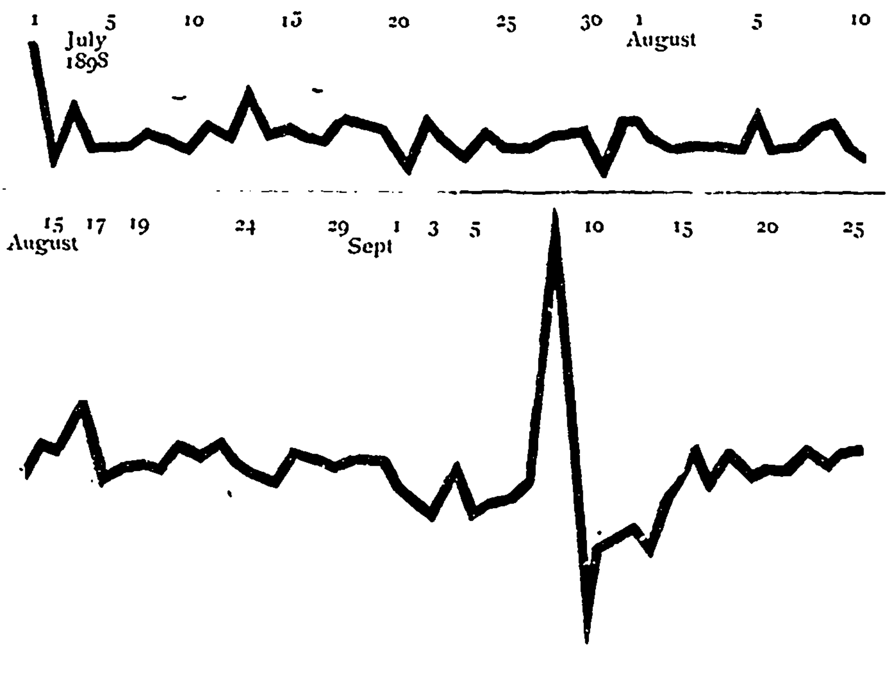
In 1862 Prof. Young was observing a disturbance in the chromosphere (?) which led to the breaking out of a great spot. He ascertained, upon enquiry from Stonyhurst and Greenwich, that the magnets became dis-

* Transactions Imperial Institute, St. Petersburg.

turbed at that particular time, and it then began to be recognized that solar outbursts and magnetic storms had some connection. But many a spot breaks out and passes over the sun's disc without noticeably disturbing the magnets, and just what the relation is has been the subject of constant enquiry and controversy. Prof. F. H. Bigelow, of the Weather Bureau, Washington, thinks the sun is itself a huge spherical magnet, with of course a spherical field, which embraces the earth; through which pulsations shoot.

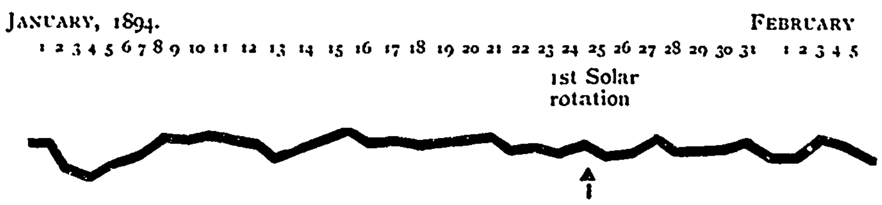
If this be so, which Prof. Hazen, of the same bureau, declares "unthinkable," the position of the spots with respect to the earth is irrelevant to the discussion, and, *mutatis mutandis*, if the position of the spots is important, Prof. Bigelow's theory must be at fault. Dr. M. A. Veeder, of Lyons, N.Y., has strenuously endeavoured to prove that the magnetic disturbance occurs when the spot first appears on the eastern limb; others say it takes place when the spot is central. The latter is the generally received opinion, though by no means justified as a universal rule.

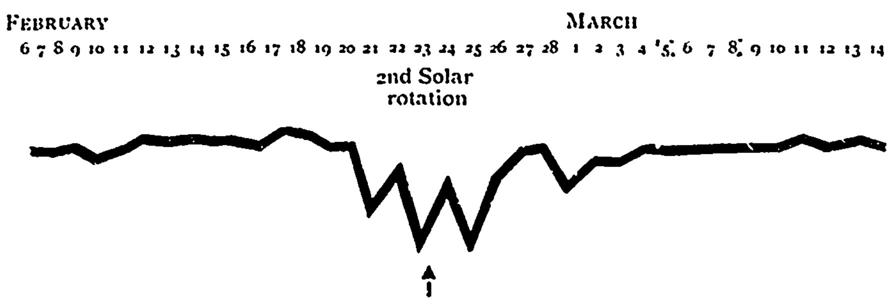
The magnets had been very quiet all last year, as usual near a sun-spot minimum; but in September a great sun-spot appeared, and a violent magnetic storm occurred. The curve of Horizontal Magnetic Force, from July 1st to September 25th, is shown on the annexed diagram.

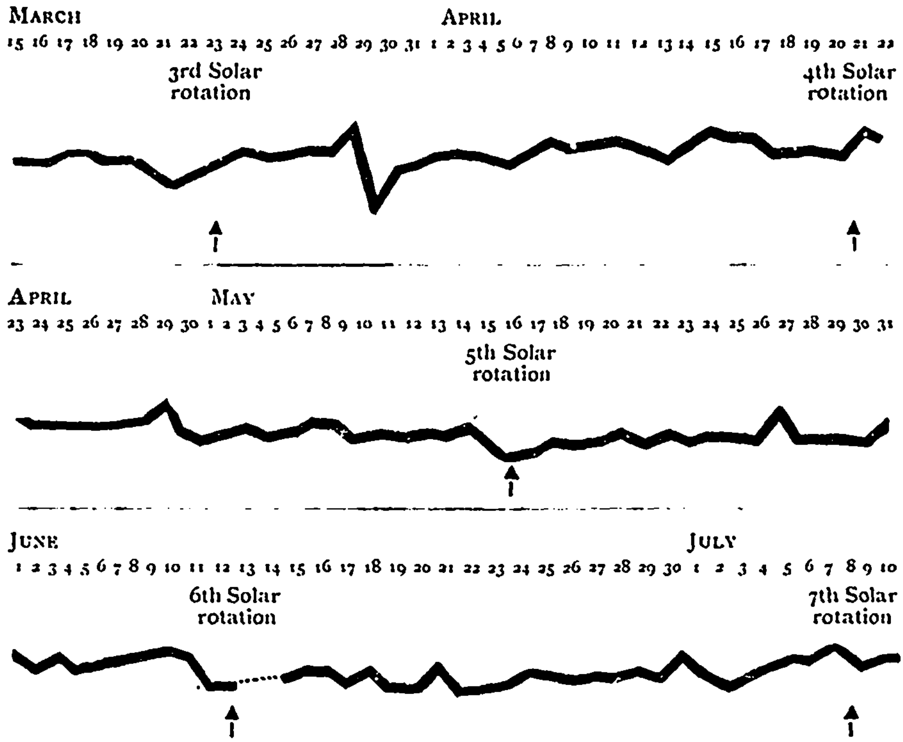


On the 2nd of September there certainly is a slight depression, the spot then being on the Eastern limb. On the 9th and 10th the magnetic storm was very severe, and these were the days of the spots' centrality. It passed off the disc on the 15th without any co-incident depression. On the 22nd it was central on the other side of the sun, and still no depression is to be seen. On the 28th it again appeared, by rotation, and a slight depression can just be noticed. It was once more central on our side—of course much reduced in size—on October 5th, but neither at that time, nor until its disappearance after the third rotation on November 8th, was there any magnetic effect traceable to it. This spot seems to have recurred a little in advance of the rotation period, which is about 27¼ days. It should, however, be observed that on August 17th, before it broke out, there was a noticeably sharp depression, preceded by a slighter but still decided one on July 20th. Also that a dip took place on October 8th—these dates corresponding with the period of solar rotation. Does it not then begin to appear that the cause of the magnetic disturbance is not the spot, but some violent change, below the photosphere and in the body of the sun, which gives rise to the spot also? For this change, whatever may be its nature, affects the magnets here in advance of the appearance of a spot, as well as after it has vanished.

This can be seen in dozens of cases, on even a casual examination of the magnetic curves, but one other instance only will be quoted here—a spot being taken for illustration which appeared nearer to the time of sun-spot maximum. The diagram shows the variations of the







daily mean readings of the Bifilar during the first half of 1894. You will not be surprised after looking at it to hear that a very great spot was visible from February 16th to the 28th. A slight depression may be seen on the 16th, when it appeared, but the full violence of the storm does not break out until the 22nd and 23rd, when it was central. Note the repetition of the depression on March 22nd, April 18th, May 14th, and June 10th to 13th—all periodical, corresponding with the sun's rotation term. The cause of the great spot was influencing the magnet every time its position faced the earth, long after the spot itself had been absorbed or filled up.

Almost every magnetic storm, sun-spot-attended or not, repeats thus regularly, often to the day, for several months. It may be asked, why not invariably, and to the precise hour? The disturbed area on the sun is usually so large, as we may fairly argue from the great size of the spots it causes, that parts of it face the earth for more than a day, and the eruption which causes the storm may be in a different part of that area, at each successive rotation. Nor am I yet prepared to admit that the radiation of force is in a single direct line from sun to earth.

It seems to be cone-shaped, driven outward from the sun, not drawn like a beam by the earth. And the intensity of the action may vary in different parts of the conical pencil.

By taking the average interval between magnetic storm repeats, the rotation of the sun ought to be accurately ascertainable, even better than by observing sun-spots, which are constantly changing their form and often their position, being so controlled by movements in the solar atmosphere that they go round in different times in different latitudes. By applying the approximate measure, 27¼ days, to a long series, to aid in the detection and identification of repeats, I found the exact synodical rotation to be 27.24575 days. My calculation is in very close accord with the best result of sun-spot observers, who differ considerably among themselves. The sidereal rotation period corresponding to the above figures is 25.354 days. Mr. Carrington gives 25.38 days.

Solar protuberances and prominences are disturbances in the solar atmosphere, and by no means so deeply-seated in their origin as spots In charting them upon a map of the sun, which by means of meridians dividing the equator into 27¼ parts one can do, they arrange themselves in belts. The record of the Italian Spectroscopical Society, edited by Tacchini, is that which I have followed. True, it is an exaggeration to mark down the prominences of a whole year, as if they were all in play at one time, but it is the best way that occurs to me to get a synoptic view. The resemblance to the belts of Jupiter is striking, and for that matter, the earth would not present a very different appearance in this respect, if looked at from the moon, for there are fairly regular zones of moisture and clouds on both its northern and southern hemispheres, as well as regions which clouds seldom obscure. If then the belts of Jupiter, Saturn and Earth are atmospheric, we may reasonably conclude that those on the sun are of similar nature. The magnetic curves supply another reason; they are not affected by prominences, so far as I can discover, though as prominences are only noted at the edge of the sun, and not after they have been brought on the disc, the inference as to their want of effect when central is open to objection. The most important prominence of 1897 was that seen on the western limb, at latitude +8° 2, on November 23rd. The locality whence it was ejected had therefore been central on the 16th. There was no magnetic dip on either date, nor was there any spot near the place where it was seen.

Prominence belts change their latitude from year to year. I have some reason to believe that the foci of the disturbances which produce sun spots are more permanent, and break out into renewed activity from time to time, as do volcanic regions on the earth. I have a long series of recurrences in several years, but instance 1896, premising that while the observations were made here, with imperfect appliances, the latitudes, longitudes, and areas have been kindly furnished by Mr. Maunder from his Greenwich observations :—

1896.								
February	24.	A fine spot, central	Area*.	80	Lat.	16°	Long.	220°
March	23..	A large spot "	"	. 150	"	13°	"	215°
April	20 .	A fine spot "	"	.. 80	"	18°	"	215°
June	14..	An enormous spot.......	"	.. 700	"	15°	"	215°
July	12..	A fine spot	"	.. 50	"	14	"	217°
September	5..	A fine group	"	.. —	"	18°	"	212°
October	30..	A noteworthy spot	"	.. 100	"	15°	"	203°
November	26..	A spotted region, central.	"	.. 100	"	19°	"	148°
December	23.	A fine spot†.............	"	. 100	"	—	"	—
1897,								
January	21..	A group‡.......	"	. 270	"	18°	"	210°

No spot of any consequence was noted in May, August, or the beginning of October, but here are ten occurrences within the year of considerable spots, in the same region. If we omit the November spot, owing to the difference of longitude, and that in December, not catalogued at Greenwich as in the same solar region, there still remain eight occurrences.

I support this view by a remark of Tacchini's on a spot of 1898 :—

"Notevole fu il bel gruppo di macchie del febbraio, che nel giorno 14 trovavasi al centro del disco fra i paralleli di —6° e —12° per un' estensione in longitudine di circa ⅓ del raggio del disco solare, cosa piuttosto rara in epoca di minimum dell' attività solare. Dopo quasi un' intiera rotazione cioè intormo all' 11 de marzo, un nuovo gruppo di macchie trovavasi nella parte centrale del disco cioè nella stessa regione del gruppo del 14 febbraio, ma un poco più al sud e pressochè della stessa estensione, cioè 5'. 3, *ciò che prova come in quella regione abbia perdurato a lungo la causa interna capace di produrre macchie per molto tempo nella stessa località*, ciò che non potrebbe spiegarsi colla sola differenza di velocità nelle zone superficiali."

So far Tacchini, reading from the book of observational Astronomy. We will now open the magnetic page and carry the history farther by the aid of the curve of Horizontal Force (in scale divisions like preceding ones) from January 1st to April 20th.

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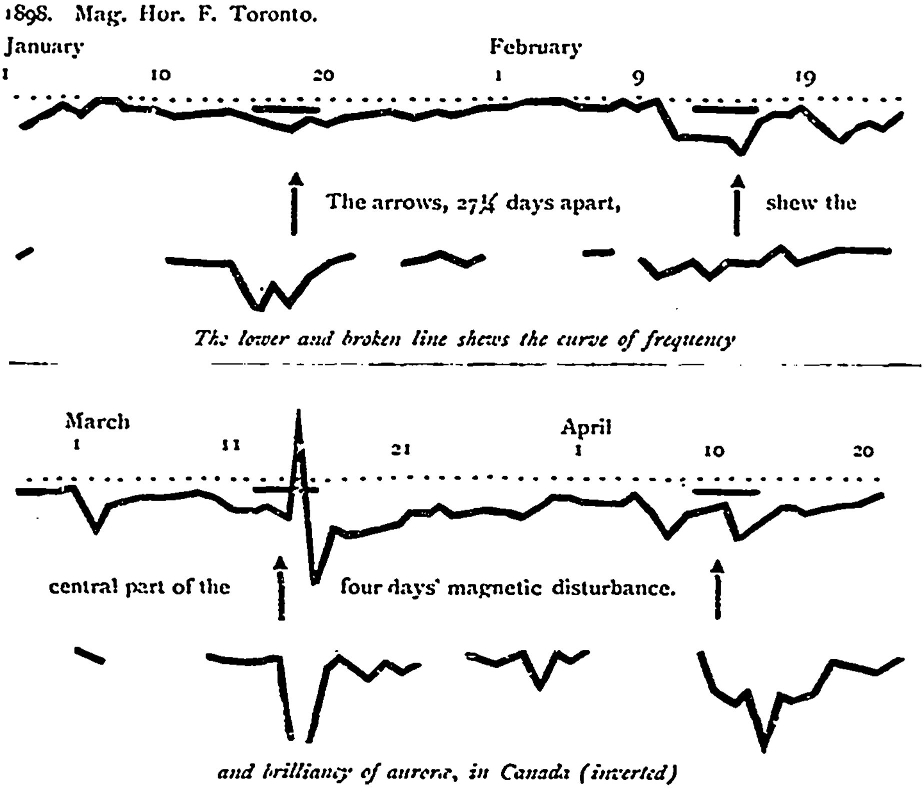
*The areas are calculated in millionths.

†Given in Mr. Pursey's charts as nearly central on this day.

‡Mr. Maunder kindly supplied this: omitted on Mr. Pursey's chart.



January, 1898, was a very quiet month, but any one accustomed to inspect such curves would not let pass without notice the depression on the 5th, and especially the double dip on the 18th and 20th, for these pulls in pairs often develop into severe storms, which frequently preserve their two-headed character.

The dip of January 5th did not show in February, but reappeared on March 2nd and 29th, where we will leave it for future reference.

The double dip of the 18th and 20th January was connected with a depression beginning on the 14th, and at the next solar rotation, on the 10th of February, a return of the depression was observable, and a huge sunspot coming into full view at the same time, a magnetic storm might reasonably be expected. It did occur, and lasted several days. The eruption must have involved a large solar area, for the spot developed thereby covered a third of the disc, in breadth, and therefore took four days and a half to pass any given point. It may be seen that the occurrence developed no magnetic energy on coming into view around the eastern limb.

The curve continued to show disturbance, and on March 2nd, when the volcanic area was central on the side of the sun opposite the earth, it is conceivable that it might exert the influence shown by the sharp dip, though I prefer to think this a recurrence of the slight February variation above alluded to. When the spot reappeared, it had changed its form so much that it seemed no longer the same. It had drifted a couple of degrees southward, and was evidently re-inforced by its original cause. Tacchini calls it a new spot. Whether it was so or not the eruption was still going on, for between March 15th and 17th the magnets were jerked about with unusual violence. It had not quieted down even during another rotation, for it made the instruments record its work, perhaps on coming into view, the 7th, but surely at centrality on April 12th. All this while it had preserved its character as a double depression—the two parts separating from each other more widely as their forces required more room for their display. The disturbed area was in the southern solar hemisphere, and not improbably therefore, in our spring, exerted a remarkable effect upon the earth.

The solar eruption was accompanied by auroral displays, and the curve which shows their number and intensity in Canada is given on the same diagram, but inverted for convenience in printing.

Faculæ are probably the crests of photospheric waves, raised by interior disturbances above the level of the solar atmosphere, and therefore brighter in appearance than the general grey-yellow of the disc They seem to be, in a sense, the coverings of foci of impending outbursts, which may or may not be violent enough to cause spots, by breaking through the photospheric envelope. They accompany spots, and magnetic effects are frequently noticeable when a faculous area becomes central.

Some observers, accustomed to solar work, can see faculæ almost clear across the disc. Prof. Hale, of Yerkes Observatory, has turned the camera's photographic eye upon them, and has succeeded marvellously. It is to be hoped that at an early day regular observations may be taken, at least for a term, so as to be available in the interest of magnetology.

Like the prominence belts, faculæ gird the sun, in both hemispheres, with their wonderful flames, but, unlike the prominences, in sun-spot latitudes only.

The fact that auroral displays accompany magnetic storms has long been known. Thus they also are an effect of the force which affects millions of square miles of the solar envelopes, and gives rise to spots.

Referring only to the two instances of magnetic storms and sun-spots alluded to at the beginning of this paper, it is on record that on September 9th, last year, the finest aurora occurred which had been seen here for a long while; it was seen all over Europe, and was said to be truly magnificent. In the Transactions of the Astronomical Society of Toronto is an account, by the late Mr. Carpmael, director of our Observatory, of the aurora of February 22nd and 23rd, 1894, the date of another of the magnetic storms and sun-spot displays above noted. He says that "on the 22nd, streamers from the corona extended to the celestial equator," and that on the 23rd, "we seemed to be in the centre of a vast tent of brilliant colors, yellow, red, green, and bright silver."

Every great aurora corresponds to a severe magnetic storm, and even bright local ones seldom occur without some magnetic disturbance. Nansen, in the "Fram," noted eleven auroræ. Two are coincident with remarkable magnetic dips, three with slight ones, the others were evidently strictly local, possibly not intense, for they did not influence the daily mean of magnetic forces. The connection is so close that since Auroræ have been regularly reported from the observing stations to the weather service here, it has been possible to make an auroral curve for Canada, and in doing so I have found no single instance of a widespread aurora without a magnetic dip of importance.* Curves have been studied out at Rome by the aid of the several foreign reports, and adding to American and Canadian records some from Norway, Sweden and Russia, given by the Specola Vaticana, I find reason for the belief that auroral displays, as well as magnetic force, are a measure of solar activity. In other words, so much solar disturbance, so much terrestrial magnetic disturbance, and so much aurora. If we could cover the earth with observers, stationing them in polar regions and in both hemispheres, if we could observe by day as well as by night, at full moon as well as new moon, it is probable that the auroral curve compiled from the united reports would exactly correspond with that made up from the records of the quivering magnets.†

*A curious instance of the singular localisation of auroræ is given in the "Transactions of the Astronomical and Physical Society of Toronto," for 1894, page 46. Mr. Copland and Mr. Urquhart, of the "Globe" staff, reported a case in which terrestrial magnetism interfered materially with the working of the telegraph between Toronto and Ottawa. No aurora was visible at either place, but it was discovered that brilliant auroræ were observable at several intermediate points.

†Father Lais, of the Vatican Observatory, treating this subject in his recent Report, analyzes the statistics he has obtained from Christiania, Upsala, St. Petersburg, and Washington, and divides them into three categories. He deals principally with the year 1894, and his lists embrace:

1. Auroræ accompanied by magnetic storms (five cases).

2. Magnetic storms without auroræ (six cases).

3. Auroræ without magnetic disturbances (three cases).

His data are incomplete, and his arrangement, therefore, faulty.

Just as the coincidence of auroral phenomena with magnetic storms proves their connection, so if changes in the nuclei and the appendages of comets are synchronous with magnetic storms and solar outbursts, we may regard it as proved that solar outbursts which disturb the magnets here reach the comets too, and, in a similar way, whatever it may be.* It has not been easy to collect facts bearing on this branch of my subject, because astronomers have hitherto had no hint from the magnetologists to look for and note the precise dates of changes in comets' tails. The next great comet must, however, be most carefully watched at every symptom of a magnetic disturbance. Such observations as I have gathered together are presented :—

1. Encke's Comet, 1871, was globular, but on November 9th "it exhibited a new aspect, anything but globular."

On that day the principal depression of the month occurred, though not an important one.

2. Coggia's Comet, 1874, had a tail which "became exaggerated" on July 13th. There was a noticeable depression on that day.

3. Brooke's Comet of 1883 showed nothing remarkable until October 22nd, when a photograph disclosed the fact that it was broken up into

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Thus, he places April 17th in both the latter categories, which is manifestly wrong. It should be ruled out of both.

The remaining two cases in No. 3 are July 1st and September 27th. Now, on July 1st, a magnetic dip does begin, and continues until the 3rd. On September 27th there is a dip also. In both cases the depressions are only sufficient to produce local auroræ, and as his own tables show that there were many auroræ in the United States on these dates, though there were none observed in Sweden or Norway, and only one in Russia, the rule is followed, but the dates should not be given in the list of auroræ of a general nature.

The dates given in Category No. 2 are March 1st, July 20th, September 14th and 19th, and November 13th.

The magnetic depression of March 1st is part of the storm of February 21st to 26th, not nearly so severe, and the tables given by Father Lais shew an almost exact concordance between the intensity of the magnetic storm and the frequency of auroræ observed, including March 1st and 2nd, especially when we add the Canadian record.

The figures for July 15th to 24th, in the Washington Weather Review are:

Days	15	16	17	18	19	20	21	22	23	24
No. of Auroræ	0	0	0	2	2	5	3	1	1	1
" " in Canada	2	5	3	0	5	7	1	1	4	1

The auroræ observed were few, the moon being full, but by far the greatest number corresponds with the day of the dip.

In September the figures are:

Days	12	13	14	15	16	Days	17	18	19	20	21
No. of Auroræ	0	0	43	4	0	No. of Auroræ	0	13	27	3	4
" " in Canada.	1	4	30	8	1	" " in Canada.	3	8	18	3	5

There was a full moon at the earlier dates also, but again the increase in number agrees with the day of the dip. The magnetic disturbance of November 13th gave rise to auroræ too. It was a bright, full moon, but there were none seen from the 7th to the 13th, when there were 8, and none the next day after.

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*Dr. Veeder thinks that planetary space is so full of particles of matter that electrical force is transmitted from sun to earth by continuous induction.

irregular masses of cloud. These continued to disintegrate, and the comet literally broke in two.

On the 23rd (which answers to the 22nd astronomical time, if the observation was taken in the morning) a magnetic disturbance began which reached its acme on the 25th, while another raged violently on November 1st. The end of October was the most disturbed period of the autumn, and, the influence of the disturbance being once conceded, the wonder ceases that this little comet was torn to pieces.

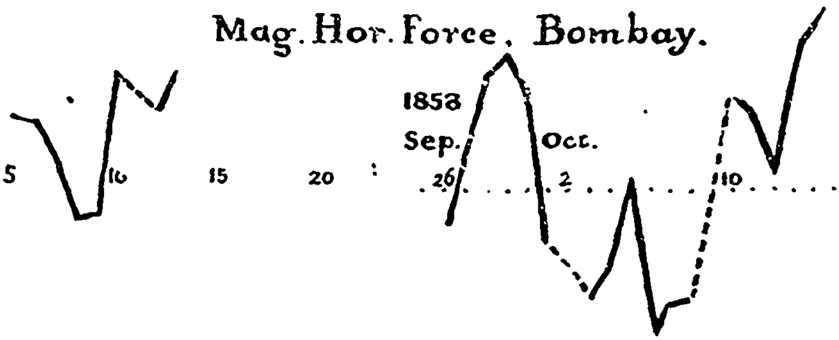
4. I mention Comet 1861 II., because the earth is thought by some to have passed through its tail on June 30th, and it is worth noting that there was no magnetic disturbance then.* I was living at Quebec, and saw behind very light clouds a glow which I took to be auroral. I have since come to think it was the comet's tail; perhaps small particles of matter incandescing by friction in the higher regions of the air, as do the falling stars, which some say are the discards of comets, and thus producing a diffused mild radiance.

The history of this comet is not well given, but it "suffered a great change" at some date, possibly July 2nd. for it is noted then. There is so slight a depression in the solar magnetic curve that I can scarcely connect it with the cometic change. No solar disturbance is reflected by our magnets between June 13th and July 5th which seems powerful enough to produce the effect hinted at rather than described, and the depression of July 5th is only moderate.

5. It was with some excitement that, after examining the records of these late and small comets, I turned to the history of the magnificent Donati's comet of 1858, that flaming scimitar which after sunset spanned the Western sky, and whose splendid beauty none but those of over fifty can remember. All the records agree that "on October 3rd, the matter comprising the nucleus and envelope was evidently in a continual state of local excitement." For some reason, quite immaterial, the Toronto magnetic records for 1858 are not among my collection—immaterial, that is, because the magnets are similarly affected all round the world, as I shewed the Institute in a previous paper, in which the curves from Toronto and those from Tiflis, in the Caucasus, were placed on the same sheet, which showed their practical identity as to the time of disturbance. The Institute fortunately possesses the Bombay magnetic records for 1858, and they shew that the most important dip for many days took

*There is no disturbance of the magnet during the period of the stream of Leonid meteors, nor of Perseids, nor probably of any other. There is thus no magnetic influence in comets' tails or their possible discards, which acts upon the earth, or, *a fortiori*, on the sun.

place at the date mentioned. I exhibit the curve drawn from the data there given as to the Horizontal Force, where you can see this depression, and I may add that the vertical force was more marked on October 3rd than on any other day in the whole year.



It seems then that if, while a comet is near perihelion, a great solar outburst takes place on the side of the sun which faces it, or if the outburst, as is usually the case, remains magnetically active until by rotation it is brought to face the comet, the vagrant body is thrown into a state of excitation, and is in danger of disruption.

This strange, yet quite to be expected connection, is a new discovery, so far as we here know, and if on further observation and enquiry it proves unchallengeable, it will have interesting consequences.

Having thus shewn that solar activity has an effect which we can see, on bodies other than the earth, it will be in order to examine if it influences the belts on Jupiter. If Mr. Stupart will have Venus examined with care when there is a magnetic storm, he may find traces of aurora there, and the occasional vision we get of the unilluminaed part of her disc may be accounted for with reasonable certainty.

Magnetology has for a long time been stationary, but signs are not wanting that it is about to take higher rank among the sciences. It may be that another branch is being added to it, and that celestial magnetism may occupy some pages in the book of knowledge.

The science has been hitherto in a position comparable to that of astronomy in pre-Copernican times. The ever-varying curves, which when superimposed in any way—by solar rotations, by sun-spot periods, or by aliquot parts of the Terrestrial calendar—interlace in apparently inextricable confusion, are like the motions of the planets under the

Ptolemaic system, when, in Milton's phrase, the heavens were "with cycles and epicycles plastered o'er." Yet, to one who traces them time and again, there comes a conviction that there is some rhythm underlying the seeming confusion. As the movements of the heavenly bodies were seen to be subject to simple laws so soon as they were heliocentrically regarded and the mathematical astronomer learned to look out upon the cosmos from its local ruling body, so a beginning having been made to refer magnetic motions to the pivot of the needle instead of merely noting those of its extremities, we may hope that their complexity will vanish. When such motions are expressed in measurements of angles, and a mean adopted like the thermometrical zero, simplicity may replace apparent confusion. Diurnal movements may perhaps be eliminated, as being the effect of heat or solar distance, neutralising each other as the earth rotates. Seasonal changes may in like manner balance each other, hemisphere against hemisphere, and be removable too. Abstracting these and local elements, should we not be left with a curve depending upon solar activity alone? Then we should have, by means of wireless telegraphy between Sun and Earth, the exact measure and period of solar excitation, which, as now measured by sun-spot area and position is uncertain and irregular, for these are not an accurate index to the violence of sun-spot phenomena. Then, although we may not, in Mr. Preece's language, hear on this earth the thunderstorms in the sun, solar weather will be found to be governed by the intensity of solar outbreaks, the maxima and minima of sun-spots will likely coincide with those of prominences, and regularity will resume its sway. Possibly we may then hope to derive practical human advantages from understanding the connection between solar weather and our own.*

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*Since the date of this paper Prof. Kreutz, of Kiel, Germany, has been so obliging as to send me several "comet notes." Some are remarkable, but especially the following:—"Comet, 1888, I., on the 20-21st May, suddenly changed its appearance." On May 20th the greatest magnetic storm of the half year occurred, the lowest dip being at 23 o'clock of the 20th. There were many magnificent auroral displays on the earth, while the changes in the appearance of the comet were proceeding. Mr. A. Elvins has given me the date of changes in Swift's comet, 1892, I., viz.:—April 6th and 7th, which were the dates of sharp vibrations of the magnetic needle. Herr Leo Brenner, of the Manola Observatory, Lussinpiccolo, Austria, only once observed a brilliant aureole round the dark side of Mercury; it was on May 18th, 1896, which was the crisis of a magnetic storm on earth. The aureolar phenomena of Venus are now under investigation, to ascertain if they are so co-incident with magnetic storms here as to prove a connection.—THE AUTHOR.

THE CONTEST FOR THE COMMAND OF LAKE ERIE IN 1812—1813.

BY LIEUT. C . ERNEST CRUIKSHANK.

(Read May 6th, 1899.)

Long before the actual declaration of war took place Major-General Brock had foreseen and pointed out that the defence of Upper Canada would be largely dependent on the command of the lakes and that a successful invasion of that province was scarcely possible as long as this remained with the British. In a letter to the Governor-General dated December 2nd, 1811, he remarked:—

"From Amherstburg to Fort Erie my chief dependence must rest on a naval force for the protection of that extensive coast. But considering the state to which it is reduced, extraordinary exertions and great expense will be required before it can be rendered efficient. At present it only consists of a ship and a small schooner, the latter of a bad construction, old, and in want of many repairs yet she is the only King's vessel able to navigate Lake Huron, whilst the Americans have a sloop and a fine brig capable of carrying twelve guns and in perfect readiness for any service."*

In merchant shipping the Americans possessed an undoubted superiority. They had three stout schooners and a sloop of between sixty and ninety tons burden besides five or six smaller vessels, while only five small schooners or sloops were the property of Canadian owners. The construction of a schooner to carry twelve guns which was named *The Lady Prevost* was at once authorized. Brock then urged the superannuation of Commodore Alexander Grant, who was eighty-five years of age and had been in command a full half century, and that two companies of the Royal Newfoundland Regiment should be sent forward to act as seamen and marines.† These precautions, trifling as they were, gave him the temporary control of Lake Erie, for the American Government was

*"Canadian Archives," C. 673, p. 171.

†"Canadian Archives," C. 728, p. 64.

strangely negligent in utilizing its extensive resources in that quarter *until disaster convinced them of the necessity.*

The services of the only two British ships afloat when hostilities began were by no means inconsiderable although they were weakly manned and not efficiently officered. Captain Hall, who had succeeded Grant in the command, blockaded the United States brig *Adams* at the shipyard in the mouth of the River Rouge below Detroit, where she had been lately rebuilt. On July 3rd, Lieut. Frederick Rolette, a young French Canadian officer in command of the *Hunter*, captured the *Cayahoga Packet* with General Hull's baggage and many official documents of value. He then cruised along the south shore of the lake taking several boats and small craft loaded with provisions and effectually cutting off Hull's communication by water with the coast below from which he expected to draw most of his supplies, and finally on August 7th, he captured a convoy of eleven batteaux having on board the baggage and fifty-six wounded men belonging to a column sent to re-open the communication with Ohio by land.

At the same time the *Queen Charlotte* by her presence in the river alone had delayed Hull's operations and prevented the advance of his siege artillery against Amherstburg while Brock was enabled to send forward reinforcements by water from Long Point and Fort Erie in perfect safety, gaining several days' time and avoiding the fatigue of the overland march. On August 16th that ship covered the landing of the British troops in Michigan while part of her crew manned the batteries opposite Detroit. On the surrender of the garrison the only two armed vessels possessed by the American Government on the upper lakes, the *Adams* and a worn-out sloop, were taken.

Although only a few merchant schooners and a sloop still remained uncaptured and these had been collected at the ship-yard of Black Rock in the mouth of Niagara river where they were blockaded by batteries on the opposite bank, Sir George Prevost still felt far from secure in that quarter.

As early as October 27th, 1812, he informed Lord Bathurst that "The Government of the United States have become sensible of the great advantages we have hitherto derived from our naval superiority on the lakes and are using uncommon exertions to obtain a force superior to ours both on Lake Ontario and Lake Erie.

"It is necessary I should dwell a few moments upon this circumstance to solicit the attention of His Majesty's Government to that important part of the defence of Upper Canada. Having already transmitted to your Lordship's predecessor a list of the vessels in commission, I have now to state the difficulties which attend providing them with proper officers and suitable crews. For the present I have allotted the Newfoundland Fencibles for that service and the Quarter-Master General has picked up a scanty supply of sailors at Quebec.

"But the officers are in general deficient in experience, and particularly in that energetic spirit which distinguishes British seamen. In consequence it will be highly necessary in the event of the continuance of the war with America that tried officers of the rank of lieutenant and trusty men from the navy should be appropriated for that service and sent to me as early as possible next spring."*

The *Lady Prevost* had been launched at Amherstburg about the middle of July and as soon as she could be made ready to sail, was sent to Fort Erie to protect that flank of the line of defence on the Niagara while the greater part of the regular troops were withdrawn for the relief of Amherstburg. The *Adams* was put in commission as the *Detroit* soon after her capture and for the remainder of the year all the vessels were chiefly employed in transporting troops and stores, the *Hunter* on Lake Huron and the others on Lake Erie, although there were scarcely seamen enough to navigate them in fair weather.

A return of October 2nd, 1812, shows that there were only six officers, eleven petty officers, eight able seamen and nineteen ordinary seamen distributed among these four vessels, while their regular complement was twelve officers, thirty-six petty officers, forty-four able seamen, and forty-four ordinary seamen. An attempt was made to supply this serious deficiency by putting on board an additional number of the Royal Newfoundland Regiment to act as marines or sailors as circumstances might dictate. Thus the crew of the *Queen Charlotte* consisted of a captain, a surgeon, four petty officers, three able and thirteen ordinary seamen, one volunteer, and thirty-three marines. Her proper complement was six officers, thirteen petty officers, twenty able and twenty ordinary seamen, fourteen landsmen, six boys and seventeen marines. The *Lady Prevost* had three officers, three petty officers, one able and one ordinary seaman, three landsmen, two volunteers and twenty-two marines. Her complement was three officers, eight petty officers, ten able and ten ordinary seamen, two boys, and eleven marines. The *Detroit* was manned by one officer, two petty officers, three able and three ordinary seamen, four landsmen and eleven marines. Her complement was two officers,

*"Canadian Archives." Q. 118. p. 273.

eight petty officers, eight able and eight ordinary seamen, six landsmen, two boys and nine marines. The *Hunter* had two petty officers, one able and two ordinary seamen, one volunteer and seventeen marines. Her complement was one officer, seven petty officers, six able and six ordinary seamen, two boys and nine marines.*

Vessels so weakly manned were scarcely capable of defence when boldly attacked, even by row boats, and the *Detroit* in company with the merchant brig *Caledonia*, while lying at anchor off Fort Erie, was actually surprised and taken on the morning of October 9th, by a party of 124 American seamen and soldiers, in three boats which silently approached under cover of an intensely dark night. The *Detroit* was subsequently destroyed to prevent her recapture, but the *Caledonia* was triumphantly carried off to the Black Rock navy yard, where she was added to the other vessels lying there, which were already being converted into gunboats.

This was, however, the only loss sustained by the British on Lake Erie during 1812, while the advantages secured from the control of the lake cannot easily be overestimated. While the armies of Generals Hull and Harrison were painfully struggling through the swamps and thickets of Ohio and Michigan, with their pack-horses dying by hundreds along the road, their opponents were enabled to transport troops and artillery from place to place with comparative ease and rapidity. The British commanders were accordingly enabled to strengthen the garrison of Amherstburg by troops from the Niagara River, and when danger had passed in that quarter, to take them back in time to repel an attack on the latter line. A part of the 41st Regiment was sent in this way from Niagara to Amherstburg, and was present at the surrender of Detroit. This detachment then returned and took part in the battle of Queenston. During the winter it marched overland to Amherstburg, and participated in the seige of Fort Meigs and the battle of Miami, in May, 1813. The ruinous fortifications of Amherstburg on General Hull's approach were hastily armed with cannon from Fort George at Niagara, and a few weeks later the batteries along the Niagara river were mounted with the artillery captured at Detroit. The command of the lake alone made this practicable. The movements of British armed vessels along the south shore of the lake, and the occasional landing of small foraging parties, created indescribable alarm, and considerable bodies of militia were called out from time to time, and maintained under arms at Sandusky, Cleveland, Erie, Chautauqua and Cattar-

*"Canadian Archives, Provincial Marine."

augus. The time for defensive preparations gained by the British was invaluable.

The necessity of securing the control of the lakes for the accomplishment of their plans of conquest had, in fact, been forcibly pointed out to Dr. Eustis, the American Secretary of War, as early as January 2nd, 1812, by General John Armstrong, who was destined to succeed him in office before the year was out.

"Resting, as the line of Canadian defence does, in its whole extent, on navigable lakes and rivers, no time should be lost in getting a naval ascendency on both, for *cæteris paribus*, the belligerent who is the first to obtain this advantage will (miracles excepted) win the game."*

A memorandum which appears to have been submitted to the Secretary by General Hull, soon afterwards contains this warning:

"If, Sir, we cannot command the ocean, we can command the lakes of our country. This we ought to do; but if there is no intention of building a naval force on the lakes superior to that of the British, that communication must be abandoned until we take possession of the Canadas."†

But the boastful declarations of the advocates of war, both in and out of Congress, that the militia of Kentucky or Ohio alone, could, and would, take Canada, seem to have impressed their government so strongly that it preferred to put its trust for the time in its land forces alone, which promised at least a superiority in numbers that seemed overwhelming. General Hull's discomfiture, succeeded by other disasters, convinced the President and his advisers of their mistake, and several hundred seamen, accompanied by a large body of shipwrights, were despatched to the lakes.

At the Black Rock shipyard they found the merchant schooners *Catharine* and *Amelia*, and sloop *Contractor*, to which was soon added the prize brig *Caledonia*. These vessels were rapidly fitted out as gunboats, and armed with those heavy long guns which had already proved so effective at sea.

These preparations soon became known to Sir George Prevost, and caused him much uneasiness, as his correspondence with Lord Bathurst shows. On October 26th he asked for the appointment of a captain in the Royal Navy to superintend the "naval establishment" on the lakes.

*Armstrong, "Notices of the War of 1812," I., 235.

† "Canadian Archives," C. 676.

On November 5th he wrote that the Government of the United States had sent the crew of the frigate *John Adams* to man its vessels, and begged for officers and crews for the British ships. On the 21st of the same month he announced that the Americans were actually in command of Lake Ontario, and had menaced Kingston. He predicted the entire loss of that lake next year if he w·s not powerfully assisted with men and stores. But such was the unc .nty of the mail service in the winter season that this lette: did not reach Lord Bathurst until March 3rd, 1813, one hundred and one days after it was written. At the same time, fearing that assistance from Great Britain might arrive too late, Prevost applied to Sir John B. Warren, commanding on the Halifax station, for at least a sufficient number of officers and men to navigate the ships on the lakes. In January, 1813, Captain Hall went to Quebec to enlist seamen for Lake Erie. He met with little success, owing largely to the high rate of wages then being paid in the merchant service, and the men he obtained were generally of an unsatisfactory description, being incompetent and dissipated. At the same time instructions were given to General Procter to build at Amherstburg a ship intended to carry fourteen twelve-pound carronades, and four long nines in bridle ports, in the bow and stern, and two decked gunboats, to be armed each with a long eighteen. With the exception of timber, which could be procured close at hand, the principal part of the materials—nails, bolts, pulleys, deadeyes, lead, copper, glass, paint, resin, cordage and sails would have to be sent up from Montreal or Quebec with the shipwrights.

"There are not shipwrights in this province to do half the work, Captain Gray reported on December 3rd, 1812. "It might, under those circumstances, be advisable to engage all the master shipwrights in Lower Canada with their men, and send them up to work by contract or otherwise."

There was even greater difficulty in providing guns and ordnance stores. Six carronades destined for the *Queen Charlotte* had been taken to arm gunboats on the Sorel and St. Lawrence. There were none in the arsenals at Quebec or Halifax. Prevost quite unexpectedly succeeded in purchasing eighteen old carronades from a Quebec merchant, but these were appropriated forthwith for the armament of the ships at Kingston, and those needed for Lake Erie had then to be requisitioned from England. By the middle of March only eighty seamen of the most wretched quality had entered for service on both lakes, and the Governor-General was obliged to forward a most urgent requisition to the Colonial Office for 445 seamen for Lake Ontario and 170 for Lake Erie. But even had the full number been sent out, a return showed that the Lake Erie squadron would still be far short of its complement.* The result of his repeated appeals may be traced in Lord Bathurst's despatches. On December 9th, 1812, he announced that 200 seamen had been ordered to proceed to Quebec for service on the lakes, chiefly composed of those who had lately manned the flotilla at Riga and were supposed, in consequence, to be already acclimated. On January 13th, 1813, he wrote that the number had been increased to 300, and on March 12th to 450. Finally on August 14th, when of course it was too late to avert disaster on Lake Erie, he informed Prevost that 300 additional seamen would be sent from England and that Admiral Warren would be instructed to lend him 300 more to be employed on the lakes.

Meanwhile the Government of the United States was making determined efforts to equip a squadron competent to gain possession of Lake Erie as a preliminary to the recovery of Detroit. Presqu' Isle (lately re-named Erie) was selected as the best place for building vessels of war as having a spacious and landlocked harbour, with "a sufficiency of water on the bar to let them into the lake, but not a sufficiency to let heavy armed vessels of the enemy into the bay to destroy them."† A large body of militia could also be easily assembled from the adjacent country for their protection. In the beginning of January, 1813, Commodore Chauncey, with Eckford, his naval constructor, visited the place and approved of the work already done on two gunboats and gave instructions for the construction of two large flush-decked brigs or corvettes of the class of the *Wasp* and *Hornet*, which had won such notable victories on the ocean. A considerable body of ship-carpenters and axemen had already been at work for some time, and these were reinforced about March 1st by another party sent for the purpose from New York. Chauncey designated for the command Captain Oliver Hazard Perry, lately in command of a flotilla of gunboats at Newport, R.I., an energetic young officer who had seen some active service in the war with Tripoli ten years before as a midshipman but was not otherwise distinguished. He brought with him to Erie one hundred of his best seamen, about the end of March, and found that besides the two brig corvettes, a clipper schooner and three gunboats had been already laid down. The difficulties of building, although great, were decidedly less there than on the Canadian shore. There was no lack of skilled labour as the private shipyards of the United States were absolutely idle. Pittsburg, his base

*Returns by Captain P. L. Chambers, D.A.Q.M.G., dated at Amherstburg, March, 1813. Total complement required 470 officers and men. Present, 108—short 379. "Can. Arch. Provincial Marine."

†[illegible] D. Dobbins to Capt. Elliott, Oct. 11th, 1812.

of supplies, was much nearer than Montreal and conveyance by water was practicable nearly all the way. Large boats loaded with artillery and naval stores ascended the Alleghany river, French, Deadwater and Muddy Creeks to the site of Fort Le Bœuf, now Waterford. Thence there was a passable wagon road to Erie. The work of construction accordingly proceeded rapidly. There is a wide disagreement among American writers as to the size of the brigs. Mr. Bancroft states that they were 141 feet in length and measured 500 tons, while Captain Dobbins says that they were 110 feet in length between perpendiculars, thirty feet beam and measured 260 tons. The new *Wasp* is admitted to have measured more than 500 tons, and it seems probable that on this point Bancroft is nearly correct. They were pierced for twenty guns in broadside, besides two stern ports, and being intended to carry thirty-two pound carronades their frames and sides were made uncommonly stout and thick. Redoubts were thrown up and guns mounted to command the harbour's mouth. A body of two thousand volunteers and militia was assembled for the protection of the place.

Early in May the schooners *Ariel*, *Porcupine*, *Scorpion* and *Tigress* were launched, and on the 24th of the same month the two brigs were put afloat. In addition to these vessels the prize brig *Caledonia* and five merchant schooners lying at the Black Rock ship-yard had been purchased and equipped for war, but were prevented from entering the lake by the batteries opposite. On May 28th, however, Fort Erie was evacuated and the whole line of the Niagara abandoned by the British forces. No time was then lost in removing the blockaded vessels but six days were consumed in towing them up the river and it was not until June 13th that they were enabled to sail from Buffalo, heavily freighted with naval stores

The two small gunboats whose construction had been authorized by the Governor-General, were built on the Thames near Chatham and launched early in April, but small progress was made on the new ship at Amherstburg owing both to the lack of workmen and materials.

Lieutenants Frederick Rolette and Robert Irvine, Midshipmen Robert Richardson and Thomas Bawis, two petty officers and twenty-two seamen of the Provincial Marine were engaged in the action on the River Raisin on January 22nd, 1813, when they were employed in working the field guns. One seaman was killed, both lieutenants, midshipman Richardson, one gunner and twelve seamen were wounded, leaving only eleven persons unhurt in a party of twenty-eight.

On April 23rd a flotilla composed of the *Lady Prevost*, *General*

Hunter, *Chippewa*, the new gunboats *Eliza* and *Colonel Myers*, and transports *Mary*, *Nancy*, and *Miamis*, under the command of Captain Hall, conveyed General Procter's division to the mouth of the Miami river where the troops were landed. The gunboats ascended the river until within easy range of Fort Meigs. Part of the seamen were landed to assist in manning the siege batteries, and were said by Procter to have rendered the most essential service, although they suffered no loss in action.

After the siege was raised, the *Hunter* was despatched with provisions and stores to Mackinac where the garrison was almost starving, and the *Queen Charlotte* was sent for supplies to Fort Erie as Procter's whole division was then in great distress for lack of both food and clothing. The want of seamen absolutely prohibited any offensive operation.

"Our gunboats are now idle," Procter wrote on May 23rd, "for want of hands. We are endeavouring to man one. They might have been made good use of if we had had sailors since we left Miami in intercepting supplies for Mr. Harrison, which, as Colonel Nichol observes, he can now receive by the lake only."

Rumours that ships of war were being built at Erie had reached him some time before and rendered him so uneasy that he attempted to secure information by sending spies down the south shore of the lake.

Sir John Warren had responded to the Governor-General's appeal for officers by sending him Captains Robert Heriot Barclay, Robert Finnis, and Daniel Pring and four lieutenants of the Royal Navy. Captain Barclay was thirty-two years of age and had lost his left arm in the service but had not particularly distinguished himself, although undoubtedly brave and skilful. None of the other officers were in any way known to fame. Barclay arrived at Kingston early in May and took charge of the ships lying there without crews. A few days later he was superseded by Sir James Lucas Yeo who came directly from England with thirty-six officers and 450 seamen to assume the command on both lakes. Yeo offered the command of the Lake Erie squadron to Captain William Howe Mulcaster, with whom he had been closely associated for many years. Mulcaster declined, chiefly, it is hinted, in consequence of the miserable equipment of the vessels and deficiency of seamen. It was then tendered to Barclay who accepted without hesitation, possibly from reluctance to serve under Yeo who was several years younger than himself.

The American fleet was in possession of Lake Ontario, and as it was understood to be considerably superior in guns and men, and as the result of the contest there was justly felt to be of supreme importance, Yeo absolutely refused to part with any of the officers or seamen who had come with him from England. Barclay was accordingly obliged to proceed to his post accompanied only by three lieutenants, a surgeon, a master's mate and nineteen seamen, twelve of whom were French Canadians. At York they overtook a detachment of the 8th on its way in boats to join General Vincent at Niagara. On May 27th, when within twenty miles of Fort George, they learned that Vincent had been driven from his position, and marched overland to join him at De Cew's Falls. Next day it was ascertained that the *Queen Charlotte* which had been lying under Point Abino, had gone up the lake to avoid an attack, and they were obliged to undertake the toilsome overland journey to Amherstburg, where they arrived about June 10th.

The ship on the stocks at that place was still in a very backward state from want of the most necessary stores, as nearly everything intended for her equipment had been either taken or destroyed when the Americans captured York. But on June 16th he succeeded in manning the *Queen Charlotte* and *Lady Prevost* and sailed down the south shore to reconnoitre the harbour of Erie. He ascertained that it was well protected by batteries and blockhouses garrisoned by about 2,000 men, and that the two brigs had their lower masts in.

"The only thing I can hope for," he wrote despairingly, "is that reinforcements will be sent to Brigadier General Procter to enable me to destroy the American vessels before they are ready. . . . I expected to find four companies of the 41st at Long Point, and found only one."* As Barclay cruised down the lake from Long Point towards Buffalo, Perry with his five vessels was moving slowly upwards, hugging the south shore. Off the mouth of Cattaraugus Creek the ships of both were distinctly seen, when about fourteen miles apart, by the crew of a small boat midway between them. The day was hazy and Barclay passed on without observing the American flotilla. Perry considered this a very fortunate escape for him, but it is doubtful whether the two British vessels were sufficiently manned to have risked an attack. On June 19th and 20th Perry took his ships across the bar into the harbour of Erie where they were out of danger. He had received a letter from the Secretary of the Navy directing him to name one of his new brigs the *Lawrence* in honour of the dead captain of the *Chesapeake*, and the other *Niagara*, to commemorate their recent success on that frontier.

*Barclay to Prevost, June 17th, 1813. "Canadian Archives."

On the 28th Barclay again reconnoitred the harbour and ascertained that the two new brigs were still in the inner harbour, apparently in a forward state but not yet rigged. Besides these he noted two smaller brigs and seven schooners, all of which appeared to be armed, manned and ready for sea. Next day he wrote from Long Point to the Governor-General, complaining warmly of the want of seamen and stores. "The ships," he said, "are manned with crews, part of whom cannot even speak English, and none of them seamen and very few in numbers."

In fact, nearly every letter written by Procter or Barclay at this time contained an anxious appeal for seamen and soldiers to carry out the proposed attack upon the harbour of Erie before the American squadron could put to sea.

On June 10th Procter had written, "I am very anxious to have our new vessel in the water where she will be much safer. Every effort should be made to send us seamen before the vessels at Presque Isle are ready. If reinforced I shall have some confidence."*

On the 15th he said, "I am fully aware that the enemy are not idle at Sackett's Harbour, neither are they, I apprehend, at Presque Isle. Capt. Barclay is endeavouring to ascertain their real state. I am surprised they have not appeared on this lake. We are well aware of the necessity of giving the first blow, indeed we owe everything to our having done so. Captain Barclay has, I believe, written urgently to Sir James Yeo on the necessity of our having seamen without delay."†

On the 29th, Procter informed Captain McDouall that "the *Detroit* will be launched in a fortnight. We could lend her guns," he added, "if she had seamen. I believe now that Captain Barclay is making some attempt on the enemy's vessels. We had proposed making an attempt with all our means, but I suppose he saw and learned that an immediate attempt was most eligible."‡

But the promised troops did not come and nothing could be done without them. On July 4th General Procter wrote to Captain McDouall that the detention of "the force ordered here by the commander of the forces has prevented this district from being in a state of security, which the destruction of the enemy's vessels at Presque Isle would have effected, a service that might very easily have been completely effected a

*"Canadian Archives," C. 678, p. 110.

†"Canadian Archives," C. 679, p. 107.

‡"Canadian Archives," C. 679, p. 155.

very short time since, but which, I apprehend, may now be attended with much difficulty."*

In a letter of the same date to Prevost he said, "I beg to add that if I had received from the Niagara line the reinforcement which you directed should be sent, I should by this time have had it in my power by the destruction of the enemy's vessels in the harbour of Presque Isle to have placed the dockyard and post of Amherst in a state of security that under existing circumstances it cannot be said they are in at present. However, though certainly more difficult to be effected, it may not be too late if agreeable to requisition, the remainder of the 41st Regiment are immediately sent to Long Point. There seems to have been with the Provincial Marine a general error which cannot rest with me as I early reported to Sir R. H. Sheaffe that an entire change was as requisite on this as the lower lake. Captain Barclay also arrived here in error. I am confident of the most cordial co-operation and aid from Captain Barclay whose arrival lessened considerably my anxiety. I have to transmit a letter from him to me for your Excellency's consideration. I have also to mention his strong desire to have some more of the Royal Newfoundland Regiment as his greatest reliance is on those of that corps at present employed as marines."†

General De Rottenburg who commanded the division engaged in blockading the American army at Fort George positively declined to cooperate in the proposed expedition against Erie and on July 11th, Procter wrote again.

"By my brigade major I also was informed that the Major General could not act with me and Captain Barclay at present; that he must first secure the command of the lower lake after which there will be no difficulty in recovering the command of the upper one? With all due deference I beg leave to dissent from the above. If means had been afforded me which were no more than your Excellency has repeatedly directed should be sent me, I could in all probability have effected the destruction of the enemy's vessels at Presque Isle and have secured the superiority of this lake and also in so doing have made a powerful diversion in favour of the Centre Division. I am further of opinion if we lose the superiority of this lake it will not be recovered without much difficulty. . . . .
Captain Barclay with all his resources goes to Long Point to bring Lieut. Col. Evans and in the hope of finding naval stores there, and sailors.

*"Canadian Archives," C. 679, p. 177.

†"Canadian Archives," C. 679, p. 181.

If the enemy's vessels should be out an engagement cannot be avoided and if they are not yet ready he will endeavour to keep them in the harbour. Besides the detachment of the Royal Newfoundland Regiment I have been obliged to send fifty men on board the vessels from the 41st Regiment and some of the detachment under Lieut. Col. Evans will also be detained from necessity."*

Two days later he added :—

"I have already acquainted Your Excellency that Captain Barclay was to set sail with all his vessels for Long Point where he is to embark Lieut. Col. Evans and one hundred men of the 41st Regiment and in the event of the enemy's vessels being still in the harbour of Presque Isle to keep them there until I can send him assistance which can be done soon if sailors are sent immediately as I can find guns that will sufficiently arm the *Detroit* until those intended for her shall arrive. The *Detroit* will be launched in two days which I am extremely anxious for as she will then in every respect be in much greater security than on the stocks. I beg leave to observe that even an hundred seamen pushed on here immediately would in all probability secure the superiority of this lake, at all events enable us to appear on it until further efforts may be made. I am already weakened on shore by my efforts to enable Captain Barclay to appear on the lake. If he should receive an hundred seamen, I shall be necessitated to send more soldiers on board the vessels to endeavour to supply the deficiency he labours under in respect to the number and quality of his sailors . . . .
Three hundred sailors are requisite to man His Majesty's vessels on the lake.†

Nor was Captain Barclay less plain spoken and insistent in his demands for aid. Writing after his arrival at Long Point on July 16th, he said :—

"I enclose a statement of the force of the rival squadrons and if prompt assistance is not sent, although my officers and crews will do everything that zeal and intrepidity can do, the great superiority of the enemy may prove fatal. . . . .
The *Detroit* will be ready to launch on the 20th inst but there is neither a sufficient quantity of ordnance ammunition or other stores and not a man to put in her. If that vessel was on the lake I would feel confident as to any action they might choose to risk fr the present although for

* "Canadian Archives," C. 679. p. 220.

† "Canadian Archives," C. 679. p. 224.

the good of His Majesty's Province I must attack. I cannot help saying that it is possible they may have an advantage, though I trust not a decided one.

"I have communicated with Sir J. Yeo on the same subject and if the exigencies of the service on Lake Ontario will not admit of his sending many seamen, even 50 would be of the greatest service at present but it will require at least 250 or 300 seamen to render His Majesty's squadron perfectly effective."*

The return enclosed showed that his squadron then consisted of the *Queen Charlotte* of 18 guns manned by forty French and English Canadians, twenty-five of the Newfoundland Regiment and forty-five of the 41st Regiment; the *Lady Prevost* of twelve guns manned by thirty Canadians, ten Newfoundlanders, and thirty-six of the 41st Regiment; the *Hunter* of six guns, twenty Canadians, four Newfoundlanders and fifteen of the 41st Regiment; the *Erie* and *Little Belt*, each of two guns, with a crew of six Canadians, four Newfoundlanders and five of the 41st Regiment. The *Chippewa* of two guns had been left with General Procter. Barclay's available force consisted accordingly of five vessels carrying forty guns and 255 men for which Perry's two large brigs alone would be more than a match. At Long Point, however, he took on board seventy men of the 41st Regiment without whom he declared he would be unable to work his ships at all and sailed to blockade Erie as long as possible.

Whatever hopes they may have still entertained of effective assistance must have been dispelled by the Governor-General's very unsatisfactory replies. On June 20th, writing from Kingston he announced to Procter that he had given directions to General De Rottenburg to push on the remainder of the 41st Regiment and advised him to "encourage as much as possible the exertions of the navy; bring forward the united power to both services to crush the enemy's endeavours to obtain the ascendency on Lake Erie when a favourable opportunity presents itself."† But on July 11th, he rather curtly informed him that the "ordnance and ordnance stores you require must be taken from the enemy whose resources on Lake Erie must become yours. I am much mistaken if you do not find Captain Barclay well disposed to play that game."‡

Perry's squadron was fully armed and equipped by July 10th, but he

*"Canadian Archives," C. 679, p. 197.

†"Canadian Archives," C. 679, p. 113.

‡Ibid, C. 679, p. 216.

wisely refused to take the lake until provided with a sufficient complement of able seamen. The number then at his disposal is not stated but must have been at least thrice as many as Barclay had, though he was no doubt unaware of his opponent's weakness in this essential respect. He is said to have brought 152 from Newport but of these one-third were detained for service at Sackett's Harbour. Fifty-five were detailed to his assistance by Chauncey on May 29th and there must have been some at the navy yards at Black Rock and Erie before he took command. A recruiting station had been established at Erie and over one hundred ordinary seamen and landsmen besides forty marines had been enlisted. His command is said to have suffered much from disease but he must have had nearly three hundred seamen of all descriptions when Barclay appeared off the port on July 19th. His crews could no doubt have been easily completed with boatmen, soldiers, and militia but Perry would not consent to do this and risk defeat. The British squadron passed and repassed the harbour's mouth and in the afternoon disappeared in the direction of Long Point. On the 21st it returned and ran in close enough to exchange shots with the gunboats inside.

"It is a most mortifying situation for me," Perry wrote to General P. B. Porter, "my vessels being ready and no men being forwarded for them while an enemy of inferior force in vessels and guns are blockading us."

"Conceive of my feelings," he said in a letter to Chauncey, "An enemy within striking distance, my vessels ready and not men enough to man them. Going out with those I now have is out of the question. You would not suffer it, were you here."

Two days later Sailing-master Champlin arrived with seventy men. Letter after letter from the Secretary of War and from General Harrison were received urging immediate co-operation with the army advancing upon Detroit but Perry still firmly refused to move until supplied with satisfactory crews. "The vessels are all ready to meet the enemy," he informed Chauncey, "the moment they are officered and manned. Our sails are bent, provisions on board, and in fact everything is ready." In the same letter he sharply criticised the quality of the men lately sent him whom he described as "a motley set, blacks, soldiers, and boys." Chauncey sent the officers and men demanded but retorted that he "had yet to learn that the color of the skin can affect a man's qualification or usefulness. I have nearly fifty blacks on board of this ship and many of them are among my best men." The tone of his letter offended Perry so much that he requested the Secretary of War to remove him to some other station as "he could not serve longer under an officer who had been so totally regardless of his feelings."

On the 28th Barclay was obliged to abandon the blockade by stress of weather and lack of provisions, although he had perceived that the Americans had "everything near ready for hauling their vessels over the bar. When this is done," he admitted, "we must retire to Amherstburg."* The frequently repeated tale that he stated that he expected to find the enemy fast on the bar on his return must be dismissed as purely fictitious. On the contrary, he appears to have abandoned all hope of detaining them in that port, and informed General De Rottenburg that as soon as the sailors he still expected should arrive he would proceed to join General Procter, whom he hoped to find at Sandusky Bay, where he intended to land his soldiers, and then go on to Amherstburg to equip the *Detroit*. Finding that no seamen were on the march to join him, he again stood across the lake towards Erie on August 5th, and discovering that the American squadron was out of the harbour, bore away for Amherstburg.

On the following day Perry crossed the lake to Long Point with eight vessels, and returned to Erie, where he was joined on the 9th by Captain J. D. Elliott with eight officers and a hundred seamen from Lake Ontario. Chauncey, it appears, was able to supply Perry from time to time with drafts of men without weakening his force materially, while Yeo was unable to do anything for Barclay without risking the loss of his squadron.

Writing to Prevost on August 9th, Procter announced his repulse at Sandusky, and added, "The enemy's vessels are out of Presqu'Isle harbour, and so decidedly stronger than ours that Captain Barclay has been necessitated to return to Amherstburg with all haste to get the new vessel ready for sea, which she will be in eight or ten days, and then only want hands. Whatever may happen to be regretted may be fairly attributed to the delays in sending here the force your Excellency directed should be sent. Had it been sent at once, it could have been used to the greatest advantage, but it arrived in such small portions, and with such delays, that the opportunities have been lost. . . . . . You will probably hear of the enemy's landing shortly at Long Point, whence they may gain the rear of the Centre Division, and also affect my supplies. An hundred and fifty sailors would have effectually obviated this evil."†

*Can. Arch., C. 679, p. 517.

†"Canadian Archives," C. 679, p. 371.

On the 18th he informed the Governor-General that the *Detroit* was ready, "and, if we had seamen a few hours would place this district in security, which, it is incumbent on me to say, is not the case under present circumstances. My force must be still more divided on the advance of the enemy, and, as I man the fleet, my loss must be great. I entreat your Excellency to send me the means of continuing the contest. I do not expect the least assistance from the Centre Division. The fleet drops down to the bar this evening or early to-morrow morning, as the best situation to meet the enemy's vessels. Should a landing be attempted, it will not be possible to avoid the risk of an action tho' without seamen, and the enemy's vessels well manned.*

As he had not yet received any reply to his letter of June 24th from Sir J. B. Warren, Prevost had by that time determined, as a last resort, to lay up the troop-ship *Dover* at Quebec, and send most of her crew to the lakes. This decision was made known to Procter in a letter dated at St. David's on August 22nd.

"I have the satisfaction," he wrote, "to inform you, that the first lieutenant of that ship, with 50 or 60 seamen, are now at Kingston, from whence they will be forwarded, without delay, to Amherstburg. You will make this circumstance known to Captain Barclay. You will not fail in forwarding frequent and very particular details of the state of public affairs in the Western District, as the movement I have made to this from the centre of operations has arisen, in a great measure, from my anxiety respecting your situation, and altho' it may be one of some difficulty, you cannot fail in honourably surmounting it, notwithstanding the numerical superiority of the enemy's force, which I cannot but consider as overbalanced by the excellent description of your troops and seamen valourous and well disciplined.

"The experience obtained by Sir James Yeo's conduct towards a fleet infinitely superior to the one under his command, will satisfy Captain Barclay that he has only to dare, and the enemy is discomfited."†

Such a letter could not fail to wound the feelings of both Barclay and Procter, when they had begged for assistance in vain for months, and we accordingly find the latter replying on the 26th.

"Your Excellency speaks of seamen valourous and well disciplined. Except, I believe, the 25 Captain Barclay brought with him, there are

* "Canadian Archives," C. 679, p. 447.

† "Canadian Archives," C. 679.

none of that description on this lake—at least on board His Majesty's vessels. There are scarcely enough, and of a miserable description, to work the vessels, some of which cannot be used for want of hands, such even as we have. I have the highest opinion of Captain Barclay, and have afforded him every aid I possibly could. . . . .
Captain Barclay has, besides the Royal Newf'dland, one hundred and fifty of the 41st Regt., better soldiers they cannot be, but they are only landsmen. . . . .
I will venture to offer my opinion to Your Excellency, that as long as Captain Barclay, without seamen, can avoid the enemy, he should do so. All my ordnance is on board, except the field, and in the event of any disaster to the fleet, the arrival of any body of seamen would be of no use whatever. Seamen should be pushed on even by dozens."*

The day before, Perry's squadron had left its anchorage among the Bass Islands, where great numbers of boats were being collected for the transportation of troops, and after reconnoitering Amherstburg dropped down the lake about twenty miles to a settlement on the Canadian side, where they seemed to contemplate landing. But two or three days later it again disappeared, and was supposed to have gone to Long Point.

"I can assure Your Excellency," Procter wrote on the 29th, "that every effort is making to have the fleet as effective as possible, especially in rendering the men expert at the guns, and that on the arrival of the officers and seamen, offensive operations will commence, tho' I must say, because I know it to be the case, that the supply of both officers and seamen is very inadequate. Your Excellency is not aware that the state of the Provincial Marine here was scarcely better than that on Lake Ontario, which it has been found requisite to lay aside. Interested individuals have prevented this truth from appearing, that the *Navy* might not be on this lake. I informed Major-General Sheaffe that the change was equally requisite here. I look on Captain Barclay's arrival here, tho' late, as a fortunate circumstance. I should have been very averse to sending soldiers on board but with officers of the Royal Navy. I feel it a duty incumbent on me to state circumstances as they really are. There are not on the fleet more than four-and-twenty *seamen* . .
. . . .
I entreat your Excellency to direct more sailors to be sent to this lake."†

Barclay wrote Yeo on September 1st:—

* "Canadian Archives," C. 679, p. 491.

† "Canadian Archives," C. 679, p. 504.

"By exercising the soldiers at the guns, I hope they will make a good hand of it. I trust you will add to the men of the *Dover*. The quantity of beef and biscuit consumed here is enormous, as there are such hordes of Indians with their wives and children. I am sure, if you saw my Canadians, you would condemn every one, with perhaps one or two exceptions, as a poor devil not worth his salt."

On the very day this was written, Yeo had landed two lieutenants, two gunners, and forty-five seamen, at Burlington, for the Lake Erie squadron, with twelve 24-pounder carronades, intended for the armament of the *Detroit*. The guns went no further, but the seamen, commanded by Lieut. George Bignall, late of the *Dover*, arrived at Amherstburg on the 6th, much fatigued by the journey. In this detachment there were no less than sixteen boys, and probably none of the seamen were very efficient in gunnery. Barclay wrote at once to say that the number was "totally inadequate" to make his squadron effective, but "deplorably manned as it was," unless he received certain information that more seamen were on their way to join him, he would be obliged to give battle to the enemy. Bignall was put in command of the *Hunter*, and his men distributed among all the vessels, so as to give a few of the best seamen to each.

Having waited in vain until the evening of the 9th, when there was no longer a single day's flour in store, and both troops and seamen had already been placed on half allowance of other articles, with the exception of spirits, of which there was so little that it was entirely reserved for the day of battle, after consulting with General Procter and obtaining his consent, Barclay entered the lake with six vessels. His flagship, the *Detroit*, was armed with two long twenty-four pounders, one eighteen on a pivot, six twelves, eight nines, a twenty-four, and an eighteen-pound carronade. Most of this strange medley of guns had been taken from the ramparts of Fort Amherst, and the only means of discharging them was by snapping pistols over the touch-hole. Sails, cables, blocks, and anchors were also borrowed from the other vessels to enable the *Detroit* to take the lake. The *Queen Charlotte*, Capt. Robert Finnis, carried one long twelve on a pivot, one nine, and fourteen twenty-pound carronades. The *Lady Prevost*, Lieut. Edward Buchan, had one long nine mounted on a pivot, two sixes, and ten twelve-pound carronades. The *Hunter*, Lieut. George Bignall, mounted four sixes, two fours, and two two pounders, besides two twelve-pound carronades. The *Little Belt* carried one long twelve on a pivot, and two sixes; and the *Chippewa* a single nine-pounder on a pivot. The armament of the three latter vessels was so contemptible that it scarcely deserves to be taken into consideration. Like Lord Cochrane, when he sailed in the *Speedy*, the commander of any one of them might have paced the deck with an entire broadside of shot in his pockets.

The broadside force of the squadron accordingly consisted of twenty long guns, ranging in calibre from two to twenty-four pounders, throwing in the aggregate 195 pounds of shot, and fourteen carronades throwing 264 pounds.

At daybreak on the morning of the 10th the American squadron was discovered in motion among the Bass Islands, near Put-in Bay. When last seen it had been reported to consist of twelve vessels, but only nine could then be distinguished, and it was afterwards learned that the schooner *Ohio* and two tenders had been detached to obtain provisions. The brig-corvettes *Lawrence* and *Niagara*, each carried two long twelves and eighteen thirty-two-pound carronades, and were undoubtedly more than a match in close action for the whole British squadron. Perry had, besides these vessels, the brig *Caledonia*, of two long twenty-fours, and one twenty-four pound carronade; and the schooners *Ariel*, of four long twelves, *Scorpion*, one long thirty-two, and a thirty-two pound carronade; *Somers*, one long twenty-four, and a thirty-two pound carronade; *Porcupine* and *Tigress*, each a long thirty-two, and *Trippe*, a long twenty-four. All of these guns were mounted on circles, and could be fought on either side. The total broadside force of the American squadron consisted, therefore, of thirteen long guns, throwing 264 pounds of shot, and twenty-one carronades throwing 664 pounds. In the early part of the action, it is stated that the *Lawrence* and *Niagara* used both of their long guns on the engaged side.

The standard British authority, William James, submits the following comparative statement of force:—

BRITISH SQUADRON.

NAME.	Guns in Broadside.	Lbs.	Men.	Tons.
Detroit	10	138	50 Seamen	305
Queen Charlotte	9	189		280
Lady Prevost	7	75	85 Canadians	120
General Hunter	5	30		74
Little Belt	2	18	210 Soldiers	54
Chippewa	1	9		32
	34	459	345	865

AMERICAN SQUADRON.

NAME.	Guns in Broadside.	Lbs.	Men.	Tons.
Lawrence	10	300		
Niagara	10	300		
Caledonia	3	72		
Ariel	4	48		
Scorpion	2	64	580	1,530
Somers	2	56		
Porcupine	1	32		
Tigress	1	32		
Trippe	1	24		
	34	928		

The accuracy of James, as far as the number and calibre of the guns on both sides is concerned, is admitted, with the exception that he understated the weight of metal of the American squadron by eight pounds, on the supposition that the *Caledonia* mounted three twenty-four pounders, but it is disputed by most American writers as to tonnage and the number of men. But in regard to these points they differ widely among themselves. Mr. Roosevelt is the only one who furnishes a comparative statement, which is as follows:—

AMERICAN SQUADRON.

NAME.	Tons.	Total Crew.	Crew fit for duty.	Broadside Lbs.
Lawrence	480	136	105	300
Niagara	480	155	127	300
Caledonia	180	53		80
Ariel	112	36		48
Scorpion	86	35		64
Somers	94	30	184	56
Porcupine	83	25		32
Tigress	96	27		32
Trippe	60	35		24
	1,671	532	(416)	936

BRITISH SQUADRON.

NAME.	Tons.	Crew.	Broadside Lbs.
Detroit	490	150	138
Queen Charlotte	400	126	189
Lady Prevost	230	86	75
Hunter	180	45	30
Chippewa	70	15	9
Little Belt	90	18	18
	1,460	440	459

In another place, however, Mr. Roosevelt states that the number of Barclay's effective men "was most probably somewhat less than Perry's."* Dr. Usher Parsons, the assistant surgeon of the *Niagara*, states that the crews of the American squadron consisted of about 600 men, of whom 78 were reported unfit for duty the day previous to the action. Mr. Burgess adopts this statement, while Emmons, Lossing, and Bancroft bring the number down to 490, and McAfee, who is followed by the American Secretary of War, General Armstrong, and others, further reduces it to "four hundred seamen and marines." The accuracy o Mr. Bancroft's statements may be judged from his assertion that "the British had the superiority, their vessels being stronger, and their forces more concentrated. . . . . . In action, at a distance, the British, who had thirty-five long guns, had greatly the advantage." Mr. Roosevelt takes the number 532, given by him from a prize list published in the American State papers, which classifies them as 329 officers and seamen, and 158 marines and soldiers, and 45 volunteers.

An official return shows that three lieutenants, an assistant surgeon, eight sergeants, four drummers, and 234 rank and file, of the Newfoundland and 41st Regiments, embarked on board Barclay's vessels.† If fifty seamen and eighty-five "Canadians" be added, as stated by James, the total number of officers and men on board must have exceeded 385.

As to the comparative size of the vessels, Mr. Cooper, who is far from being impartial, states that the "*Lawrence* and *Niagara* measured 110 feet on deck, and had more than 29 feet of moulded beam; or were of about 450 tons carpenter's measurement. Authentic accounts from the Custom house show that the *Detroit* and *Charlotte* were less than 100 feet on deck, and each had less than 27 feet beam. The *Prevost* and *Hunter* were much lighter vessels than has been generally supposed, and the armament of the last was very insignificant."‡ Mr. Roosevelt, it will be noted, ignores this evidence, and asserts that the *Detroit* was slightly larger than the *Lawrence* or *Niagara*. Mr. Dobbins, on the authority of his father's measurements, states the entire tonnage of the American squadron at only 840, and that of the British at 826, agreeing in the latter case very nearly with James. These accounts are, of course, hopelessly at variance, but there can be scarcely any doubt that the American squadron was actually much superior to the British, both in tonnage and number of men. A considerable number of the

* "Naval War of 1812." p. 261.

† "Canadian Archives." Q. 123, p. 67.

‡ "Naval History" (Edition of 1846), Vol. II., p. 194—Note.

seamen had served on board the *Constitution* in her actions with the *Guerriere* and *Java*, and were considered expert gunners. Mr. Roosevelt certainly falls far short of the truth when he says that "the *Niagara* might be considered a match for the *Detroit*, and the *Lawrence* and *Caledonia* for the five other British *vessels*."*

The British squadron was foredoomed to defeat because of its unpreparedness. Fugitives and deserters from Canada had kept Perry well informed of the state of the British vessels, and he was, perhaps, over-confident, while Barclay knew that the odds against him were so great that scarcely anything short of a miracle could save him.

When the American squadron was first seen the wind blew gently from the southwest giving Barclay the weather gage. He at once bore up with the intention of coming to an action among the islands but the wind very soon shifted to southeast, bringing the enemy directly to windward. All that could then be done was to heave to and form line of battle heading to the southwest, "according to a given plan so that each ship might be supported against the superior force of the two brigs opposed to them."† This was in the following order, *Chippewa*, *Detroit*, *Hunter*, *Queen Charlotte*, *Lady Prevost*, *Little Belt*.

The American squadron approached slowly with a wind that was sometimes scarcely perceptible and sometimes rose to a four or five knot breeze. A light shower of rain came on, passed over, and left the sky perfectly cloudless. It was quite ten o'clock before Perry cleared the islands, and an hour later, when about three miles distant he formed his vessels into the conventional closehauled column of attack a cable's length apart with the *Ariel* leading followed by the *Scorpion*, *Lawrence*, *Caledonia*, *Niagara*, *Somers*, *Porcupine*, *Tigress* and *Trippe*. The distance from front to rear of his column was accordingly about a mile when all the ships preserved their proper distance, and the attack was delivered obliquely at an angle of nearly fifteen degrees by which he avoided being raked fore and aft as he approached and could return the fire from the British squadron with his broadside guns trained sharply forward. He then hoisted on his flagship a blue banner bearing in large white letters the words ascribed to the dying Lawrence "Don't give up the ship!"

At fifteen minutes before noon a bugle sounded on board the *Detroit* which became the signal for three hearty cheers from the crews of the

* "Naval War of 1812," pp. 261-2.

† Barclay to Yeo," Canadian Archives," Q. 123.

squadron. Then the flagship fired her long twenty-four at the *Lawrence* but the shot fell short. Five minutes later she found the range with the same gun and struck Perry's ship fair on the bow. *Scorpion* hove to at once and replied with her long gun but the *Lawrence* kept silently on her course until five minutes to twelve when both her twelve pounders were fired simultaneously from the two forward starboard ports. Then at noon precisely several shots were fired from her carronades which fell far short. The *Detroit* and *Chippewa* continued to direct their fire solely upon her but owing to the want of even the rude appliances for discharging the guns generally in use at that time it was necessarily slow, and only the three heaviest guns on the first named vessel could have had any material effect although the smoothness of the water favoured precision in gunnery. In fifteen minutes the *Lawrence* gained a position within canister distance, that is to say about three hundred yards from the *Detroit*, where she hove to and fired her entire broadside. By that time the *Caledonia*, *Niagara* and *Somers* had engaged the *Hunter* and *Queen Charlotte*, at first opposing a long thirty-two, two twenty-fours and two twelves to a single twelve, two nines, and two sixes and later on the *Niagara* firing all her broadside guns at such a distance that they did little or no damage. After continuing this rather unequal contest for about a quarter of an hour and observing that his assailants dis played no inclination to come any nearer until they had disabled his ship, Captain Finnis directed the master's mate to bear up, pass the *Hunter* and lay the *Queen Charlotte* on the uarter of *Lawrence* where his carronades would become effective. But ust as this change of position was on the point of being successfully accomplished and before a man had been hurt on the *Queen Charlotte* a round shot from one of the American schooners instantly killed both Capt. Finnis and Lieut. S. J. Garden of the Newfoundland Regiment who commanded the troops. This was an irreparable loss and Sir James Yeo did not hesitate to say that if Finnis had lived the result of the battle would have been different; a few minutes later the first lieutenant, John Stokes, was struck senseless by a splinter. The command then fell to Lieut. Robert Irvine of the Provincial Marine, a gallant young officer, who as Barclay reported "behaved with great courage but his experience was much too limited to supply the place of such an officer as Captain Finnis." The only officers then remaining to assist him were a master's mate of the Royal Navy, two boy midshipmen of the Provincial Marine, a gunner and a boatswain. Of ten seamen belonging to the *Dover* who had been assigned to this ship one had been killed and four wounded. The remainder of the crew had suffered in proportion and nearly all this loss had been inflicted by the raking fire of the *Caledonia* and two other schooners which were absolutely out of range of the *Queen Charlotte's* guns. This ship consequently soon fell out of her new station and henceforth failed to render any material assistance to the *Detroit.* But the duel between that vessel and the *Lawrence* continued at close range for more than two hours. In their eagerness to disable their principal antagonist quickly the American gunners are believed to have overloaded their carronades with shot, and either from this cause or some other, their fire was not nearly as effective as had been expected, while the British ship although so greatly overmatched in weight of metal and other respects certainly succeeded in inflicting far more injury than she received from this particular opponent, but the long guns of the *Ariel,* the *Porcupine* and even the *Caledonia* had done her much damage. Gun after gun ceased firing as they were disabled or had their crews swept away until about half-past-two the *Lawrence* was entirely silenced and dropped astern while the remaining vessels continued to drift slowly ahead and to leeward with the rising wind. The destruction on board of her had been terrible. Two officers and twenty men were killed and six officers and fifty-five men wounded. Her masts were standing but every brace and bowline had been shot away. Her hull was dreadfully shattered. Most of the guns on the engaged side were dismounted, their breechings having been torn away or their carriages knocked in pieces until but one could be discharged.

At the rear of the line things were going badly with the British. Lieut. Bignall, commander of the *Hunter*, finding that the American schooners were rapidly disabling his vessel while the shot from his light guns were falling short, made sail to the front in the hope of assisting the *Chippewa.* The *Lady Prevost* and *Little Belt* were then attacked by the *Somers*, *Tigress*, *Porcupine* and *Trippe* which remained at long range and battered them deliberately to pieces with entire impunity. The *Lady Prevost* lost men rapidly and her commander, Lieut. Buchan, was disabled by a wound in the head which rendered him temporarily insane. The command then devolved upon Lieut. Rolette of the Provincial Marine who was soon afterwards severely injured in the side and badly burned by an explosion which disabled several of his crew. Finally the rudder was cut away by a round shot and the *Lady Prevost* drifted helplessly out of action to leeward. The *Little Belt* lost her commander and escaped destruction only by running to the head of the line where she was entirely out of the fight.

All this time the *Niagara* had remained in her original station, a cable's length astern of the *Caledonia* which had avoided coming within carronade distance, and consequently had effected little, although firing her two long guns and occasionally a broadside. When finally the *Detroit* drifted astern silent and disabled, the *Caledonia* passed her to leeward and the *Niagara* coming forward with the freshening wind went to windward of her and sent a boat on board for a supply of round shot. At this Captain Perry determined to abandon his ship and transfer his flag to the *Niagara*, which was then nearly abreast of her at a distance which was variously estimated from thirty yards to half a mile, but probably did not exceed three or four hundred yards. Telling his wounded first-lieutenant, Mr. Yarnall, that he would leave him to surrender the ship he entered a boat and reached the *Niagara* in safety. When he came on deck he informed Captain Elliott that his own vessel was quite disabled, complained that he had been sacrificed and that the conduct of the schooners in keeping so far away had lost the battle. He does not appear to have accused Elliott at that time of any misconduct and the latter cordially volunteered to carry orders to the laggard vessels. The motto flag of the *Lawrence* had been either shot away or hauled down and dropped overboard, where it was found floating by Purser McGrath who commanded the boat from the *Niagara*, and her colours were struck soon after Perry's departure, when it is said by one account only nine, and by others fourteen or eighteen unwounded men remained on board.

Finding that the *Niagara* had received comparatively little injury, Perry hoisted the signal for close action and bore down directly for the centre of the British squadron, which was then huddled in a disorderly group about their flagship. When his ship gained the weather bow of the *Detroit*, he fired a broadside, and Captain Barclay, who had already received a severe contusion on the hip, was stretched senseless on the deck by a shot which tore away his remaining arm and part of his shoulder blade. His hurt was supposed to be mortal and he was carried below. First-Lieutenant Garland had been mortally wounded early in the day, and Second-Lieutenant George Inglis took Barclay's place on the quarterdeck. As most of the larboard guns were disabled he tried to wear ship to avoid being raked and to bring the other broadside to bear, but the *Queen Charlotte* running up to leeward at that moment, the two ships fell foul and remained for some time unable to reply to the raking fire of the Niagara with a single gun. Perry's ship then passed through the British squadron firing her port broadside into the *Chippewa*, *Little Belt* and *Lady Prevost*, and her starboard guns into the entangled *Detroit* and *Queen Charlotte*, which she then engaged close to leeward within pistol shot. These wo ships were cut off and practically surrounded by the American squadron. The *Scorpion* on their weather bow, the *Ariel* nearly abeam, the *Caledonia* on their weather quarter, the *Somers*, *Tigress* and *Porcupine* nearly astern, the *Trippe* on their lee quarter and the *Niagara* on their lee bow concentrated all their fire on these hapless vessels. They are said to have suffered still more from the deliberate gunnery of the schooners than from the more hurried broadsides of the *Niagara*. "The efficiency of the gunboats was fully proved in this action," writes an eyewitness, "and the sterns of all the prizes bear ample testimony of the fact. They took raking positions and galled the enemy severely. The *Lady Prevost* lost twelve men before either of the brigs fired on her."*

When at length the *Detroit* got clear, Inglis directed the *Queen Charlotte* to shoot ahead if possible, and attempted to back the foretopsail to get astern when he found his ship completely unmanageable. A few minutes later the *Queen Charlotte* hauled down her colours. The *Detroit* was then exposed to the whole fire of all the American vessels, raking her ahead and astern. The mizentopmast and gaff had fallen, the other masts were badly wounded, most of the stays and braces were cut away, the hull was much shattered and many guns had been disabled. Seven or eight of the ten experienced seamen were killed or wounded, and more than half of the entire crew had fallen at their stations. In this situation, on being hailed from the *Niagara*, Inglis replied that he would surrender and the other vessels rapidly followed his example.

The beaten squadron had been fought to the last extremity beyond a doubt. "The sides of the *Detroit* and *Queen Charlotte*," said an eyewitness, "were shattered from bow to stern; there was scarcely room to place one's hand on their larboard sides without touching the impression of a shot, a great many shot cannister and grape were found lodged in their bulwarks, which were too thick to be penetrated by our carronades unless within pistol shot distance. Their masts were so much shattered that they fell overboard soon after they got into the bay."†

Every commanding officer and second in command of the British vessels had fallen. In all forty-one officers and men had been killed and ninety-four wounded. The loss of the American squadron was officially stated at twenty-seven killed and ninety-six wounded, of whom two killed and twenty-seven wounded were reported on board the *Niagara*. This seems to have been understated, as Lieutenant Montgomery declared on the court-martial of Captain Elliott that the total loss on the *Niagara* was thirty-three or thirty-four and an affidavit was put in, made by Dr. Barton, the surgeon, which stated that "the exact

*Brown, "Views of the Campaign of the North-Western Army," pp. 90-1.

†Brown, "Views of N W. Campaign," 1813, p. 89.

number, including those dangerously wounded, was twenty-seven, and the slight cases not reported must have amounted to six or eight more —that five were killed during the action and a few died soon after."

The chances of war had throughout favoured the American squadron. There was first the sudden change of wind which gave it the weather gage, then the death of Captain Finnis, and finally the fouling of the *Detroit* and *Queen Charlotte*. Even Mr. Roosevelt feels bound to admit that "if the victory had not been so complete it might have been said that the length of the combat and the trifling disparity in loss reflected more credit on the British."

The results of the battle were of the highest importance. The control of the upper lakes passed over to the victors. General Procter was forced to retreat from Amherstburg and owing to his indecision and unpardonable negligence was overtaken and routed.

But considerable as these advantages were, much greater were confidently expected. "Mackinac passes into our hands of course," said a writer in *Niles' Weekly Register*. "St. Joseph's, too remote for intelligence or succour from the enemy, is given into our possession. All the places of deposit for Indian supplies will be broken up, and the savages employed in the *business* of the British during the summer and cut off at this critical season from their accustomed resources must perish by thousands for want of food and clothing. The trade of the North-West Company, a mighty mercantile establishment of vital importance to Canada and of great consideration to the Mother Country, is done. In less than four weeks we may have the reality of the things here anticipated."

But these expectations were all doomed to remain unfulfilled. Most of the Indians with Procter joined the Centre Division of the British army at Burlington and took part in General Drummond's winter campaign. Others having already returned westward arrayed themselves again under Dickson's leadership next year. On the lakes misfortune attended every movement of the Americans. Four of their vessels, the *Ariel, Chippewa, Trippe* and *Little Belt* were destroyed at the capture of Buffalo (December 31st, 1813). An expedition against Mackinac was repulsed with severe loss (August 4th, 1814). Two schooners, the *Porcupine* and *Somers*, were captured, by boats off Fort Erie (August 11th, 1814), and two others, the *Scorpion* and *Tigress*, left to blockade Mackinac were taken in a similar manner on September 3rd and 4th. Practically the only service of much consequence performed by the American squadron was the conveyance of a body of troops to Long Point (May 14th, 1814), and covering the landing of a division of their army at Fort Erie (July 3rd, 1814).

THE MESENTERIAL FILAMENTS IN *ZOANTHUS SOCIATUS* (ELLIS).

By J. Playfair McMurrich, M.A., Ph.D.

(*Read April 29th, 1899.*)

Several years ago I began a study of the mesenterial filaments of *Zoanthus sociatus* (Ellis), taking this form as a representative of the order Zoantheæ, and intending, eventually, to extend my observations to other species and other groups. Various matters having in the meantime presented more pressing claims for attention, I have, so far, been unable to carry out my original plan. I have, however, been able to study with considerable thoroughness the filaments of the adult *Zoanthus sociatus*, and have also secured some data as to their development in bud-embryos. I have not been successful in obtaining egg-embryos of this species, but have observed certain interesting peculiarities in the development of the filaments in some Zoanthid larvæ, whose parentage could not be determined, some of which I collected myself, while others I owe to the kindness of Mr. Alexander Agassiz, who obtained them by the surface net in West Indian waters.

It has seemed to me advisable, notwithstanding the imperfections of my materia, to place my observations on record; the more so that it seems improbable that I shall be able to carry out my original plan of a thorough study of the filaments of the Anthozoa both from the histological and the embryological side.

I.—Historical.

Before considering the literature which refers especially to the filaments of the Zoanthidæ, a brief review of the literature of the Hexactinian filaments seems advisable, since it is in this group that the filaments have been most thoroughly studied.

Of the structures usually grouped together as parts of a mesenterial filament, the acontia, which are extruded from the body by the Sagartiadæ, were naturally the first observed, having been described by Dicquemare in 1775, and, according to Contarini, by Gesner as far back as 1558. The first description of the filament proper, of which I am aware was by Spix (1809),* but from his time onwards, frequent references to them occur. The older authors knew only that portion of the filament which we now term the *glandular streak* (Nesseldrüsenstreif), and they regarded this as a coiled tube occupying the free edge of the mesentery. The supposed tubular character of this structure led it to be considered either as a reproductive organ or a reproductive duct, a view to which Teale (1837) was the first to take exception. He, believing with Rapp (1829), that testes did not occur in the Actiniæ, and that the ova developed without fertilization, and were, therefore, rather "germ granules" or "gemmiferous bodies" than true ova, and recognizing that the filaments were not oviducts, suggested that they might be analogous to the salivary, pancreatic and hepatic follicles of higher animals. Erdl (1842), by the discovery of testes, disproved the opinions of Teale and Rapp with regard to the organs of reproduction, but he too suggested a possibly hepatic function for the filaments.

The underlying idea of these suggestions of Teale and Erdl, that the filaments were concerned in the digestive process, gained in popularity as new observations were added, while at the same time their direct homology with liver, pancreas or salivary glands became more improbable. Without reviewing the various theories as to their functions at greater length, it may be stated that their participation in the digestive processes seems to be now generally accepted, chiefly owing to the observations of Krukenberg (1880), and Metschnikoff (1880), and, more recently, of Willem (1893).

The earliest recognition of a difference in the structure of the upper and lower portions of the filaments was by Hollard (1851), who, however, merely noted its existence. A more careful description of the upper part of the filament was given by Haime (1854), who not only recognized the acontia and the glandular streaks, but speaks of the upper parts as "gros cordons," each of which had attached to its sides "un feston très regulier et muni de cils puissants." Thorell (1858) also recognized the same three portions, terming the acontia "capsule cords," the glandular streaks "mesenterial threads," and the ciliated bands, on account of their proximity to the reproductive organs, "ovary cords."

Rathke, in 1840, had observed that the acontia of *Metridium dianthus* (*Act. plumosa*) were solid structures, and not hollow, as had usually been supposed, and a year later Leuckart (1841) advanced the idea that the

* I have not been able to consult the paper of Spix, and know it only by a quotation given by Teale ('37).

mesenterial filaments were also solid. Some later authors, such as Haime and Thorell, adhered to the earlier ideas, but Gosse (1860) described them as cords, and named them craspeda, failing, however, to recognize the ciliated bands.

The first careful study of the filaments by modern methods was made by von Heider (1877). He confirmed Leuckart's observations as to their solidity, showing that the central axis of the filament was really the expanded edge of the connective tissue (mesoglœa) of the mesentery. He also figured the trilobed condition of the upper part of the filament, but failed to perceive the peculiar nature of the epithelium of the lateral lobes, each of which, according to his idea "das für die Mesenterialfilamente charakteristische Epithel trug." He seems, indeed, to have regarded the lobes merely as coils of the glandular portion of the filaments.

Finally, in 1879, the brothers Hertwig gave a very thorough account of the structure of the Hexactinian filaments, and practically nothing has since been added to our knowledge of them. The Hertwigs showed that they are solid structures, and that two portions are recognizable (three in the Sagartiadæ, which possess acontia). The upper portion consists of two wing-like lamellæ attached to the edge of the mesentery, which, in consequence, presented a somewhat trilobed condition in transverse section. The two lateral lobes are characterized by the epithelium of their outer surfaces being composed of long and very narrow cells, each of which bears a single cilium. These cells vary somewhat in length at regular intervals, so that longitudinal sections show the lobes to have a wavy contour. No glandular or nematocyst cells occur in this portion of the filaments which the Hertwigs termed the *Flimmerstreif*.

The lower portion consists of a more or less coiled cylindrical cord attached throughout its entire length to the edge of the mesentery. Its epithelium consists of gland cells, nematoblasts, supporting cells (Stützzellen), and sensory cells, the nerve fibres from these last forming a plexus between the bases of the other cells. This portion was termed the *Nesseldrüsenstreif*. In its upper part it is an almost straight cord, and in perfect mesenteries is continuous with the central lobe of the ciliated bands, and through this with the stomatodæal ectoderm ; in imperfect mesenteries, however, there is no such continuity with the ectoderm, the glandular streaks gradually fading out above, and the central lobe of the ciliated bands being wanting, the lateral lobes are separated by a depression lined by ordinary endoderm cells. It would seem from this that the central lobes of the ciliated bands is in reality the upper part of the glandular streak.

The arrangement just described may be regarded as the typical one for the Hexactinian filaments, though certain departures from it have been observed. Thus, in the Madreporaria the ciliated bands have not yet been observed, and they are also absent in certain Actiniaria, such as *Protanthea* and *Gonactinia* (Carlgren, 1893), and *Corynactis, Ricordea* and *Rhodactis* (Duerden, 1898).* So far, however, as the majority of the Hexactiniæ are concerned, both parts occur.

In the Zoantheæ the ciliated bands are, as a rule, the most striking portion of the filaments, and, consequently, have received more attention than the glandular streaks. The earliest writer on the filaments of the Zoantheæ, Lesueur (1817) describes, however, both portions in *Zoanthus Solanderi*, and in *Palythoa* (*Corticifera*) *glareola*. He described white filaments bordering the edges of the mesenteries, and noted that above, attached to the base of the stomach, there were "thick arcuated organs, situated in annulations, folded on each other, and divided through their whole length by a small "canal." He thought that the ciliated bands, or, as he termed them, the arcuated organs, might "be considered as performing the functions of the liver."

Dana (1846) described the glandular streaks in *P. cæsia* as spermatic cords, and noted that "above the spermatic cords there is attached to each larger lamella, immediately below the stomach, a pair of flat branchia-like organs." Verrill, who observed these same structures in 1869, agreed with Dana in regarding them as branchiæ, and they were again briefly described by Andres in 1877. None of these authors, however, seemed to regard the "branchia-like" or "arcuated" organs as parts of the mesenterial filaments, nor did Andres or Verrill perceive their identity with the ciliated bands of the Hexactiniæ which had been described by Haime and Thorell. This was left for R. Hertwig (1882), who described them as portions of the mesenterial filaments of his *Zoanthus Danæ* (?), and pointed out that it is quite erroneous to consider them as structures peculiar to the Zoantheæ.

Erdmann (1885) described both the glandular streaks and the ciliated bands, addng, however, nothing to our knowledge of their structure; and Koch (1886) failed to find mesenterial filaments in the forms which he studied, and maintained that they were not present, at least in the same form as in other Actinians.

*I may state that I can confirm Duerden's observations as to the absence of the ciliated bands in the last two forms.

Three years later I described (1889) the two portions of the filaments of *Zoanthus flos-marinus*, and, in addition, noted that the cells covering the surfaces of the mesenteries for some distance outwards from the glandular portions of the filaments were much higher than the general endoderm, and were loaded with green granules and fragments of sponge spicules. I suggested that this region of the endoderm was essentially digestive in function, an opinion which has since been confirmed experimentally by Willem (1893) for the Hexactiniæ.

Haddon and Shackleton (1891 and 1891*a*) confirmed my observations in other Zoanthids, and pointed out that slight variations in the form of the ciliated lobes occurred in certain forms, such as *P. axinellæ*. Finally, Von Heider (1895), in his description of *Zoanthus chierchiæ*, entered somewhat fully into the structure of its mesenterial filaments. He found in the ciliated bands what he regarded as a distinct area intervening between the central lobe and the ciliated portions of the lateral wings, and characterized by possessing numerous gland cells. He terms it the glandular swelling, and attributes to it a digestive function. He also observed the heightened epithelium lateral to the glandular portions of the filaments, which had been described by Haddon and Shackleton and myself, but objects to its interpretation as a digestive area, believing it to be the region in which the reproductive cells are to develop, none of the specimens which he examined possessing these cells.

II.—Descriptive.

1. *The Ciliated Bands.*

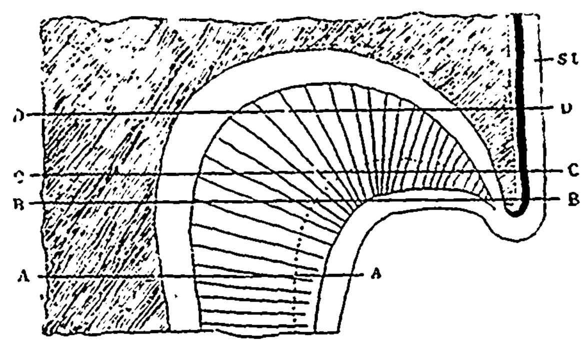

Fig. 1.—Diagram to show the relations of the ciliated bands. *St* = Stomatodæum; *AA*, *BB* = level of sections shown in Fig. 2: *CC* = level of Fig. *DD* = level of Fig. 4.

To correctly interpret a series of transverse sections of an adult *Zoanthus*, it is necessary to understand the course of the free edge of the mesentery. For this purpose I made a wax reconstruction of the upper part of one of the perfect mesenteries of *Zoanthus sociatus*, together with the portion of the stomatodæum to which the mesentery was attached. From this it is evident that the lower edge of the stomatodæum is bent back upon itself as represented in the diagram (Fig. 1), and its ectoderm becomes continuous with the epithelium of the large ciliated bands. From the reflected stomatodæum the free edge of the mesentery, with the filament, extends outwards, and then arches downwards. Consequently, in transverse sections through the column, the filament will be cut practically longitudinally above (Fig. 1, *DD*), then somewhat obliquely, and below transversely (Fig. 1, *AA*).

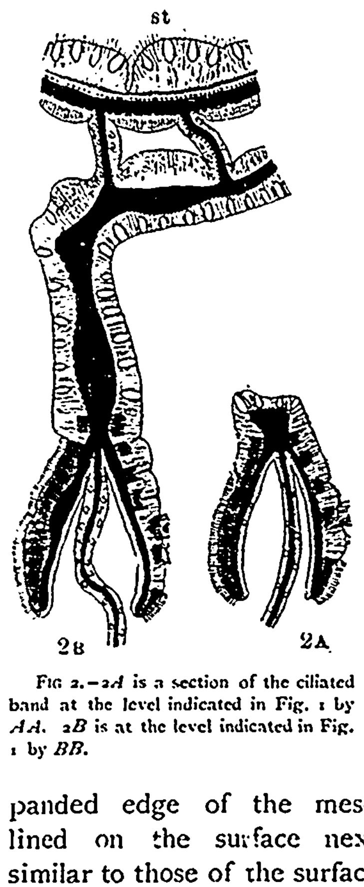

FIG. 2.—2*A* is a section of the ciliated band at the level indicated in Fig. 1 by *AA*. 2*B* is at the level indicated in Fig. 1 by *BB*.

I have represented in Figs. 2, 3 and 4, sections through the ciliated bands at approximately the levels indicated in Fig. 1 by *AA*, *BB*, *CC*, and *DD*. In Fig. 2, two mesenteries are shown, and the section probably not having been perfectly transverse, and the amount of contraction not having been quite the same in each mesentery, the filaments are cut at different levels—2A approximately at the level indicated by *AA* in Fig. 1, and 2B at the level indicated by *BB*. In 2A the filament is cut almost transversely. The free edge of the mesentery is occupied by a tolerably high epithelium which contains numerous clear gland cells, probably mucous in character; the free edge of the mesoglœa is somewhat expanded to support this epithelium, and, resting upon it, is a layer of very fine longitudinal muscle fibres. Probably a layer of nerve fibres is also present, but I could not be sure of it. From each side of the base of the expanded edge of the mesoglœa a strong wing-like lamella arises, lined on the surface next the mesentery by endodermal cells, similar to those of the surface of the mesentery; on the surface, turned away from the mesentery, however, the epithelium is of a different nature. Nearest the free edge of the mesentery it consists of cells for the most part resembling ordinary supporting cells (*Stützzellen*) with an occasional gland cell, containing numerous deeply staining granules, interpose Towards the free edge of the lamella, however, the cells are very slender, so that the nuclei seem closely packed, and are provided with rather long cilia; no gland cells are to be seen in this region. On one lamella of Fig. 2A, these cells form a continuous layer occupying the greater part of the surface, at the attached edge appearing to dip under the less specialized epithelium. On the other lamella they are arranged in groups, separated by patches of the less specialized epithelium, beneath which some of the groups, indeed, appear to lie. This latter arrangement is, however, merely an apparent one, and due partly to the contraction of the tissues, and partly to the obliquity of the section of this lamella; all the groups are really at the surface in an expanded filament. The arrangement in groups, however, is a normal characteristic, whose significance will be more readily understood from longitudinal sections, and the difference on the two sides of Fig. 2A is due to a slight difference in the plane on which the section passes through the two lamellæ, one of which is probably slightly curved.

In 2B a section higher up, at the level indicated by *BB* in Fig. 1, is figured. It cuts the median portion of the filament longitudinally and shows clearly its histological continuity, and, it may be said, its histological identity with the stomatodæal ectoderm. The structure of the epithelium of the lamella is the same as in 2A.

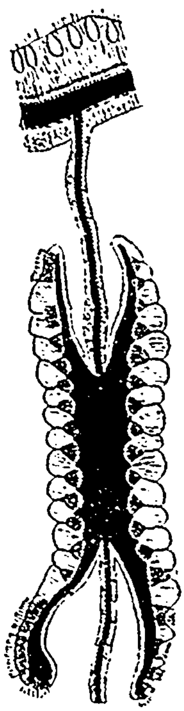

FIG. 3 — Section of the ciliated band at the level indicated in Fig. 1 by *CC*.

In Fig. 3 the section no longer cuts the median portion of the filament but takes the wings twice nearly transversely and the intermediate portion, near the line of attachment of the wings to the edge of the mesentery, practically longitudinally. It is at the level indicated in Fig. 1 by *CC*, the edge of the region of attachment of the wings to the edge of the mesentery being indicated in this figure by the dotted line. In this section one sees the ciliated areas dividing the less specialized, or, as it may be termed the *intermediate* epithelium into a number of bands, a depression between each of these leading down to a group of ciliated cells, it being plainly evident that these latter do not reach the surface merely owing to the state of contraction of the tissues.

In Fig. 4 the section passes along the line indicated by *DD* in Fig. 1, that is above, the line of attachment of the lamellæ to the mesentery.

FIG. 4.—Section through the ciliated bands at the level indicated in Fig. 1 by *DD*.

The intermediate portion of the ciliated band is again cut longitudinally and the marginal portion obliquely. The arrangement of the ciliated cells in bands is clearly seen, the bands being much wider in comparison with the bands of intermediate tissue than in the last section, indications, indeed, of their continuity being shown by the short but narrow and closely packed cells, which line the surfaces of each intervening ridge. Finally, it may be stated, in a section still higher up one finds a perfect continuity of the bands of ciliated cells, the section cutting the marginal ciliated cells longitudinally.

The general structure just described is essentially that described by previous authors and more especially by von Heider (1895). My interpretation of the various parts differs, however, somewhat from that given by von Heider. He recognizes the intermediate epithelium, but regards it as an endodermal layer separating the marginal ciliated ectoderm from the median lobe of the filament, which he identifies with the glandular streak of the Hexactinian filament. I shall return to a discussion of the nature of the epithelium of the median lobe later; in the meantime I may point out what seems to me to be a fundamental error in von Heider's interpretation. He regards the entire intermediate region of the wings as digestive in function, terming it the "Drüsenwulst" and identifying it with the endodermal areas of the glandular streaks which Willem (1893) has shown to be digestive.

As a matter of fact there are two very different kinds of epithelium in this intermediate region; (1) that lining the furrows which run across it and (2) that occupying the intervals between the furrows. The former is exactly like the epithelium found at the free margins of the lamellæ and is, indeed, continuous with this. In other words, the ciliated epithelium, which forms a continuous streak near the free edge of each lamella sends inward almost to the free edge of the mesentery a number of prolongations which line the bottom of depressions on the surface of the lamellæ. Each of these prolongations is separated from its neighbours by a non-ciliated band (at least I have not been able to detect cilia in my preparations) of epithelium. It is this arrangement of the ciliated cells in transverse streaks which produces the characteristic transversely striated appearance of the lamellæ noted by nearly all observers, and it is interesting to note that Thorell in 1857, with his usual accuracy, described the arrangement of the ciliated cells in transverse streaks in the ciliated bands of *Metridium dianthus*.

The intermediate area cannot then be regarded as consisting wholly of endoderm since it is generally admitted that the ciliated cells are ectodermal. Is then the intermediate epithelium endodermal and digestive? This is a question difficult to answer, but it may be said that the epithelium is certainly continuous with the stomatodæal ectoderm above and not with the endoderm. I do not find it essentially glandular in *Z. sociatus*; indeed it contains relatively few gland cells in comparison with the epithelium of the median lobe. Those which do occur, however, are very different from the usual stomatodæal glands with clear contents, since they stain deeply and are packed with granules. It is possible that such glands are digestive in function; they are especially abundant, as will be seen later, in the glandular streak of the filament, but they also occur here and there in the stomatodæal ectoderm and their occurrence in the intermediate epithelium cannot be accepted as evidence of its endodermal nature. From the evidence at my disposal I am inclined to regard the intermediate epithelium as being ectodermal as is the rest of the ciliated band epithelium, and think it erroneous to homologize it with the digestive, or rather ingestive, area described by Willem which is unquestionably endodermal. I think, however, that intracellular digestion does occur in this epithelium, as I have seen imbedded in it particles which were neither Zooxanthellae nor normal constituents of the tissue, but which may have been ingested food particles.

II.—The Glandular Streak.

Following a series of sections downwards below the level represented in Fig. 2A we find the lamellæ of the ciliated bands extending downwards for some distance, but they finally disappear, the median lobe of the filament alone persisting. The general appearance of the glandular streak has been described and figured frequently, and reference may be made to the figures given by von Heider (1895), Haddon and Shackleton (1891) and myself (1889). The epithelium of this part of the filament forms a rounded or crescentic layer resting upon a somewhat T-shaped enlargement of the edge of the mesoglœa. The tips of the crescent extend to about the tips of the transverse limb of the T, the outer surface of the limb being covered by a very different kind of epithelium, generally admitted to be endodermal. The general surface of the mesoglœa of the mesentery, immediately external to the attachment of the T-shaped enlargement, is covered by a thick endodermal epithelium, which, traced outwards, gradually diminishes in thickness to pass into the ordinary epithelium of the mesentery.

In *Z. flos marinus* I found (1889) in this thickened epithelium numerous foreign bodies and suggested that it was a special region for intracellular digestion. Haddon and Shackleton (1891*a*) have described the thickening in *Z. Macgillivrayi* and von Heider in *Z. Chierchiæ*, the latter however taking exception to my interpretation of its function, and believing it to be the area in which the reproductive elements will develop. This idea is readily disproved by the examination of specimens in which the gonads are developed. For instance, I have preparations of *Z. nymphæus* which show the thickened endoderm very distinctly, crowded with foreign bodies, and quite externally to this, in the region where the endoderm has assumed its usual low form, the sexual cells are found. On the other hand, my interpretation is confirmed by Willem (1895), for it is in exactly the region of the thickening that he finds an abundant ingestion of carmine particles in the Hexactiniæ, these forms also presenting thickenings of the endoderm, usually less pronounced than in the Zoanthids, immediately external to the glandular streaks of the mesenterial filaments.

It is very generally believed that the epithelium of the middle lobe of the ciliated bands is in direct continuity with the epithelium of the glandular streak; indeed it has generally been regarded as the upper part of the glandular streak. It appeared that there was a marked difference in *Z. sociatus* between this median epithelium and that of the glandular streak and to test the accuracy of this appearance I endeavoured to obtain a longitudinal section of the filament which would cut the epithelium of the median lobe above and the glandular streak below. After many trials I obtained a series from three successive sections of which it was easy to reconstruct a median section through the filament. Such a reconstruction is represented in Fig. 5, somewhat diagrammatically.

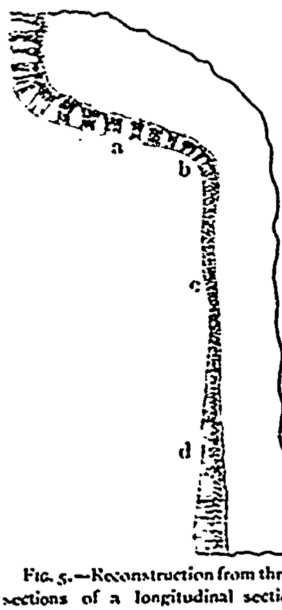

FIG. 5.—Reconstruction from three sections of a longitudinal section through the stomatodæum, the median lobe of a ciliated band and a glandular streak of *Z. sociatus*; *a-d* = the levels from which Figs. 6-9 are taken.

In Fig. 6 is shown the appearance of a portion of the stomatodæal ectoderm for the region indicated in Fig. 5 by *a*. It will be seen from this that the epithelium in this region is high and that it contains numerous gland cells with clear contents; gland cells

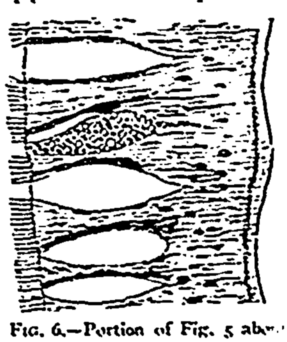

FIG. 6.—Portion of Fig. 5 about the region marked *a*, more highly magnified.

with granular contents are, on the contrary, rather rare. In addition, some darkly staining, slender, probably sensory, cells occur, the rest of the tissue being composed of ciliated cells which stain only moderately and are probably supportive cells. As I have already stated, the median epithelium of the ciliated bands is continuous with this above and is histologically identical with it. Tracing the section downwards, however, it will be found that the median epithelium gradually becomes lower, and, at a certain region, it changes somewhat abruptly its histological character.

Fig. 7 represents a portion of the epithelium at the region where the change takes place (*b* in Fig. 5). The upper part of the portion figured is essentially the same as the stomatodæal ectoderm, but in its lower part there appear cells which stain somewhat darker than the ordinary supporting cells and have large oval nuclei situated about the middle of their length. At the same time the large mucous gland cells disappear. Lower still (*c* in Fig. 5) the change is complete and an entirely new form of epithelium occurs (Fig. 8). In this the cells are still lower, they contain large oval nuclei arranged in about two or three layers at the middle part of the epithelium, and there is apparently an entire absence of gland cells. I could not distinguish cilia in this region in my preparations, but am not prepared to say that they do not exist.

FIG. 7.—Portion of Fig. 5 about the region *b*, more highly magnified.

FIG. 8.—Portion of Fig. 5 about the region *c*, more highly magnified.

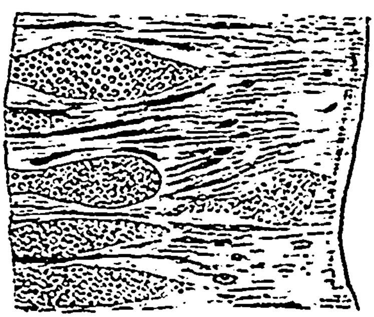

FIG. 9.—Portion of Fig. 5 about the region *d*, more highly magnified.

Following this stretch of tissue downward it is found to change again to form the epithelium of the glandular streak (Fig. 9). This is very high again, higher even than that of the stomatodæum. It consists, like the latter, of supporting, sensory and gland cells, but the gland cells are all of the kind with granular contents. I have found no nematocysts in the glandular streak of *Z. sociatus*, but their absence is by no means peculiar to that form.

It is clear then that in *Z. sociatus* there is neither a histological continuity nor a histological identity of the upper part of the median streak of the filament with the lower part or glandular streak proper. The upper part is merely a continuation downwards of the stomatodæal ectoderm, and this gives place to a low epithelium destitute of gland cells and of a generally indifferent character, below which the characteristic epithelium of the glandular streak comes into view. It seems to me from these results that one is not justified in assuming, as has so frequently been done, that the glandular streak epithelium is a prolongation of the stomatodæal ectoderm. What I have just described, taken in conjunction with the observations of E. B. Wilson (1884) on the development of the filaments in the Alcyonaria and with what I have found (1891) as to their development in the Hexactiniæ, seems to me rather to point to a complete distinction between the two kinds of epithelium, and I regard the structure of the adult filament of *Z. sociatus* as confirmatory of the conclusions obtained from embryological studies, that the ciliated bands of the filaments are ectodermal in origin, while the glandular streak proper is an endodermal structure.

III.—THE DEVELOPMENT OF THE FILAMENTS IN EGG EMBRYOS.

The material at my disposal for the study of the embryonic development of the filaments was not sufficient for an exhaustive study of the subject. The youngest larvæ already possessed twelve mesenteries arranged in the manner described by van Beneden (1890) and myself (1891*a*.). On none of the mesenteries were there any indications of the ciliated bands, but, on the other hand the glandular streaks were plainly indicated on the perfect mesenteries as an epithelium occupying the free edge of the mesentery and composed of cells with closely set, elongated and deeply staining nuclei, very different from those of the general endoderm of the mesenteries. But what is more interesting, on the lower part of the free edge of each of the imperfect mesenteries a similar, but smaller, patch of epithelium was plainly visible. In Fig. 10 is given a representation of a part of a section through the lower portion of

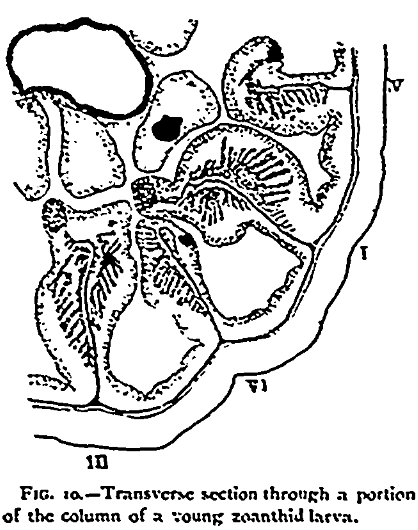

FIG. 10.—Transverse section through a portion of the column of a young zoanthid larva.

the column of one of these youngest larvæ. Owing to its base having been somewhat depressed by contraction this has been cut towards the central part of the section. Transverse sections of four mesenteries are shown; the two larger mesenteries are one of the macrodirectives (III) and one of those which I have taken to be the first formed (I), and the two smaller are those indicated in a previous paper (1891*a*, Pl.IX, Fig. 6) as V and VI.

The larger mesenteries, when traced upwards, are seen to become attached to the stomatodæum, while the smaller ones are imperfect. The epithelium which represents the glandular streak seems to be continuous above with the ectoderm of the stomatodæum in the cases of the perfect mesenteries, though close examination shows some slight differences in the two epithelia. In the cases of the imperfect mesenteries such a continuity is out of the question, and there is not the slightest indication of a band of ectoderm extending up the outer wall of the stomatodæum, across the under surface of the disk and thence down the free side of the mesentery, by which a connection between the glandular streak and the stomatodæum might be accomplished. The glandular streak epithelium can be traced upwards upon the imperfect mesenteries to a level a little above the lower edge of the stomatodæum, where it fades out, the free edges of the mesenteries being occupied from that point upwards by cells of exactly the same nature as those covering their surfaces. That there may have been in an earlier stage some continuity between the stomatodæal ectoderm and the glandular streaks of the imperfect mesenteries is possible; in my youngest embryos there are, however, no signs of any such continuity.

In the adult condition, mesenteries V and VI have no filaments (VI has in macrocnemic forms), and one might expect that older embryos would show a disappearance or diminution of the filaments of the mesenteries. In Fig. 11 is represented a part of a section through a somewhat older larva, in which the number of mesenteries still remains at twelve.

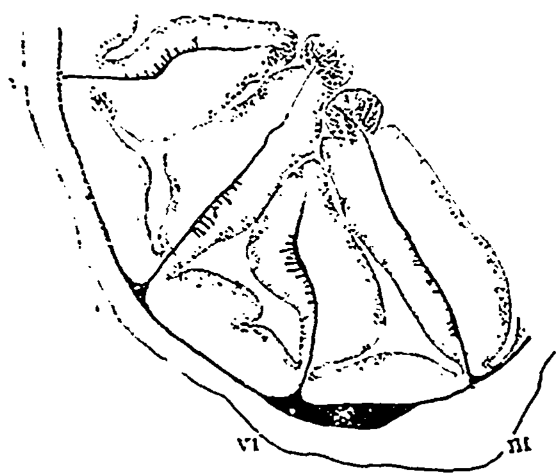

FIG. 11.—Transverse section through a portion of the column of a zoanthid embryo somewhat older than that from which Fig. 10 is taken.

The filaments, however, have assumed an appearance much more like those of the adult, and the histological differentiation of this epithelium is quite pronounced. The mesenteries figured are the same as those shown in Fig. 10, but of the opposite side of the body. It will be seen that in mesentery VI all traces of the glandular streak have vanished, but in mesentery V the streak is still persistent, and, indeed, has undergone a progressive development just as those of the perfect mesenteries. That this is not because the larva is the young of a macrocnemic species is shown by the fact that it is not mesentery VI, the additional perfect mesentery in these species, which has retained its filament, but mesentery V. Probably later stages would show a disappearance of the filament of this mesentery also; but the point which is of concern is the fact of the development of filaments on these imperfect mesenteries whose epithelium is, so far as can be ascertained, at no point in contact with ectoderm.*

IV.—THE DEVELOPMENT OF THE FILAMENTS IN BUDS.

The time relations of the ciliated bands and glandular streaks in buds is just the reverse of what obtains in the egg embryos, that is to say, the ciliated bands are the first to develop, the glandular streaks appearing later.

In a bud of *Z. sociatus* 2mm. in length, the stomatodæum is already formed, and on the edge of the perfect mesenteries, immediately below the lower margin of the stomatodæum, the ciliated bands can be seen presenting practically the same appearance as in adult polyps. Following a band downwards, it is found to disappear below, and no trace of the glandular streak can be found, and no enlargement of the endoderm just external to the free edge of the mesentery. Indeed, there is nothing to distinguish a perfect mesentery from an imperfect one, below the level of the stomatodæum, except its greater width. The free edge of both mesenteries is occupied by cells indistinguishable from ordinary endoderm, except by their apparently somewhat smaller size.

The glandular streaks begin to develop, however, soon after this stage, since in a bud but little older they were readily recognizable, and the ectoderm just external to them had become relatively very high, and

*Attention may be called to the fact that the discovery of filaments in these mesenteries serves to emphasize the correctness of the conclusions as to the order of the appearance of the mesenteries in the Zoantheæ which have been stated by Boveri (1889), and myself (1891*a*), and I may add that indications of filaments on the microdirectives can also be distinguished, though they are much less evident than those of V and VI, possibly on account of an earlier degeneration.

was packed with foreign bodies; in buds 3.5mm. in length all the parts of the filament occurring in the adult were present.

It is interesting to note that in the buds of Alcyonaria the same acceleration in the development of the ciliated bands has been observed by E. B. Wilson (1884), the glandular streaks in the egg embryos of these forms developing before the ciliated bands, as in Zoanthids.

V.—Conclusion.

I have shown above (1) that in adult polyps of *Z. sociatus* there is no histological continuity between the glandular streaks and the ciliated bands; (2) that in egg embryos the glandular streaks develop before the ciliated bands make their appearance; (3) that in the same embryos the streaks make their appearance on mesenteries that are not connected in any way apparently with the ectoderm; and (4) that in bud embryos the ciliated bands appear before the glandular streaks.

It seems to me from these facts that the ciliated bands must be regarded as being ontogenetically distinct from the glandular streaks. The two have been very generally regarded as different parts of the same structure, but this idea is, I think, untenable.

If they be recognized as distinct structures, there are no *a priori* reasons for regarding both as products of the same germ layer. The question of the origin of the filaments, whether from the ectoderm or from the endoderm, is one that has frequently been discussed, with very varying answers. The majority of authors have regarded both parts as ectodermal, or as endodermal, E. B. Wilson having been the first, from his studies on the Alcyonaria, to point out the probability of the development of the ciliated bands in these forms from the ectoderm and that of the glandular streaks from the endoderm. In my studies on the development of the Hexactinians (1891) I reached the same conclusion, and the evidence presented above seems to point to a similar story in the Zoanthids.

However, there is a more fundamental consideration at the base of all questions as to ectodermal and endodermal origin in the Cœlentera. Is there a sufficient fixity of the germ layers in these forms, whether the layers are regarded from the morphological or the physiological standpoint, to warrant the importance which has generally been attached to them? The germ layers have evolved; like other structures they have had a phylogeny, and, it may be remarked, that just as in other structures, we find discrepancies between the phylogenetic and ontogenetic development, so too we may expect, and undoubtedly do find, discrepancies between the phylogeny and ontogeny of the germ layers. It has generally been accepted that the Cœlentera represent a stage in the phylogeny of the germ layers, two of them being fully differentiated; indeed, Huxley's homology of the Cœlenterate ectoderm and endoderm with the epiblast and hypoblast of the embryologists may be regarded as one of the foundation stones of the germ layer theory. But, after all, can we directly homologize the embryological and Cœlenterate layers? Are the Cœlenterate layers morphologically differentiated? It seems to me that they are not; every kind of cell, glandular, muscular, sensory, ganglionic, and even nematoblastic, which we find in the ectoderm, occurs also in the endoderm. The Cœlentera represent a stage in the evolution of the diploblastic condition, rather than the completion of that condition, and we are assuming too much when we make a direct homology of their ectoderm and endoderm with the epiblast and hypoblast of, let us say, a vertebrate embryo.

I have spoken of only two layers in the Cœlentera, omitting the mesoglœa. This term, now generally accepted for the intermediate layer of the Cœlentera, is sufficient reason for so doing, since it implies a lack of homology of the intermediate layer with the mesoderm of higher types. It seems to me, and I have so expressed myself elsewhere, that if we are to seek for a homologue of the Cœlenterate mesoglœa in higher forms we must look for it in the limiting membrane which occurs just below the ectoderm. Indeed, a comparison of the mesoglœa with the limiting membrane of certain Polyclades is exceedingly instructive.

If, then, we regard the Cœlentera as presenting merely an approximation to a diploblastic condition, the distinction between an ectodermal and an endodermal origin of any of these parts becomes relatively of little moment. And, furthermore, we need not be surprised to find that structures which, in certain antimeres, develop from one so-called germ layer, may arise from the other in other antimeres. This may be the case with the glandular streaks. Both those who have spoken in favour of their ectodermal origin and those who have maintained that they were endodermal may have right on their side. The observations of Goette (1893), and Miss Hyde (1894), have given reasons for believing that, in the Scyphomedusæ, while the first pair of radial chambers is endodermal, the second pair is ectodermal in origin. If such variation occurs in this group in connection with such fundamental structures, surely we may meet with variations in the origin of the glandular streaks in the Anthozoa. H. V. Wilson may be quite correct in maintaining an ectodermal origin for the glandular streaks of the first four mesenteries of *Manicina* (1888), and altogether wrong when he extends this origin to the streaks of the later formed mesenteries.

I would conclude, from my own observations, that the ciliated bands are, probably in all cases, ectodermal, and that, in some mesenteries at least, the glandular streaks are endodermal; yet, I am prepared to accept as correct the ectodermal origin of the glandular streak on other mesenteries. It is to be understood that I use the terms ectodermal and endodermal here merely for convenience, and not as expressing a definite homology.

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ON THE STRUCTURE, MICRO-CHEMISTRY AND DEVELOPMENT OF NERVE CELLS, WITH SPECIAL REFERENCE TO THEIR NUCLEIN COMPOUNDS.*

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(Read January 14th, 1899.)

The finer structure of the nerve cell has attracted a great deal of attention in the last few years, chiefly because the cell body contains masses that have a peculiar affinity for certain nuclear stains. These masses were first observed in 1882 by Flemming,[1] who was not certain whether they were nodular thickenings of the ordinary protoplasmic fibrillæ or independent structures. His preparations, however, were, for the most part, from material that had been fixed in chromic or osmic acid, and stained in hæmatoxylin or carmine, and for this reason the bodies in question did not exhibit any distinctive staining properties. It was reserved for Nissl[2] who examined the cells of the cerebral cortex of mammals after fixation in alcohol and staining in basic aniline dyes, to show that these bodies stain differently from the remainder of the cell protoplasm, and in fact resemble in this respect the large nucleolus. For this reason these structures are commonly called Nissl granules or "Schollen." Some observers have employed other names, such as tigroid bodies, chromophile corpuscles, basophile or basic substance, cytoplasmic chromatin, etc.

The variable form exhibited by nerve cells from different sources with respect to these granules makes the selection of a suitable name based on morphological data difficult, but for the purposes of this memoir as

*A short account of some of the facts recorded here was given for me by Prof. Macallum before the Fourth International Physiological Congress, Cambridge, 1898, and the British Medical Association, Edinburgh, 1898. See Journal of Physiology, XXIII, supp. p. 33, and British Medical Journal, September 17th, 1898.

1 Flemming, W., "Vom Bau der Spinalganglienzellen," Festgabe für J. Henle, p. 12, 1882.

Also: "Zellsubstanz, Kern and Zelltheilung," p. 41, 1882.

2 Nissl, Fr., "Ueber die Untersuchungsmethoden der Grosshirnde," Tagebl. der Versammlung deutschr. Naturforscher, Strasburg, p. 506, 1885.

far as it pertains to the nerve cells of adults, the name of Nissl granules will suffice. It will be shown later that this name, in some cases at least, implies an incorrect inference as to the mode of occurrence of the chromophilous substance in the cell.

The chemical properties of the Nissl granules have been studied by Held,[3] Eve,[4] Mackenzie,[5] Bühler[6] and others. Held found the granules were soluble in dilute alkalies, did not digest in pepsin and hydrochloric acid, were not acted on by acids and gave no reaction with Millon's reagent, Adamkiewicz's or the xanthoproteic tests. Held, however, obtained a positive reaction for phosphorus by the employment of Lilienfeld and Monti's test for that element. He concluded from these reactions that the Nissl granules were of a nucleo-albuminous nature. Eve, however, was doubtful whether the granules were really dissolved in the alkali or were merely altered in their staining powers; and found that after treatment with acids or salt solutions, the granules stain more diffusely. Bühler found the granules were soluble in salt solutions as well as in alkalies. It has recently been observed that nuclear chromatin gives with the Millon reagent a definite reaction, and Macallum[7] has shown that the reaction of Lilienfeld and Monti does not differentiate the phospho-molybdate, formed by the combination of the molybdate employed and the phosphorus of the cell, from the ammonium molybdate which has simply been absorbed and retained.

The only undisputed evidence, therefore, adduced by Held in favour of the nucleoproteid nature of these granules is their resistance to digestion. His conclusion is, however, further supported by the observation of Mackenzie who obtained, after treatment with acid alcohol, a reaction for iron in the granules.

In the present research the micro-chemistry of the nerve cell has been reinvestigated by the more recent methods and the results indicate that Held's conclusion is correct, although, as we have seen, based on insufficient grounds.

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3 Held, Hans, "Beitrage zur Structur der Nervenzellen und ihrer Fortsätze."

Erste Abhandlung, Archiv. f Anat. u. Phys., Anat. Abth., p. 396, 1895.

Zweite Abhandlung, ibid, p. 204, 1897.

4 Eve, F. C., "Sympathetic Nerve Cells and their Basophil Constituent in Prolonged Activity and Repose," Journal of Physiology, XX, p. 334, 1896.

5 Mackenzie, J. J., "Investigations in the Micro-chemistry of Nerve Cells," Report British Assn., Toronto Meeting, p. 822, 1897.

6 Bühler, Anton, "Untersuchungen über den Bau der Nervenzellen," Verhandlungen der Phys. Med. Gesell. zu Würzburg, XXXI, p. 285, Verlag von Stahel, 1898.

7 Macallum, A. B., "On the Detection and Localization of Phosphorus in Animal and Vegetable Tissues," Proceedings of Royal Society of London, Vol. LXIII, p. 467, 1898.

The mode of occurrence of these granules in embryonic and foetal cells has evoked considerable interest. Vas[8] and Eve found the chromophilous substance uniformly distributed in the nerve cells of fœtal rabbits, and Szczawinska[9] observed the same for embryonic cells of selachians. Bühler noticed that the granules were entirely absent from the nerve cells at an early stage. Timofeew[10] observed that in the interval between the fourth and sixth day of incubation in the chick, the chromophilous substance increased markedly in amount and was uniformly distributed.

None of the above observers seem to have suspected any other than a cytoplasmic origin for this substance and none of them have followed out in detail the appearance of this substance in the cell. The nucleoproteid nature of these bodies suggested the nucleus as a possible source of the substance forming them, and this inference has been confirmed by a series of observations made on mammalian and avian embryos. Further evidence in support of the nuclear origin of these bodies is found by the examination of the structure of the nerve cells of animals in which no Nissl granules occur. These observations will form Parts 2 and 3 of the present memoir, while Part 4 will be devoted to the discussion of certain general considerations with respect to the structure of the nerve cell that have recently been the subject of much investigation.

The question of a good fixing agent for nerve cells has been discussed by many writers but more particularly by Flemming,[11] v. Lenhossek[12] and Held.[13] Flemming, v. Lenhossek and with them many others find that saturated aqueous sublimate is the most satisfactory fixing fluid for nerve cells. Held, believing in the foam-like structure of protoplasm, does not consider it as good as other fluids. Besides sublimate, Carnoy's fluid, Flemming's fluid and picrosulphuric acid are generally found to give good results. With all these fluids fair results were produced, but the sharpest granules and the clearest intergranular substance were obtained by using the modification of Foa's fluid as recommended by Bensley,[14] viz., equal

8 Vas, Friedrich. "Studien über den Bau des Chromatin in der Sympathischen Ganglienzelle." Arch. f. Mik. Anat., XL, p. 375. 1892.

9 Szczawinska, W., "Recherches sur le systeme nerveux des Selaciens," Arch. de Biologie, XV, p. 463, 1897.

10 Timofeew, D., "Beobachtungen über den Bau der Nervenzellen des Spinalganglien und des Sympatheticus beim Vogel," Inter. Monat. f. Anat. u. Physiol, XV, p. 259, 1898.

11 Flemming, W., "Ueber den Bau der Spinalganglienzellen bei Saugethieren, und Bemerkungen über den der centralen Zellen." Arch. f. Mik. Anat., XLVI, p. 379, 1895.

12 v. Lenhossek, M., "Ueber den Bau der Spinalganglienzellen des Menschen," Arch. f. Psychiatrie, XXIX, p. 345, 1897.

13 Held, H., l. c. and Arch. f. Anat. u. Phys., Supp., p. 273, 1897.

14 Bensley, R. R., "Mammalian Gastric Glands," Proceedings of Canadian Institute, Vol. I, Part 1, p. 11, 1897.

parts of sublimate saturated in ninety-five per cent. alcohol and of a two per cent. solution of potassium bichromate in water. Small pieces were left in the freshly prepared mixture for two to four hours, washed in fifty per cent. alcohol, and then passed through the grades of alcohol. Material intended for chemical investigation was fixed in alcohol. The cells obtained from alcohol fixation are not materially different from those obtained with other fluids. The cone of origin and the process of spinal ganglion cells have nearly the same appearance in well preserved alcohol tissue that they have in sublimate material. Flemming's failure to get good results with alcohol may have been due to the circumstance that he did not leave his tissue in the alcohol for a sufficient time. Three days in alcohol as in Flemming's[15] method is not enough to insure complete coagulation of the proteids of the cell.

After fixing and hardening the material was imbedded in paraffin, using oil of bergamot for infiltration. Sections were attached to the slide by the distilled water method and stained.

I.—THE STRUCTURE AND MICRO-CHEMISTRY OF THE NERVE CELLS OF MAMMALS.

It is generally believed that three substances enter into the formation of the body of nerve cells: (1) the Nissl granules, (2) a spongioplasm that is generally believed to be fibrillar but which may be reticular, and (3) a hyaloplasmic ground substance in which the two former are embedded. As this structure is found in the nerve cells of mammals and the nerve cells of this class have been most frequently studied, they will form the subject of this section.

Material was used from the following animals:—man, ox, pig, sheep, dog, cat, rabbit, guinea pig and mouse. In most cases pieces from the cortex, cerebellum, cord, spinal and sympathetic ganglia were obtained and fixed in various fluids, but by preference in alcohol and the bichloride-bichromate mixture. The shape and distribution in the cell of the Nissl granules are best demonstrated by staining sections fixed to the slide for a few minutes in an aqueous solution of toluidin blue or methylene blue, but preferably in toluidin blue, which v. Lenhossek regards as a specific stain. After staining, the sections are differentiated in a mixture of aniline and alcohol, cleared in oil of bergamot and mounted in balsam. The results obtained with this method are similar in every respect to those obtained with the more laborious process of Nissl.

15 L. c., p. 385.

Nissl[16] describes the bodies stained by his method, as having the form of larger or smaller, round, oval, spherical, often angular or irregular masses which have thread-like processes. These thread-like processes often unite the different masses into a true reticulum. Bühler[17] and Cox[18] for the spinal ganglion cells[19] and Flemming[20] for the cells of the cord of *Gadus* have noticed this reticulum of chromophilous substance. The reticular nature of this substance is frequently seen in the spinal or sympathetic ganglion cells, or in the cells of Purkinje in the cerebellum, and is occasionally seen in the cells of the cord and cortex. In sections stained with toluidin blue alone, the nucleus is seen as a clear space in the cell containing a large, round, deeply-stained nucleolus. There is usually nothing else stained in the nucleus, but occasionally there may be a faint bluish tint along certain lines.

If instead of employing toluidin blue alone, we use a cytoplasmic stain with it, we get the intergranular substance stained as well as the granules. The combination of eosin and toluidin blue, as employed by Mann, was the one used most frequently, although erythrosin and methylene blue, as employed by Held, give good results. Using these dyes we find the Nissl granules are stained blue, while the intergranular substance appears red. (Figs. 1 and 2). The nucleolus is also blue, but the blue is not the same as that of the Nissl granules, nor is the blue uniform throughout, for in many cases one can see a distinct red centre having a blue-stained layer on the outside. (Fig. 21). Probably the greatest change the addition of eosin to the stain has made in the appearance of the cell is in the nucleus. Here, instead of finding an unstained substance, one sees stretching from the nucleolus to the nuclear membrane a network of eosin-stained material. This substance is generally abundant near the nucleolus and adjacent to the nuclear membrane, while extending across the intervening space is a loose network of the same material. Sometimes, however, this material is found scattered throughout the nucleus in a finely granular form. This eosinophilous substance is generally more abundant in the nuclei of spinal and sympathetic ganglion cells than in the nuclei of cells of the central nervous

16 Nissl, F., "Mittheilungen zur Anatomie der Nervenzelle." Allgemeine Zeitschrift für Psychiatrie, L., p. 372, 1894.

17 Buhler, l.c., p. 98.

18 Cox, W. H., "Die Selbstandigkeit der Fibrillen im Neuron," Internat. Monat. f. Anat. und. Phys., XV, p. 209, 1898.

19 Lugaro (Lo sperimentale, 1895), also observed the reticular nature of this substance. Quoted from Robertson, Brain, 1899, p. 212.

20 Flemming, W., "Ueber die Structur centraler Nervenzelien," Anat. Hefte Heft, XIX, p. 563, 1896 (Original inaccessible. Quoted from Bühler).

system. It has been suggested by v. Lenhossek[21] that this substance is the same as the lanthanin of Heidenhain[22] or the œdematin of Reinke.[23] This substance is undoubtedly a nuclein compound and is oxyphile, yet it will be seen later that it has very peculiar properties which distinguish it from all chromatins or other substances heretofore described, and I shall therefore call it for the present the oxyphile substance of the nucleus.

Staining sections in gentian violet or safranin and differentiating, gives figures almost similar to those obtained with toluidin blue alone, but if one fixes in Flemming's fluid and stains with his orange method, one finds the granules are a deep violet on a reddish ground, the nucleolus is red with an outer colouring of violet, while the oxyphile substance is also a deep violet. This method has given me some of my most instructive preparations, especially of spinal ganglion cells, the unattached sections of which may be left in the stains.

The iron-alum stain of Heidenhain has been extensively used by Flemming, v. Lenhossek and others to show the structure of the cell. As this stain colours the cytoplasm as well as the chromatin, it ought, in my opinion, to be used on nerve cells with care, for the granules are often fibrillar in character and with the iron-alum hæmatoxylin stain alone it is often impossible to distinguish the fine fibrillar processes of the granules from the intergranular substance. An after stain of rubin removes a great deal of the difficulty, as then the fine processes of the granules are stained like the granules themselves.

The granules in different classes of cells exhibit a variable affinity for the methyl green in the Ehrlich-Biondi combination, but such affinities are not constant. In this stain the nucleolus is generally greenish, but the green is unlike that in the nuclei of the neuroglia cells, a circumstance that v. Lenhossek has also noticed. There is usually no other green staining substance except the nucleolus in the nucleus, but Levi,[24] Heimann[25] and Bühler[26] have found such a substance. This of all staining mixtures is hard to manipulate, and one cannot lay any great stress on differences obtained with it.

21 V. Lenhossek, M., Arch. f. Psychiatrie, XXIX., p. 375.

22 Heidenhain, M., "Kern und Protoplasma," Festsch. f. Koelliker, p. 128, 1892, and Arch. f. M. Anat. XLIII.

23 Reinke, Friedrich, "Zellstudien," Arch. f. Mik. Anat., XLIII, p. 402, 1894.

24 Levi, G., "Su alcune particolarità di struttura del nucleo delle cellule nervose." Rivista di pat nervosa e mentale, 1896. (Quoted from v. Lenhossek, Arch. f. Psych., XXIX, p. 376).

25 Heimann, E., "Beitrage zur Kenntniss der feineren Struktur der Spinalganglien," Virchow Archiv. CLII, p. 298, 1898.

26 Buhler, l. c., p. 46.

It has been shown by Macallum[27] that iron is a constant constituent of all chromatin. Mackenzie,[28] using the ferrocyanide method and the hæmatoxylin method of Macallum,[29] found the Nissl granules to contain iron. Using the hæmatoxylin method, which consists in keeping sections in acid alcohol (sulphuric acid 4, alcohol 100, by volume) for a few hours at 37° C., washing the acid out in alcohol and transferring them to an aqueous solution of hæmatoxylin, one finds the Nissl granules are stained bluish black, which is an indication that they contain iron. Besides the Nissl granules the nucleolus and the oxyphile nuclear substance have the same colour, showing that they also contain iron (Fig. 4). After the sections have been treated with the acid alcohol they may be transferred to acid ferrocyanide solution, when a Prussian blue reaction will be found in the three parts mentioned. The same result is obtained if teased-out cells are baked at 60° C. for several days in a mixture of ammonium sulphide and glycerine according to the method of Macallum, when the Nissl granules, nucleolus and oxyphile nuclear substance turn green, owing to the formation of ferrous sulphide. With any of these methods the Nissl granules are seen in the cell as masses or a reticulum. The appearances obtained by these methods are similar to those obtained by staining with toluidin blue alone, except that the oxyphile nuclear substance is also affected.

Using the test for phosphorus as described by Macallum,[30] the Nissl granules, nucleolus and oxyphile nuclear substance give a marked reaction for phosphorus, while the intergranular spongioplasm gives a faint reaction. (Fig. 3). For the purposes of this test, material that has been fixed in alcohol is extracted in a Soxhlet apparatus and imbedded in paraffin. Sections fixed to the slide are washed several times in distilled water to insure the absence of all alcohol, and then transferred to a solution of ammonium molybdate in nitric acid. After sections have been in this solution for some time they are brought into a solution of phenylhydrazin hydrochloride which reduces the phospho-molybdate to a greenish oxide of molybdenum but does not reduce the molybdate itself. Sections treated for a few minutes in the molybdate solution show little or no phosphorus. It is necessary to leave the sections in the molybdate solution for several hours in order to bring out clearly a reaction in the cell. After treating with phenylhydrazin hydrochloride the

27 Macallum, A. B., "On the Distribution of Assimilated Iron Compounds, other than Hæmoglobin and Hæmatins, in Animal and Vegetable Cells." Quarterly Journal of Microscopical Science. Vol. XXXVIII, p. 175, 1895.

28 Mackenzie, l. c.

29 Macallum, A. B., "A New Method of Distinguishing between Organic and Inorganic Compounds of Iron." Journal of Physiology. XXII, p. 92, 1897.

30 Macallum, l. c.

sections are washed in water, dehydrated, cleared in oil of cloves and mounted in balsam. The preparations show that in the parts in which organic iron is present phosphorus occurs, and that a fainter reaction for phosphorus obtains in the spongioplasm.

Held[31] found the Nissl granules are not digested in pepsin and hydrochloric acid solutions. This is correct, but the oxyphile nuclear substance also digests and the nucleolus under certain circumstances disappears. This is an important fact and is the chief objection to calling the oxyphile nuclear substance oxychromatin, for chromatin is always considered to be indigestible. Held's figures seem to show that he obtained the same result on digestion. No mention is made of this in his text, but in the description of the cells given under his plate he adds, "Nucleolus und ein Theil der Kernmasse noch nicht verdaut," thus indicating that he considered it an ordinary circumstance for nuclear parts to digest.

The oxyphile nuclear substance digests very readily indeed, but it is doubtful if the disappearance of the nucleolus is really due to the digestion of its substance. I shall show later that the nucleolus has an oxyphile centre and it is probable that this centre would digest, thus liberating the whole nucleolus, if it were attached to the slide only by its centre. If on the other hand, the nucleolus is attached by its periphery it will not be removed. Sometimes the nucleolus, after digestion, appears as a shell. The nucleolus is also very loosely attached to the nuclear network, a feature to which v. Lenhossek[32] has called attention and which will afterwards be discussed. After digestion the deepest iron-alum stain of Heidenhain or any other stain, will not show a reticulum in the nucleus, consequently there would be nothing to hold the nucleolus in its place in material digested in bulk. Considering everything, it is probable that the peripheral or basophile portion of the nucleolus is never digested. It is not the weak acid that affects the oxyphile nuclear substance, for one may leave loose sections in weak (0.2 per cent.) hydrochloric acid for days at 37° C. and yet the nucleus will contain oxyphile substance.

In the digestion experiments fresh material was sometimes first submitted to digestion and then hardened and imbedded, but generally the tissue had been fixed in alcohol beforehand. The material employed was in the form of sections attached to the cover glass or in thin pieces which were afterwards dehydrated and then imbedded.

31 Held, Arch. f. Anat. u. Phys., Anat. Abth., 1895, p. 396.

32 v. Lenhossek, M., Arch. f. Psych., XXIX, p. 373.

Held[33] found the granules are insoluble in weak or in concentrated mineral acids. Eve[34] observed that acids had a slight dissolving action on the granules.

Acids have a marked action on the granules and nuclear contents. One way to detect the presence of iron in the cell is to treat the sections with acid alcohol, when the iron can be detected by ordinary reagents. (vide ante). If the sections are left in the acid for longer time all the iron will be extracted from the cell and then on staining them with eosin and toluidin blue, no blue-stained substance will be seen, the result being the same as if unaltered cells were stained with eosin alone. There are no vacuoles in the cell and the granules may still be detected with Heidenhain's hæmatoxylin stain. After all iron has been extracted from the cell the granules in the cytoplasm, the nucleolus and the oxyphile nuclear substance still contain phosphorus.

The action of alkalies on the cell has been studied by Held,[35] Eve,[36] Bühler[37] and Ruzicka.[38] Held and Bühler find the granules are first altered in their staining powers and then are soluble in alkalies, forming vacuoles in the cell where the granules were originally. Eve is doubtful whether the granules are soluble in the alkalies or are merely altered in their staining powers. Ruzicka finds the granules are insoluble in alkalies and are not altered in their staining properties.

After treatment with alkalies the granules, I find, do not stain blue with toluidin blue or do not give an iron reaction, but most cells do not contain vacuoles. Since alkalies detach sections from the slide, either loose sections of spinal ganglia were used, or thin pieces of material which had been fixed in alcohol were left in the alkali for the desired time and then washed, dehydrated and imbedded. As alkalies the following solutions were employed: sodium hydrate 0.25 per cent., 0.5 per cent. and 1 per cent.; potassium hydrate, 0.2 per cent. and 0.5 per cent. and lithium carbonate in saturated aqueous solution. Held[39] figures a vacuolated cell obtained by leaving a thin piece of cord in saturated lithium carbonate for four days. Material was left in lithium carbonate solution for as long as ten days and yet no vacuoles were

33 Held, Arch. f. Anat. u. Phys., Anat. Abth., 1895. p. 396.

34 L. c.

35 Held., H. Arch. f. Anat. u. Phys., Anat. Abth., 1895. p. 396. and 1897. p. 204.

36 Eve., l. c.

37 Bühler., l. c.

38 Ruzicka. Vladislaw, "Untersuchungen, über die feinere Structur der Nervenzellen und ihrer Fortsätze." Arch. f. Mik. Anat., LIII. P. 485. 1898.

39 Held, l.c., 1895. Fig. 10.

observed in many cells. Material has been left in the weak potash or soda solutions for seven days with the same result. After treatment with the alkali, staining with eosin and toluidin blue will produce the same result in the nerve cell as staining unaltered sections with eosin alone, except that the nucleolus will probably be quite blue. The nuclei of the neuroglia cells are still stained normally, as are also the nuclei of the cells of the walls of the blood vessels and of white blood corpuscles present in them, thus showing the stains are effective and would still bring out the granules if they were unaltered. Held[40] has also observed that after treatment with alkalies the nuclei of the neuroglia and connective tissue cells are unaltered.

If one treats cells altered in this way to determine the distribution of iron in the cell, one finds the nucleolus and oxyphile nuclear substance may still be quite rich in iron but the remainder of the cell is devoid of it. The neuroglia cells also contain iron, this showing that the reaction would still detect any iron if it were present in the cytoplasm of the nerve cells. After prolonged treatment with the alkali, the distribution of phosphorus is quite normal, as the granules in the cell, the nucleolus and oxyphile nuclear substance still give the phosphorus reaction.

One can obtain similar results if tissue is hardened in an alcoholic solution, containing a small percentage of alkali, such as Held employed, when the iron-holding substances of the nerve cell are extracted from the cytoplasm but the nuclei of the neuroglia cells are only slightly affected. A ten per cent. solution of lysol, which Reinke found to be a solvent of chromatin, was also used with the same result; it altered the staining properties of the nerve cell but did not affect those of the neuroglia cells.

Ruzicka used material that had been fixed in sublimate for his experiments. The mercurial compound of these granules is much less easily altered than the granules coagulated in alcohol; but if treatment with the alkali be prolonged the same result is obtained.

When the tissue is placed in the alkali it swells but shrinks again on placing it in alcohol. This swelling and shrinking causes clefts in the protoplasm of some cells. Although these clefts do not correspond in position or form with the granules in the cell, it seems probable they are the vacuoles noticed by Held and Bühler and considered by them as the spaces left by the dissolved granules. It seems highly improbable that

40 Held, Arch. f. Anat. u. Phys., Anat. Abth., 1897, p. 207.

alkalies should remove the granules, leaving vacuoles, but not the nucleolus or the oxyphile nuclear substance which are related substances.

The slight degree of alkalinity necessary to alter the granules suggested that the blood, which is really more alkaline than some of the solutions used, might act in a similar way. This was tried and found to be the case. After loose sections of a spinal ganglion that had been fixed in alcohol had been in fresh defibrinated ox-blood for twenty hours, the granules were altered in the same way as if they had been in potash or soda solutions for the same time. We thus find that the granules, as they occur in the cells after fixation, are altered by the animal's own blood.

Eve observed that salt solutions had little action on the granules, but Bühler found the granules were soluble in physiological salt solution in twenty-four hours, leaving vacuoles in the cell. My results coincide with those of Eve, for when fresh spinal cord and ganglia were left in salt solutions for as long as three days at room-temperature the substance of the Nissl granules was still present. The cells contained vacuoles, forcing the granules into distorted shapes, but the substance stained normally with toluidin blue, and contained iron. In one case, after material had been in the salt solution for three days, the granules were so altered that they would not stain with toluidin blue. On examination the salt solution used was found to be distinctly alkaline, but in all cases where neutral salt solution was used the substance of the granules was not removed.

Leaving fresh material in distilled water for five days at the temperature of the room does not alter the staining powers of this substance, although the cell may contain vacuoles. Hardening material, however, by putting it into boiling water, has an action on nerve cells somewhat similar to the action of dilute alkalies. If the boiling has been continued long enough the granules will not stain with basic dyes and the iron cannot be detected in them with the acid alcohol method. The distribution of phosphorus is, however, normal throughout the cell.

Held failed to obtain a Millon reaction in the granules. A Millon reaction may, however, be obtained throughout the cell body, the nucleolus and oxyphile nuclear substance, if sections of material fixed in alcohol are left in freshly prepared Millon reagent for several hours at room temperature.

Besides the granules, the nerve cells frequently contain a yellowish pigment in their body. The pigment has been found to be especially common in man and monkeys. (Warrington).[41] The pigment present in the cells of a thoracic sympathetic ganglion of an ox, after it had been hardened in alcohol, gave the following reactions. It was still present after a one per cent. solution of potash had acted on loose sections for three days at room-temperature. It was not removed from the free sections by the action for a week of one per cent. hydrochloric acid solution, nor did it give, after the use of acid alcohol, any reaction for iron, which confirms what Warrington found for the pigment present in the nerve cells of man. It did, however, give a positive reaction for phosphorus, using Macallum's test.

Before leaving this section I would like to discuss the structure of the nucleolus. There is always one, and there may be several, nucleoli present in the nucleus of the nerve cells of mammals and in most other classes of animals; but there is rarely a nucleolus in the nerve cells of the Urodela and if present it cannot be distinguished with certainty from the remainder of the nuclear chromatin.

The nucleolus is considered by most observers to consist of a single substance which may be vacuolated. Several observers, however, have described the nucleolus as consisting of fine grains embedded in a ground mass. This view is supported by v. Lenhossek,[42] Held,[43] Ruzicka,[44] Obersteiner,[45] but more particularly by Timofeew[46] who says the nucleolus consists of basophile grains embedded in an oxyphile ground substance.

The nucleolus consists of two substances, but the relation of these two is different from that usually described. I find the nucleolus is a vesicle with an oxy-centre and a basophile covering.[47] This relation is often seen in sections stained with eosin and toluidin blue, or in material fixed in Flemming's fluid and stained with his orange method. A somewhat similar structure has lately been described by Heimann[48], who noticed the periphery of the nucleolus had a great affinity for stains.

This structure is best seen in the nerve cells of rodents but occurs in

41 Warrington, W. B. "On the Structural Alterations observed in Nerve Cells," Journal of Physiology, XXIII, 1898.

42. v. Lenhossek, l. c.

43. Held, Archiv f. Anat. u. Physiol., p. 207, 1897.

44. Ruzicka, Zeit. f. Wiss. Mikroskopie, p. 452, 1897.

45. Obersteiner, Zeit. f. Wiss. Mikroskopie, p. 60, 1898.

46. Timofeew, l.c.

47 Mackenzie also observed this relation in the nucleolus. Oral Communication, British Association, Toronto Meeting, 1897.

48 Heimann, l. c.

all animals and in well-stained sections is easily observed. Vacuoles are also quite frequent in the nucleolus, a fact which has attracted the notice of several observers. That this is quite correct is shown by the action of alkalies or of digestive fluids on the nucleolus. The action of digestive fluids in sometimes leaving a shell of undigested material has been referred to, but the effect of alkalies is more convincing. Held found that after prolonged treatment in the alkali the nucleolus no longer stained with methylene blue, and he thought that this showed that the nucleolus was formed of fine grains embedded in a ground mass. Alkalies have an altering action on the nucleolus similar to that on the Nissl granules but the action must be prolonged. If tissue which has been fixed in sublimate is used the action is very slow and one can often find the outer covering of the nucleolus broken, between the portions of which the oxyphile centre may be seen. This structure can be seen in sections stained with eosin and toluidin blue, or in iron-alum hæmatoxylin, but the clearest way of demonstrating it is the gold method of Apathy.[49] Figs. 9 and 10 are the nuclei of cells that have been treated with potash and then stained with this method. The oxyphile centre can be seen between the pieces of the basophile covering which has undergone fragmentation.

The above considerations render it clear that there are at least three distinct nuclein compounds in nerve cells, the Nissl granules, the basophile covering of the nucleolus and the oxyphile nuclear substance. Each of these bodies contains iron and phosphorus, the usual constituents of many nucleo-proteids. Van Gehuchten[50] and Cajal[51] believe the nuclein is condensed into the nucleolus, while v. Lenhossek maintains that the nerve cell does not contain true nuclein or chromatin. There seem to be many different nuclein compounds in different cells, but we shall see that for the nerve cells these different nuclein compounds are genetically related, and that intermediate substances are found in the nerve cells of different animals.

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49 Apathy, Stefan, "Das leitende Element des Nervensystems, etc." Mitth. aus der Zool. Station zu Neapel, XII, p. 495, 1897.

50 Gehuchten, A. van, "L'anatomie fine de la cellule nerveuse," La Cellule, XIII, p. 313, 1897.

51 Cajal, S. R., Revista Trimensal Micrografica, 1896. (Original inaccessible, quoted from van Gehuchten).

II.—THE DEVELOPMENT OF NERVE CELLS WITH SPECIAL REFERENCE TO THE DEVELOPMENT OF THE CHROMATIC SUBSTANCE OF THE CELL BODY.

Several attempts have been made to determine the origin of the Nissl granules, but all have failed to detect it. Vas made some interesting observations on the chromatin of fœtal sympathetic ganglion cells but did not attempt to ascertain the origin of the chromatic substance of the cell body. Eve found the chromatic substance completely filled the cell body at an early date. The cells of the vagus ganglion were the first to show an appearance like the adult cell with regard to the distribution of this substance. Szczawinska, working with selachian embryos, did not trace it further than the stage in which the cells were uniformly stained. Bühler[52] states that fœtal cells are devoid of granules, but does not ascertain the origin of the granular substance. He did, however, notice that the nuclei of young nerve cells are basophile and gradually become oxyphile as development proceeds. Timofeew observed that in chick embryos the basophile substance increased markedly in amount in the cells of the spinal ganglia, between the fourth and sixth day of incubation. He says nothing of its origin and evidently considers it cytoplasmic.

The chromatic substance which forms the Nissl granules is undoubtedly derived from the nuclear chromatin. A series of pig embryos from 7mm. onward to birth was the chief material used for these observations, but calf, sheep, rabbit and chicken embryos were used to confirm the results.

The embryos were fixed in the bichloride-bichromate mixture or in picro-corrosive fluid. Material intended for chemical methods was fixed in alcohol.

The development of the chromatic substance which forms the Nissl granules is closely connected with the morphological development of the cell. His[53] showed that the neuroblasts are derived from cells, lying, in mammals, next the medullary canal, which he calls germinating cells. These cells have a protoplasm which may be divided into an outer clear

52 L. c., p. 46.

53 His, W., "Die Neuroblasten und deren Entstehung im embryonalen Mark," Arch. f. Anat. u. Phys., Anat. Abth., 1889, p. 249.

Also, "Histogenese und Zusammenhang der Nervenelemente," Arch. f. Anat. u. Phys., Supp. 1890, p. 95.

and an inner granular layer. The next distinct stage which His distinguishes in the development of the nerve cell is the neuroblast phase. Here an oval nucleus bears a conical cell body, and this in turn is continued into a long process. The nucleus is moderately rich in chromatin of which there are several masses united by a filament. There are no protoplasmic processes and the protoplasm around the nucleus is very scanty. The neuroblasts arise in the inner layer from the germinating cells and pass out secondarily into the mantle layer of the wall. In the transformation of the germinating cells into neuroblasts His distinguishes five stages:

(1). Germinating cells of round form with a broad protoplasmic body.

(2). Germinating cells of round form with initial point and broad protoplasmic mantle.

(3). Intermediate cells of pear shape with little protoplasm around the unclosed nucleus. The cytoplasm is continued into a long process and the cells may still lie close to the internal membrane.

(4). Intermediate cells of pear shape with closed nucleus, deeply staining, outer cone, but little protoplasm around the remainder of the nucleus.

(5). Finished neuroblast.

My observations confirm those of His on the origin of the neuroblasts and in addition show the fate of their chromatin, a point not touched upon by His.

Germinating cells occur in the pig from the earliest stage procured by me (7mm.) to that of 18mm. length. If a section of a cord of, *e. g.*, a 10mm. pig, is stained with eosin and toluidin blue, one finds that all the blue-staining substance in the germinating cells is confined to the chromatin of their nuclei. The reactions for iron demonstrate that the cytoplasm is devoid of substance containing this element. At this period all iron-holding material is confined to the chromatin of the nucleus.

These cells are of round or oval shape, (Fig. 12), and are in some stage of mitosis. The cytoplasm is free from iron-holding material, or from material staining with toluidin blue. The cells are sometimes in the loose-skein phase, sometimes in the dyaster stage but most frequently in the equatorial-plate phase. The cells are generally in the equatorial plate phase when the process begins to be formed. As the cone increases the chromatin becomes excentric (Figs. 13 and 14). There is still no nuclear membrane and still no iron-holding nuclein compounds in the cell body or process. The cell bodies appear, quite frequently, reticulated.

The equatorial-plate stage is soon passed, and the chromatin begins to distribute itself in the nucleus. Various steps in the distribution of the chromatin may be followed until a stage, such as is represented in Fig. 15, is reached. By this time a nuclear membrane has been formed. Usually several masses of chromatin are found touching the nuclear membrane, while others are found towards the centre of the nucleus, but all seemingly connected by filaments. There is, as yet, no oxyphile substance in the nucleus. These cells are usually found under the membrane of the medullary canal but in very young embryos they occur in the mantle layer. The nucleus is entirely excentric and the cell body runs out into a long process. The cell body and process are still entirely free from iron-holding nuclein compounds.

As the cells pass outward into the mantle layer and become older, the substance having affinity for toluidin blue in their nuclei disappears and a substance with more affinity for eosin takes its place. Synchronous with this change, a substance with great affinity for toluidin blue appears in the cell around the nucleus (Figs. 16 and 17). With the appearance of this substance in the cell body iron may be detected there for the first time. In this stage, which would correspond to stage 4 of the series described by His, there are several granular masses in the nucleus with marked affinity for toluidin blue, but the most of the nuclear chromatin stains intermediate between the red and the blue.

As development proceeds (Figs. 18 and 19) the basophile substance in the nucleus continues to decrease, while the basophile substance in the cell body increases, and as it does so the affinity of the nuclear chromatin for eosin also increases correspondingly. One part of the chromatin does not alter but remains basophile and constitutes ultimately the peripheral portion of the nucleolus. Figs. 18 and 20 represent cells from the same embryo. The one indicates the distribution of the oxyphile and the basophile parts, while the other shows that both contain iron.

In Figure 21 is represented a cell from the medulla of a 32mm. pig embryo. The basophile substance forms a homogeneous mass filling the cell body. The cell may be said to have undergone at this time complete development of its chromatic substance, for now the nuclear oxyphile substance is completely digestible, and it stains like the substance found in the nuclei of adult mammalian nerve cells.

These facts indicate that the three nuclein compounds of the adult nerve cell, the Nissl granules, the nucleolus and the oxyphile nuclear substance, are derived from the chromatin of the nucleus of the germinating cell. This chromatin divides into two parts, each containing iron and phosphorus, but the one is oxyphile and remains in the nucleus, while the other is basophile and diffuses into the cell body and becomes the Nissl granules. The nucleolus seems to correspond in character to the chromatin of such a stage as is represented in Fig. 15, where little change has occurred from the equatorial-plate phase.

The cell body is filled with diffused chromatin before the protoplasmic processes are formed, but as the cell grows and the protoplasmic processes arise, the diffused chromatin is formed into masses and these in turn into smaller pieces until the size observed in the adult is reached. The breaking up of the diffused chromatin into masses is probably due to growth, and not to functional activity as one might think from the results obtained by Vas and Eve, for the ganglion cells of the retina of a fœtal calf of 60 cm. were distinctly granular. If the process of fragmentation proceeds far enough, the masses will be isolated in the cell, but if not they will constitute a reticulum. No evidence was observed of a connection persisting between this diffused chromatin and the nucleus.

One criticism of the observations of His is necessary. His stage 4 in the development of the neuroblast should succeed his stage 5, for the description of the latter stage is of a cell in which the basophile substance has not yet diffused from the nucleus, while the description of the former stage is of a cell in which this diffusion has taken place. That such a mistake might arise is seen from the fact that the basophile substance is not distinct in the cell body for a long time after neuroblasts are formed and have migrated into the mantle layer. Thus germinating cells are found in all the stages from the earliest procured (7 mm.) to that in which the embryos are about 18mm. long, while neuroblasts of the type that His describes as developed are abundant in the mantle layer at 7mm. and continue to be so until the formation of neuroblasts ceases. The chromatic substance, however, is not abundant in the cell body till the embryo is about 15mm. long. Consequently the process of transformation and diffusion of the chromatin is going on while the embryo grows from at least 7mm. to 15mm. In an embryo of 15mm. there are still many neuroblasts in the mantle layer that have not a distinct colourable cone but only a thickened mass of basophile substance around the nuclear membrane.

A single section of an embryo pig from 15 to 18mm., since it contains germinating cells and neuroblasts with diffused chromatin, shows all stages in the process of transformation and diffusion of the chromatin. This circumstance enables one to be sure that the gradual loss of affinity of the nucleus for basic dyes is not due to overstaining in eosin, for after the chromatin begins to change, an overstaining with eosin will make it red, but a shorter time in the eosin will colour it purplish. If one examines a section in which all stages of the diffusion of the chromatin are seen, one can easily see the great affinity the nuclei of the nerve cells next the medullary canal have for toluidin blue. The nuclei of cells lying farther from the canal have less and less affinity for basic dyes, but one can observe that with this loss of affinity on the part of the nucleus for these dyes, a substance with marked affinity for them appears in the cytoplasm. This substance is first seen as a thickened nuclear membrane, but as more of it diffuses from the nucleus it takes the form of a distinct cone in the cytoplasm forming a cap on the nucleus.

These observations have been confirmed on the cells of the cortex, cerebellum and spinal ganglia of mammals and also on the cells of the chicken. The chick embryos are not as suitable as mammalian embryos for following this process, on account of the general distribution of yolk nucleo-proteids, but the stages can be distinctly observed.

The chromatic material appears in the cytoplasm of the cells of the medulla before it appears in those lower down in the cord, but my observations on the rate of the development of the material in the different centres are incomplete.

The action of dilute alkalies on the cell varies with the degree of its development. At a stage such as is represented in Figure 21 the action of alkalies is similar to their action on adult cells. After treatment with alkalies the cell body would not stain with toluidin blue or did not contain iron, but the body of the cell still remained. If the view of Held and Bühler regarding the nature of the Nissl granules is correct, then the whole cytoplasm should have disappeared.

Alkalies are very slow in altering the staining powers of the chromatin in mitosis. The nuclei of germinating cells and of the nerve cells in which the kinetic chromatin was only slightly altered, contained a large quantity of material that stained with toluidin blue and proved to be iron-holding, after small pieces of tissue, that had been fixed in alcohol, had been treated with potash (0.2%) for six days. In this same solution the Nissl granules had been altered so that they would not give their ordinary reactions in six hours, but the nucleolus of the nerve cell and the nuclei of the neuroglia cells manifested their ordinary reactions, although more diffusely, at the end of the six days.

On digestion of material which had been fixed in alcohol there was no appreciable effect on the nuclein compounds until a stage of which Figs. 19 and 21 are representations. In the stage illustrated in Figure 21, which is from the cord of an embryo of 32mm., all the oxyphile nuclear substance digests as in the adult, but in stages before this one, there is always some substance which does not disappear on digestion. After digestion the periphery of the nucleolus always remains. In this respect as well as in all its other reactions it resembles the chromatin found in primitive nerve cells.

In order to facilitate reference to the different stages through which the chromatic substance passes in getting into the cytoplasm of the nerve cell I shall adopt the example of His and divide the process (arbitrarily) into different stages.

Stage 1. Germinating cells (Figs. 12, 13, and 14), stages 1, 2, and 3 of His. The chromatin is confined to the nucleus and is in mitosis. Weak alkalies alter this substance very slowly. Digestion dissolves the cell body but does not alter the staining power of the chromatin.

Stage 2. Neuroblast stage (Fig. 15), stage 5 of His. The chromatin is confined to the nucleus but is broken into masses. A nuclear membrane has been formed and the greater portion of the chromatin is distributed around the membrane. Alkalies and digestive fluids have little or no power to alter the reactions of this substance.

Stage 3. (Figs. 16, 17, 18, 19 and 20), stage 4 of His. Some of the kinetic chromatin is transformed into two other kinds, an oxyphile and a basophile. As the chromatin alters, the basophile part diffuses into the cytoplasm but the oxyphile substance remains in the nucleus. Most of the chromatin alters at the same rate but there may still be masses in the nucleus with marked affinity for basic stains. Alkalies have an altering action on the diffused-out chromatin in extracting the iron from its substance, thus changing its staining reactions. Digestive fluids affect the nucleus but still leave the basophile parts behind.

Stage 4. (Fig. 21). The transformation of the kinetic chromatin into the oxyphile and basophile kinds is now completed and the diffused basophile part fills the whole cell body. Alkalies alter the chromatin, especially the diffused part. Digestion dissolves the oxyphile substance completely but leaves the diffused substance and the periphery of the nucleolus unaffected.

Stage 5. Adult cell. Differs from stage 4 only in the distribution of the chromatin which has diffused into the cytoplasm.

III.—ON THE STRUCTURE OF THE NERVE CELLS IN OTHER CLASSES OF ANIMALS.

When such a remarkable change as that described in the development of the Nissl granules occurs in mammals and birds, one would expect to find some trace of it in the nerve cells of other animals. With this in view the nerve cells of adult animals of the different classes were examined. Before giving the results it would be advisable to make as complete a list as possible of those forms in whose nerve cells a substance analogous to that of the Nissl granules has been found. The following authors have dealt with the structure of the nerve cells of different mammals:—Flemming,[54] Nissl, Vas, Mann,[55] Dogiel,[56] Held, Eve, v. Lenhossek,[57] Lugaro,[58] Cajal, van Gehuchten, Cox,[59] Bühler, Heimann, Rohde,[60] Ruzicka and many others. In all cases recorded for mammals the nerve cell contained the granules. The only exception to this statement is that of Reinke who, in the discussion of v. Lenhossek's paper before the Anatomische Gesellschaft, stated that he had found large nerve cells in the ganglion of a cat free from granules. In all ganglion cells of the cat examined Nissl granules were present, and it is probable the cells found by Reinke were in a diseased or otherwise altered ganglion.

The nerve cells of the animals below mammals have been studied with methods that would show the Nissl granules as follows:—

From Aves: in the pigeon,[61, 62, 63] raven,[62] and fowl.[63]

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54 Flemming, l.c., and Archiv f. Psychiatrie, XXIX, p. 969, 1897.

55 Mann, Gustav., Journal of Anatomy and Physiology, XXIX, p. 100, 1894.

56 Dogiel, A. S., Archiv f. Mik. Anatomie, XLI, p. 62, 1893.

57 v. Lenhossek, M., l.c., also Verhand. der Anat. Gesellschaft, 1896, p. 29.

58 Lugaro, Rivista di pathologia nerv. e. ment., 1896, p. 12.

59 Cox, W. H., l.c. and Anat. Hefte, X, Heft 31, p. 73, 1898.

60 Rohde, E., "Die Ganglienzelle," Zeit. f. Wiss. Zool., LXIV, p. 697, 1898.

61 Held, l.c.

62 Bühler, l.c.

63 Timofeew, l.c.

From Reptilia: in the ganglia of *Testudo*, *Emys*, *Uromastix*, and *Agama*.[64]

From Anura: in *Rana*,[65,66, 68] and *Bufo*.[67]

From Pisces: in the electric lobe of *Torpedo*,[69] in *Gadus*,[70] in *Leuciscus*,[71] in *Cyprinus*,[72] in *Alopias*.[73]

From Invertebrates: in the crayfish,[74] earthworm,[74, 75] molluscs[74, 76] and insects.[74]

With the exception of Szczawinska, who states that granules are not present in a few cells of some rays, all these observers find a substance analogous to that of the Nissl granules present in the nerve cells of the different animals examined. I think the reticulum, in the cells without granules which Szczawinska figures, is made up of this chromatic material, for one frequently finds the chromatic substance in such a reticulum in some of the nerve cells of the earthworm, *Limax* and *Limnæa*, while neighbouring cells have the chromatic substance in a granular form. In any case the observations on the occurrence of this substance in the nerve cells of the pigeon, frog, earthworm, crayfish and various molluscs were confirmed.

The nerve cells of other forms which have not been studied, so far as I know, by others, were examined, and this chromatic material was found in the following forms:

From Reptilia: cells of cord and cortex of *Chrysemys picta*.

From Ganoidei: cells of cord of *Amia calva*.

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64 Pugnat, Charles Amedee. "Recherches sur la structure des cellules des ganglions spinaux de quelques reptiles." Anat. Anz., XIV, p. 89, 1898.

65 v. Lenhossek, M., "Centrom und Sphäre in den Spinalganglienzellen des Frosches." Arch. f. Mik. Anat., XLVI, p. 345. 1895.

66 Dehler, Adolf., "Beitrag. zur Kenntniss von feineren Bau der sympathetischen Ganglienzellen des Frosches," Arch. f. Mik. Anat., XLVI, p. 724. 1895.

67 Bühler, l.c.

68 Rohde, l.c.

69 v. Lenhossek, M., "Der feinere Bau, etc.," p. 159. 1895.

70 Flemming, l.c.

71 Bühler, l.c.

72 Szczawinska, l.c.

73 Paladino, G., "Sur la constitution morphologique du protoplasma des cellules nerveuses." Arch. It. de Biol., XXIX, p. 60, 1898.

74 Pflüke, Max, "Zur Kenntniss des feineren Baues der Nervenzellen bei Wirbellosen," Zeit. f. Wiss. Zool., LX, p. 500, 1895.

75 Eve, l.c.

76 McClure, Charles F. W., "The Finer Structure of the Nerve Cells of Invertebrates," Zoologische Jahrbücher, Abth. für Anatomie, XI, p. 13, 1897.

From Teleostei: cells of cord of *Amiurus catus*.

In all cases this substance in the cell body, although distributed differently, stained with toluidin blue and gave the reactions for iron and phosphorus. In all cases tried the substance was found to be insoluble in pepsin and hydrochloric acid but to be easily altered by dilute alkalies.

The widespread occurrence of this substance in such diverse forms has been taken by some (Rohde,[77] Marinesco[78]) to indicate that this material is an essential constituent of all nerve cells. This, however, is not the case, for in 1895 Bühler[79] described the cells of the forebrain of *Lacerta agilis* as frequently devoid of Nissl granules, and I find that the vast bulk of the nerve cells of the Urodela are absolutely devoid of them. It will therefore be necessary to enter into a detailed account of the nerve cells of these forms.

Several specimens of *Necturus*, *Amblystoma*, *Plethodon* and *Diemyctylus* were obtained and the cord, brain and ganglia fixed in different fluids. A series of a *Salamandra* larva was also examined[80] and series of larval *Amblystomata* of various ages were made. The nerve cells of all these different forms were found to correspond in their structure and characters.

In the nerve cells of these animals the cytoplasm, instead of holding granules which contain iron and phosphorus and which stain with basic dyes, is often free from iron, phosphorus or substance staining with toluidin blue, and on the other hand, their nuclei, instead of containing very little basophile substance, abound in granules of such basophile material. This is true of ganglion, retinal and central nerve cells.

If one fixes in Flemming's fluid and stains with his orange method there is no gentian-stained substance in the cell body while the nucleus is filled with granules and threads which stain deeply with the gentian. If instead of the orange method one uses safranin and light green, according to Benda's process, one finds all the substance staining with safranin confined to the nucleus.

In material that has been fixed in alcohol or in sublimate, and stained

77 Rohde. l.c.

78 Marinesco, G. "Recherches sur la biologie de la cellule nerveuse." Arch. f. Anat. und Phys., Phys. Abth., 1899, p. 89.

79 Bühler, Anton, "Protoplasma-Structur in Vorderhirnzellen der Eidechse." Verh. d. phys. med. Ges., Würzburg. Stahel. 1895.

80 For this privilege I am indebted to Dr. J. Stafford.

with eosin and toluidin blue, there is in the bodies of most nerve cells no blue-stained substance, while the nucleus is full of blue-stained granules and threads (Fig. 5). On staining sections in the Ehrlich-Biondi mixture, one finds the cell body is red, but all the nuclear chromatin is greenish, and there is no difference in the staining reactions of the nuclei of nerve and neuroglia cells such as is found between these cells in mammals.

The reactions for iron (Fig. 7) and for phosphorus (Fig. 6) show there is no iron and little phosphorus in the bodies of most nerve cells.

In a few cases a little basophile substance was observed in the cell body. In these the cytoplasm also contained a slight amount of iron and phosphorus-holding substance, but the much greater part of this substance, or of the substance staining with basic dyes, is in the nucleus A sufficient number of specimens to determine the cause of the presence or absence of this slight amount of basophile substance in the cytoplasm have not been examined, but when it is present, it is most frequently diffuse and not in granular form, although the latter, in rare cases, has been seen.

On digestion little material is dissolved from the nucleus, but the oxyphile substance, which was present in traces previously, has now disappeared (Fig 9). Those cells which contain a little basophile substance in the cytoplasm retain it after digestion.

The action of alkalies on the nerve cells of these animals is similar to their action on the neuroglia cells of the adult, or on the nerve cells of embryo mammals. Thus, after six days in a solution of potassium hydrate (0.2%) the nuclei still held a large quantity of material which contained iron and phosphorus, and which stained with toluidin blue. This same solution had removed all the basophile material from the cytoplasm of the nerve cells of adult mammalia in a few hours, but the nucleolus of the nerve cell and the neuroglia cells stained with basic dyes after six days, and the same was true of the embryonic nerve cells of mammals. The nuclei of the neuroglia cells of these Urodela, as in mammals, resist the action of alkalies. There is, therefore, in the former, no difference with respect to the action of alkalies between the nuclei of nerve and neuroglia cells. The slight amount of the basophile material present in some cells is easily and quickly altered by the alkali.

For some reason, the transformation and diffusion of the chromatin has not proceeded, in the cells of the Urodela, past a certain stage, corresponding to stage 2, given above for mammalian development. Compare Fig. 15, which is the nerve cell of an 11mm. pig, with Fig. 5, which is the motor nerve cell of an adult Necturus, fixed in the same fluid and stained with the same dyes. Besides the staining reactions the effect of alkalies or of digestive fluids is practically the same in both cases.

Levi[81] has examined the nerve cells of different types of Vertebrata (*Vespertilio, Cavia, Canis, Bos, Testudo, Zamenis, Rana, Triton, Proteus, Spelerpes, Tinca, Raja, Scyllium, and Petromyzon*), and has noticed the peculiar nature of the nucleus in the cells of the Urodela. He offered no explanation of the peculiarities of these cells, nor did he draw any conclusion about the nature of the substance in the cytoplasm of other forms.

A comparison of nerve cells of larval *Amblystomata* with those of the adult form shows them to be exactly similar. There is no transformation, except to a slight degree, of the chromatin into an oxyphile and a basophile part. I have noticed that those cells of the adult that had a little basophile substance in the cell body also had some oxyphile substance in the nucleus.

There are other forms that have not yet reached the adult or mammalian degree of differentiation. Thus in *Limax* and *Limnæa* (and from the descriptions of Pflüke and McClure, in all Gasteropods) the cells have stopped developing at a stage between 3 and 4 of the mammalian development. There is a quantity of iron and phosphorus-holding substance in the body of the nerve cell, but the nuclear chromatin is peculiar. It is not affected by digestive fluids, it stains green with the Ehrlich-Biondi stain, it stains with safranin, and is generally purplish with eosin and toluidin blue, although, by long action of eosin and short action of toluidin blue, it may be quite red.

Other forms (earthworm and crayfish) were also noticed to vary slightly from the mammalian type. I believe that if the nerve cells of all adult animals were examined, one would find a complete series in the diffusion of the chromatic substance to the cytoplasm.

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81 Levi, G., "Su alcune particolarita di struttura del nucleo delle cellule nervose," Rivista di patologia nervosa e mentale, Vol. I, p. 141, 1896.

Also: "Ricerche citologiche comparate sulla cellula nervosa dei Vertebrati." Ibid., Vol. II, pp. 193 and 244, 1897.

(Both papers inaccessible, quoted from the Zoologischer Jahresbericht for 1896 and 1897.)

IV.—Some General Considerations on the Structure of the Nerve Cells.

It may seem strange to revert to this subject, but owing to the fact that the Nissl granules were thought to be cytoplasmic structures, several views concerning the structure of nerve cells have been advanced that would not have been if the true nature of the granules had been known.

The first question is, whether the Nissl granules are formed elements of the cell body, or are precipitated while the cell is dying or when it is affected by the fixing agent. Held[82] accepts the latter explanation, as he claims to have seen fresh cells in which there were no granules but a homogeneous cell body. On standing for a few minutes the cells become granular, thus showing the granules were precipitated while the cells were dying. On adding water to the cells they become vacuolated, but the vacuoles would collapse on adding a fixing agent, thus leaving the granules around a vacuole. Held also believes that the granules are soluble in alkalies, and that the normal reaction of the nervous system is alkaline, but it becomes acid shortly after death, and that this is the reason the cells contain vacuoles in tissue hardened in alkaline alcohol.

v. Lenhossek and Flemming say the granules are visible in the fresh condition shortly after death. Each animal has a typical form of granule in the spinal ganglion cell, whatever fixing fluid has been used, which could not be if the granules were precipitated either in dying or with the acid reagent.

Bühler maintains that the granules are not seen in a fresh state, or even in a fixed condition, but this is no argument for their non-existence in the living cell, for the nucleus is often invisible in a fresh state.

Ruzicka believes the granules are only due to differentiation in staining, because if you overstain you do not see them, and if you extract too much they are invisible.

I agree with Held and Bühler that these granules are invisible in a fresh condition, and with Bühler also that the granules are hardly visible as such in the fixed cell. If one examines an unstained section of a spinal

82 L. c., 1895.

ganglion, one cannot be sure that there are distinct granules in the cell, but the chromatic substance is responsible for its optical appearance, for the periphery of the cell is homogeneous, and does not resemble the central parts where we usually find the granules. The cone of origin, and the layer around the nucleus, described by v. Lenhossek as free of granules, are also homogeneous.

For observing fresh nerve cells I used the retina, because one can examine nerve cells in this organ more easily and more quickly than in any other place, and because the retina is transparent, and does not need to be crushed or removed from its normal medium for examination. The eye was generally excised immediately after death, but it was often half an hour before it was opened and the retina placed in some vitreous humour. It was laid on the slide with its nerve-fibre layer uppermost, and a cover slip placed upon it. Observing such a preparation, one can frequently detect absolutely no structure in the retina, other than the blood corpuscles in the vessels, even with the best lenses. After a few minutes, the rods and cones come into view, and then, after a considerable time (sometimes an hour) the outlines of the ganglion cells appear but for a longer time the cells themselves are homogeneous. Eventually the nuclei of these cells become visible, and still later the cytoplasm becomes turbid.

One might quite as properly contend that the retina did not exist in life except as a homogeneous substance, and that the cells were precipitated in dying or by the fixing reagent, as that because the Nissl granules are not seen in a fresh condition, they are not formed elements of the cell. We have seen that the granules are not soluble in alkalies, so that argument of Held's on the present point is valueless.

Since it might be argued that it was one of the properties of the retina to be transparent the cells of the cord and cortex of young animals also were examined. These were killed by decapitation, the skull or vertebræ opened and a small piece of tissue taken and put in a drop of methylene blue. A cover was placed on the preparation and gently pressed till the latter was transparent enough for observation. The cells were found to have a granular appearance, resembling what would be found if the tissue had been fixed, embedded and stained with toluidin blue, and this within two minutes of death.

Held lays stress on the fact that different fixing agents produce a different form of granule. It is well known that different fixing fluids

83 Turner using methylene blue on fresh brain has observed the normal appearance of the cells shortly after death. ; Brain, part I, page 100, 1899, also Journal of Mental Science, 1898.

produce slight differences in distribution of all chromatin, and different fixing fluids also form a slightly different intergranular substance which would cause the granules to have a different appearance.

Putting all things together we may conclude that during life the granules have the same refractive index as the remainder of the cell, but that they are formed elements in the cytoplasm as much as ordinary chromatin is a formed part of the nucleus. It is probable that all chromatin is more or less plastic, for different fixing fluids produce a slightly different disposition of chromatin in the nuclei of all cells. It seems to me to be impossible to answer Flemming's objection that the cone of origin of the process of spinal-ganglion cells is always free of granules, if the latter are precipitated elements in the cell.

Many authors, including De Quervain,[84] Held, Flemming, v. Lenhossek and others, consider the Nissl granules are made of fine particles embedded in another substance. It is true that the Nissl granules, in the different cells, but more particularly in the spinal-ganglion cells, do not appear homogeneous. Is this due to one kind of substance embedded in another different substance, or is it due to irregularities in contour of the same substance? I think the latter is the correct explanation. In sections 1μ thick and stained with eosin and toluidin blue, iron-alum hæmatoxylin or other dyes, or treated to liberate the "masked" iron, the same result was always obtained; the granules appeared homogeneous but of different densities. The edges of the granules are never straight, a circumstance that many have noticed, and thus a section of the cell must contain different thicknesses of the material. The granules often contain vacuoles, which would also tend to give them a heterogeneous appearance. The vacuolated appearance is also due to inequalities of the surface of the granules, for one can see in almost every preparation how a section at right angles to the plane being examined would appear to leave cavities in the chromatic material.

I do not intend to discuss in this paper the arrangement of the Nissl granules in the cell, and shall refer only to the presence or absence of these granules in the axis cylinder and cone of origin of this process. The history of development would tend to show that the Nissl granules would not be found in the axis cylinder process, and this is what all observers who have worked with material that had been fixed and then

84 De Quervain, Fritz, "Ueber die Veränderung des Centralnervensystems bei experimenteller Kachexia thyreopriva der Thiere," Virchow's Archiv. CXXXIII, p. 527. 1893.

stained, have observed. Dogiel,[85] however, finds the cone of origin and axis cylinder itself are finely granular, and considers the Nissl granules are formed by the running together of these fine grains. Dogiel's method consists in staining the fresh material in methylene blue, fixing in ammonium picrate, and transferring to a mixture of ammonium picrate in glycerine, where the tissue remains for some time, in order to get sufficiently transparent for examination.

Using this method on the retina, and spinal and sympathetic ganglia, one obtains figures of cell-structure exactly resembling the figures of Dogiel. In this way spinal ganglion cells were obtained with the cone of origin, and the process filled with bluish-black grains resembling some of Dogiel's figures. This structure must be considered entirely artificial, for these grains occur more or less uniformly throughout the whole preparation, and the examination of tissue before and after fixation shows that they are formed by the precipitation of uncombined colouring matter. Examining the cells, stained in methylene blue, but not fixed in the picrate, one sees they are either granular, *i.e.*, the Nissl granules only are stained or they are uniformly stained, *i.e.*, the intergranular substance is stained as well as the granules, but if one puts the same cells through the fixing process, one finds fine dots of precipitated colouring matter all over the cells. This can be most easily followed in the retina, as little or no teasing of the preparation is necessary, and errors from that source are avoided. If one stains a retina with methylene blue, and examines it after washing as much of the colour as possible out of the preparation, one will find the nerve fibres are uniformly stained; but, if one puts the same retina through the fixing process, and then examines again, one sees the nerve fibres are filled with spindles and round masses resembling what Dogiel figures. The same change may be followed in sympathetic and spinal ganglia, in which uniformly stained cells become covered with precipitated colouring matter in the process of fixation. The Nissl granules have, in the fixed preparations, a different tint from this precipitated colouring matter, and could not be formed by the running together of these masses, even if the latter were elements of the cell. From my observations on preparations stained by Dogiel's process, I have concluded that his method is one of the best to show the morphological connections between the

85 Dogiel, A. S., l. c. and "Die Structur der Nervenzellen der Retina." Archiv. f. Mik. Anat., XLVI. p. 394. 1895.

Also: "Zur Frage uber den feineren Bau des Sympathischen Nervensystems bei den Säugethieren." Arch. f. Mik. Anat., XLVI, p. 305, 1895.

Also: "Zur Frage uber den feineren Bau der Spinalganglien und deren Zellen bei Säugethieren." Inter Monat. f. Anat. u. Phys., XIV, p. 73. 1897.

cells, but that it gives entirely artificial appearances in the cytoplasm of the cells.

The true structure of the cytoplasm of nerve cells has been the object of much investigation by Flemming, v. Lenhossek, Dogiel, Held, Lugaro, Cajal, Marinesco, van Gehuchten, Cox, and many others, in fact, nearly all the works mentioned contain references to it, and there are good reviews of the literature in van Gehuchten, and in Goldscheider[86] and Flatau. The question is whether there are independent fibrillæ, or fibrillæ forming a reticulum in the cell, or whether the cytoplasm has a foam-like structure.

In this paper I do not intend to discuss the structure of the cytoplasm but shall point out, that since the substance of the Nissl granules does not diffuse into the cell body before the structure of the cytoplasm is determined, (in other words, these are superadded to the cytoplasm), they cannot be a part of the fibrillæ or reticulum. Thus the Nissl granules are not thickenings of the protoplasmic fibrillæ, or are not the nodal points of the cytoplasmic reticulum, but are independent of the cytoplasmic structure; and although the fibrillæ, if they exist, might even run through the granules, they would never lose their independence. Several of the above-mentioned authors have reached the same conclusion, but could give no definite proof of its truth.

No definite conclusion has been reached as to whether the nucleus keeps sending new material from the nucleolus to the cytoplasm, during the life of the cell. If it does give out new material to the cytoplasm it certainly does not do so in the manner described by Rohde. The latter has described the migration of the accessory nucleoli into the cell body to become the Nissl granules, and the migration of the ordinary nucleoli to become the nuclei of neuroglia cells. He used iodine green and fuchsin as stains, and found the accessory nucleoli (which are only masses of oxyphile substance) resembled in their staining power the Nissl granules. Iodine green and fuchsin form a difficult combination to differentiate exactly, and the two appearances described by Rohde[87] can be obtained by a little longer or shorter differentiation; in any case, the resemblance of the staining properties of the oxyphile nuclear substance to the Nissl granules is much better seen by using Flemming's orange method (vide ante). Rohde says that by staining with iron-alum hæmatoxylin and long differentiation, the accessory nucleoli retain the stain longer than any other part, and thus the process of migration of

86 Goldscheider und Flatau, "Anatomie der Nervenzellen," Berlin, 1898.

87 L. c., p. 705.

these bodies can be easily followed. I find it is not the accessory nucleoli that retain the stain but the ordinary nucleoli themselves. In all places examined by Rohde (spinal and sympathetic ganglia) it is well known that several nucleoli are found, as can be easily seen by staining with toluidin blue. In the cells of the cord where one nucleolus is the rule, it is this nucleolus which retains the iron-alum hæmatoxylin stain, and not the neighbouring oxyphile substance.

If these nucleoli which retain the hæmatoxylin stain are outside the nuclear membrane they are artificially brought there. One can sometimes find, as v. Lenhossek has pointed out, the nucleolus pulled out of the spinal ganglion cell. He believes this occurs because the nucleolus is loosely attached to the linin thread, or because the nucleolus is very hard under certain conditions. I have never seen a nucleolus outside the nuclear membrane in the cells of the cord, and in ganglia that have been fixed in sublimate this appearance is far more common than it is in material that has been fixed in alcohol. The fact, (and I have carefully examined my preparations to see that it is a fact), that where more than one cell have their nucleoli displaced in the same section the direction of the displacement of the nucleoli is always the same, shows that these have been displaced in cutting. One can make the appearance of migrating nucleoli quite common, if one cuts sections, 1 or 2 μ thick, of ganglia fixed in sublimate, but all the apparent migration is in the same direction. If, however, thicker sections are cut, or if material that has been fixed in alcohol is used, the appearance may be said to be non-existent.

Holmgren[82] also believes in the migration of formed masses of the nuclear chromatin to the cytoplasm. In the cells of the spinal ganglia of *Lophius* he has described the migration of the chromatin out of the nucleus to form the Nissl granules, the migration of accessory nucleoli, and the passage of the Nissl granules back into the nucleus These changes are brought about through the agency of the micro-centre with its radiating threads, and are supposed to be different stages in the activity of the cells. Some of the cells observed so differed from the usual condition that they could only be considered as dying, and yet it is from cells in the same ganglia that these changes are described. Holmgren tries to justify his position by a study of the cells of *Acanthias*, *Gadus*, *Raja*, and *Rana*, in which similar conditions were observed. In the spinal ganglion cells of *Rana* I have never observed such conditions, except in cases which are manifestly artifacts made in cutting, as

82 Emil Holmgren. "Zur Kenntniss der Spinalganglienzellen von Lophius piscatorius Lin." Anat. Hefte, XXXVIII, p. 71, 1899.

described before, nor have I noticed any difference in the staining power of the nuclear membrane next the micro-centre, although I have observed many of the different conditions of the cell with respect to the distribution of the granules described by Holmgren. Thus, after the chromatin has once diffused from the nucleus, nothing occurs, in my opinion, to indicate the renewal of the granular substance from that organ. I do not deny that such renewal may take place, but if it does, it is in solution and not in formed masses. Further investigation, however, is necessary to decide this point.

Concerning the reason for the diffusion of the chromatin from the nucleus, it may be to aid physiological action, for it is a general rule, which no physiologist would now deny, that an iron-holding nucleo-proteid is necessary for the cell to carry on its normal function. These compounds are generally confined to the nucleus, but they occur in the cell body of all gland cells. It seems to me that it would aid physiological action in having these nuclein compounds in direct contact with the cytoplasm of the nerve cells, for in this case the cytoplasmic action would not be delayed by immediate participation of the nucleus. Thus cytoplasmic impulses may pass from one process of the cell into another without going through the nucleus, which could not happen if the chromatin had remained in the latter.

V.—CONCLUSIONS.

The Nissl granules are of a nucleo-proteid nature, since they contain "masked" iron and organic phosphorus, and are derived from the nuclear chromatin of the germinating cells. Pepsin and hydrochloric acid do not dissolve them, nor are they dissolved by alkalies or acids which, however, liberate the iron, and in consequence of this their staining reactions are altered. Digestion with pepsin and hydrochloric acid does not affect the occurrence of iron and phosphorus in the granules.

The nucleolus consists of an oxyphile centre with a basophile covering. The basophile covering seems to correspond to the original kinetic chromatin of the germinating cell. It contains iron and phosphorus, and alkalies extract the iron very much more slowly from it than they do from the Nissl granules.

The oxyphile nuclear substance is also a nuclein compound since it contains iron and phosphorus. It is readily dissolved in pepsin and hydrochloric acid. It is altered but not dissolved by acids and alkalies, which liberate the iron from it. The alkali acts much more slowly in removing the iron from this substance than from the Nissl granules.

The three nuclein compounds of the adult nerve cell are derived from the mitotic chromatin of the primitive nerve cell. It follows from this that the Nissl granules are constituted of chromatin that has diffused from the nucleus into the cytoplasm.

A substance analogous to that of the Nissl granules is found in the nerve cells of most animals, but not in all, as it is rarely present in the nerve cells of the Urodela. Those animals, whose nerve cells are devoid of this material, have chromatin in the nuclei of such cells similar to that found in the nuclei of the cells of other tissues.

The Nissl granules are morphological elements of the cell, and consist of one substance. They have the same refractive index as the cytoplasm during life, and are not found in the axis cylinder process.

All the results obtained go to support the view that all iron-holding nuclein compounds are derived from pre-existing ones, and in mitosis all the iron-holding substance of the cell is confined to the nuclear chromatin.


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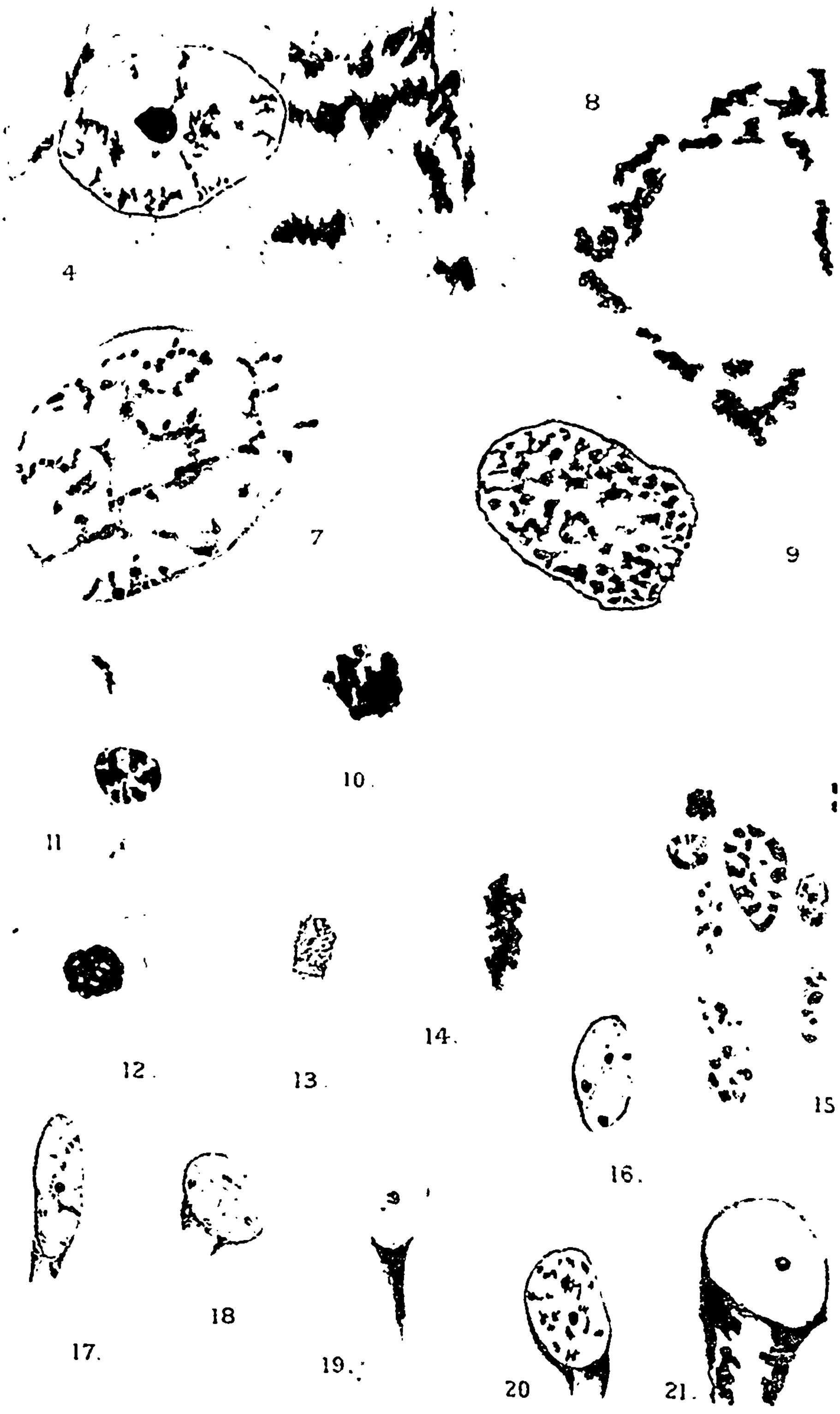

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EXPLANATION OF PLATE NO. I.

Illustrating Mr. F. H. Scott's paper "On the Structure, Micro-Chemistry, and Development of Nerve Cells, with special reference to their Nuclein Compounds."

NOTE.—All figures were drawn to the same scale with the aid of Abbe's camera lucida, as seen under the Leitz 1-12 homogeneous immersion lens, with compensation ocular 12 of Zeiss.

FIG. 1.—Motor nerve cell of cat. Alcohol, eosin, and toluidin blue.

FIG. 2.—Spinal ganglion cell of frog. Bichloride-bichromate, eosin, and toluidin blue. (To show the occurrence of granules in the Anura, as distinguished from the Urodela.)

FIG. 3.—Motor cell of cat. Alcohol, ammonium molybdate in nitric acid 7 hours, phenylhydrazin hydrochloride.

FIG. 4.—Motor cell of cat. Alcohol, acid alcohol 5 hours, hæmatoxylin.

FIG. 5.—Motor cell of *Necturus maculosus*, Raf. Bichloride-bichromate, eosin and toluidin blue. (Many cells have far more basophile substance in their nucleus than this one, which was selected to show the cytoplasm. It is the only cell in which anything like a fibrillar structure was observed.)

FIG. 6.—Motor cell of *Necturus*. Alcohol, ammonium molybdate in nitric acid 7 hours, phenylhydrazin hydrochloride.

FIG. 7.—Motor cell of *Necturus*. Bichloride, acid alcohol 6 hours, potassium ferrocyanide.

FIG. 8.—Motor cell of cat. Alcohol, section digested in pepsin and hydrochloric acid 20 hours, ammonium molybdate in nitric acid 12 hours, phenylhydrazin hydrochloride.

FIG. 9.—Motor cell of *Necturus*. Alcohol, eosin and toluidin blue.

FIGS. 10 and 11.—Nuclei of motor cells of dog. Bichloride-bichromate, piece ½mm. thick treated with sodic hydrate 0.2% for 6 hours, section 0.5% gold chloride 20 hours, formic acid very dilute in light, 10 hours.

FIG. 12.—Germinating cell, 7mm. pig. Bichloride-bichromate, eosin and toluidin blue.

FIG. 13.—Germinating cell, 11mm. pig. Bichloride-bichromate, acid alcohol 6 hours, potassium ferrocyanide, eosin.

FIG. 14.—Germinating cell, 11mm. pig. Bichloride-bichromate, acid alcohol 6 hours, hæmatoxylin, eosin.

FIG. 15.—Neuroblast from 11mm. pig. Bichloride-bichromate, eosin and toluidin blue.

FIG. 16.—Neuroblast from 14mm. pig. Bichloride-bichromate, eosin and toluidin blue.

FIG. 17.—Neuroblast from 15mm. pig. Bichloride-bichromate, eosin and toluidin blue.

FIG. 18.—Neuroblast from 15mm. pig. Bichloride-bichromate, eosin and toluidin blue.

FIG. 19.—Neuroblast from 15mm. pig. Bichloride-bichromate, long stain in eosin, short stain in toluidin blue. The oxyphile nuclear substance appears redder than it would be if the time of staining had not been altered. In this respect it resembles the nuclear substance of *Limax*. (See text.)

FIG. 20.—Neuroblast of 15mm. pig. Bichloride-bichromate, acid alcohol $5\frac{1}{2}$ hours, haematoxylin.

FIG. 21.—Neuroblast from 32mm. pig. Alcohol, eosin and toluidin blue.

ON THE CYTOLOGY OF NON-NUCLEATED ORGANISMS.

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(Read May 6th, 1899.)

In the following pages I have endeavoured to describe the results of observations which I have made during the last five years on the structure of certain types of non-nucleated organisms. These studies are not as complete as I would wish them to be, especially in the case of Bacteria, for only a few of the forms of the latter accessible to me were of sufficient size to enable me to employ all the micro-chemical methods used in the case of the Cyanophyceæ and *Saccharomyces*, but the results described may prove of service to other investigators in the same line, and at the same time stimulate the employment of comprehensive methods of technique in the study of non-nucleated organisms. It is doubtful if the ordinary or more complicated methods of staining which have been used in this department give results which are of the morphological value possessed by results obtained in this way in more highly specialized animal and vegetable cells. The existence of a nucleus in these low forms of life, if not denied by the great majority of observers is at least in dispute. If it is absent what takes its place? Is chromatin present or does there exist in them an analogous substance? As there are in many animal and vegetable cells other substances which may take up dyes, more especially of the aniline kind, it is obvious that staining methods alone are not sufficient to enable the observer to determine the solution of questions like these in regard to the lowest forms of life. A more satisfactory determination of such questions can be made only with methods which comprehend micro-chemical reactions of definitely ascertained values.

It may be pointed out also that it is in these low forms of life that we must look for a key to the secret of the origin of the cell nucleus, as well as for data to determine the morphological character of the primal life organism. It is of course suspected by many that in *Saccharomyces* the cell as it is now found does not represent what it once was, that it is the product of the degradation of a higher form of cell. In that case it may be contended that one cannot obtain from the present structure of the cell data which can be of service in ascertaining what the structure of the primal cell was. If the yeast cell, which, as I claim, is non-nucleated, is the product of the degeneration of a higher type of cell, of, for example, a nucleated cell, an examination of it may still serve a purpose in assisting in determining the origin of the cell nucleus, for we can then ascertain how in the yeast cell its surplus of chromatin is distributed in the cytoplasm in all conditions, and this may possibly indicate to us in what manner the original non-nucleated cell disposed of the excess of the analogous chromatin compound.

From this point of view, therefore, the employment, not only of methods of staining, but also and particularly of micro-chemical processes in the investigation of these low forms of life is absolutely necessary if results of any value are to be obtained. These methods I have endeavoured to employ to a certain extent and this constitutes the excuse for adding one more contribution on the subject.

CONTENTS.

THE CYANOPHYCEÆ.

I.—LITERATURE.

The first to examine carefully the structure of the Cyanophyceæ was Schmitz,[1] who found in the cells of *Glœocapsa polydermatica* a homogeneous central portion which stained with hæmatoxylin and represented, as he thought, the nucleus of the cell. He found also that there were in the cell substance a number of spherules of unknown composition, to which he applied the term "Schleimkugeln." In the cells of *Oscillaria princeps*, after being stained with hæmatoxylin, he observed a dark, spherical, somewhat excentrically placed body which he regarded as a nucleus, but he was unable to demonstrate its presence in all preparations of this form.

Further observations,[2] however, led Schmitz to regard the cells of Cyanophyceæ as non-nucleated and the supposed nuclei of *Glœocapsa* as simply very large chromatin granules which react with hæmatoxylin like the chromatin granules of the nuclei of higher organisms. He distinguished in *Oscillaria princeps* a peripheral, finely punctated zone in each cell which stained with hæmatoxylin less deeply than the central portion.

In a later work he denies the existence of a chromatophore and claims that the functions performed in the special parts of highly differentiated cells, are in the Cyanophyceæ the property of the cell protoplasm generally.

Tangl[4] also was unable to determine the presence of a nucleus, but he found a chromatophore in *Plaxonema Oscillans.* According to Wille,[5] however, a nucleus exists in *Tolypothrix lanata.* After being stained with a dilute or a concentrated hæmatoxylin solution, preferably the latter, the nucleus appeared faint blue, the nucleolus, on the other hand, intense blue, while the remaining cell contents were scarcely stained. In the dividing cell he observed two nuclei, each with a

1 "Untersuchungen über den Zellkerne der Thallophyten," Sitzungsb. der Niederh. Gesell. für Natur— und Heilkunde zu Bonn. Sitz. vom August 4, 1879. p. 355.

2 "Untersuchungen über den Strukter der Protoplasma und der Zellkerne der Pflanzenzellen," Ibid, Sitz. am Juli 12, 1880. p. 150.

3 "Die Chromatophoren der Algen," Bonn, 1882, quoted by Deinega.

4 "Zur Morphologie der Cyanophyceen," Wien, 1883.

5 "Ueber die Zellkerne und die Poren der Wände bei den Phycochromaceen," Berichte d. deutsch. bot. Gesell., Vol. I, 1883, p. 243.

nucleolus, and in another stage of division he found one nucleus with two nucleoli. The next observer, Lagerheim,[1] found no nucleus in *Glaucocystis Nostochinearum*. The chromatophore in the young cells of this form is, according to his description, in the form of a band or thread surrounded by the colourless elements of the cell, but in the older cells it is composed of a large number of small granules which form a membrane lying at some distance from the cell wall and enclosing the colourless cell substance.

Reinhard[2] found in *Oscillaria major* (?) when fixed with picric acid and stained with hæmatoxylin, a large granular nucleus with large granules as nucleoli. The protoplasm contains large and small granules, the former constituting the chromatophores. Hansgirg, although maintaining the existence of a chromatophore and nucleus in *Chroodactylon Wolleanum*, a unicellular blue-green form, held that in the thread-like Cyanophyceæ there is neither a nucleus nor a chromatophore and that the cell protoplasm discharges the functions of both.

Borzi[4] found neither a nucleus nor a chromatophore. He distinguished by micro-chemical methods, amongst the granules present, a kind the examples of which are partly imbedded in the protoplasm and partly applied to the cell wall. These granules are formed of a gelatin substance, which he believes replaces starch in these forms, and which he names cyanophycin. The granules, he believes also, are secreted in dividing cells by the young transverse septa. In *Nostoc*, *Anabæna*, *Spermosira*, *Cylindrospermum* and *Sphaerozyga*, the protoplasm of two adjacent cells is connected by fine strands, sometimes of plasma, at other times of cyanophycin, which pass through openings in the transverse septa. These openings are specially marked in heterocysts in which they closed by plugs of cellulose, protein or cyanophycin. Similar perforations were observed in the transverse septa in *Oscillariæ* and Borzi explains their function as that of uniting the protoplasm of all the cells to enable them to act as a unit in the case of movement.

In his first publication[5] on the subject of a nucleus in the Cyanophyceæ, Zacharias stated that he found this organ in the terminal cells

1 "Ein neues Beispiel des Vorkommens von Chromatophoren bei den Phycochromaceen," Berichte d. deutsch. bot. Gesell., Vol. II, 1884.

2 "Algologische Untersuchungen. I. Materialen zur Morphologie und Systematik der Algen des Schwarzen Meeres," Odessa, 1885, (Russian). Abstract given by Deinega.

3 Ein Beitrag zur Kentniss von der Verbreitung der Chromatophoren und Zellkerne bei den Schizophyceen (Phycochromaceen)," Berichte d. deutsch. bot. Gesell., Vol. III, 1885.

4 Malpighia, Anno I, 1886. Abstract in Bot. Centralbl., Vol. XXXII, p. 35, 1887.

5 "Beiträge zur Kentniss der Zellkerns und der Sexualzellen," Bot. Zeitung, 1887, Nos. 18–24.

of *Tolypothrix* after treatment with a digestive fluid, and extraction with alcohol and ether, and on examination in a solution of hydrochloric acid of 0.3 per cent. strength. In this case the nucleus was demonstrated by the nuclein lustre produced. The nuclein was extracted with a soda solution of 0.05 per cent. strength from threads which had previously been submitted to digestion. He found also in a species of *Oscillaria*, after treatment with digestive fluids, a large nucleus, containing nuclein network, in every cell. From such preparations the nuclein was removed by extraction with very dilute soda solutions.

Scott[1] has described the occurrence of nuclei and nuclear division in *Oscillaria* and *Tolypothrix*. The nuclei were rounded, sometimes contracted, and presenting evidences of a fibrillar structure like that observed in the "skein" stage of the nuclei of more highly specialized cells. Scott regarded this structure as due to the division of the nucleus, as it was accompanied by division of the cell as a whole, and he found in a few preparations indications of colourless striæ connecting the portions of the nuclear structure, and suggesting the idea of "achromatin fibres." In some cells the nuclear fibrillæ were broken up into smaller portions which resembled the chromatin segments of division in ordinary cells.

A second publication[2] by Zacharias contained the results of a very comprehensive research on the structure and micro-chemistry of the cells of the Cyanophyceæ. He found in all the forms examined by him that only the peripheral portion of the cell substance is coloured, the central portion appearing colourless. The coloured substance was more abundantly present on the lateral than on the transverse walls. He was unable to determine the existence of a chromatophore. Vacuoles were not present in the normal cells, but made their appearance in threads which were observed dying under the microscope. In *Oscillaria*, after several days' culture, with the exclusion of light, vacuoles of an undetermined character were found to occur. In the colourless central portion of the cells articulated or granulated structures, with one or two bodies which possessed the appearance of nucleoli, could be recognized in favourable cases. The nucleoli-like elements were colourless, spherical, not sharply circumscribed, and appeared as if their peripheral substance was of a denser consistency than their centre. A portion of the central body of the cell was found to be soluble in artificial gastric juice, the undissolved residue being composed of two substances, or of one only.

1. "On Nuclei in *Oscillaria* and *Tolypothrix*." The Journal of the Linnean Society. Botany. 1887. Vol. XXIV, p. 188.

2. "Ueber die Zellen der Cyanophyceen." Bot. Zeitung, 1890, Nos. 1-5.

One of these two, related to plastin in its characters, was always found to be present; the other, denominated the "central substance" (Central Substanz), which might be absent, was found to be similar to the nuclein of higher organisms in many respects. The substance of the nucleoli-like elements was not found to differ from that of the nucleoli of higher plants.

Zacharias discussed the question whether the central colourless body represents a nucleus, contrasting it with the nuclei of higher forms of vegetable life, and pointing out that in the Cyanophyceæ nuclein may be present in some cells of a thread, but wholly absent in others, a condition not observed in the tissues of more highly organized vegetable forms. Nuclein was wholly absent in the dividing cells of Cyanophyceæ, while division in the cells of higher organisms is always preceded by an increase in the quantity of chromatin or nuclein. On account of such contrasts Zacharias regarded it as uncertain whether the "central substance" of the Cyanophyceæ represents the nuclein of other organisms, and he concluded that the central body is different in all its relations from a nucleus. The absence of a nucleus is, he believes, associated in some way with the absence of a sexual process.

Bütschli,[1] in his studies on the structure of Bacteria and Cyanophyceæ, came to the conclusion that in both the same type of structure prevails. He found in the cells of the Cyanophyceæ a peripheral coloured zone of cytoplasm which stains feebly with hæmatoxylin, enclosing a colourless "central body" which takes the hæmatoxylin stain more strongly. The two structures are vesiculated, that is, provided with a honeycomb-like structure (Wabenstruktur). In the cytoplasm hæmatoxylin reveals, by the red colour which it gives them, a number of granules, termed by Bütschli the "red" granules, which are situated in the nodal points of the vesicles, and are more abundant and larger at the periphery of the central body than elsewhere. These are not to be found after the cells have been treated with hydrochloric acid and pepsin, but he attributes their disappearance to the digesting reagent, having deprived them of the power of taking up dyes, since they readily lose their power of staining when they are fixed with osmic acid, corrosive sublimate, or with the picro-sulphuric or chrom-osmic-acetic mixtures. He is inclined to regard them as composed of a substance like chromatin in many respects. Other granules of a different nature were found in the peripheral cytoplasm, and more particularly near the transverse walls in *Oscillaria*, which exhibited an affinity for eosin, but

1 "Ueber den Bau der Bacterien und verwandter Organismen," Leipzig, 1890.

were wholly unaffected by hæmatoxylin. The colouring matter of the cell is disposed in the framework of the vesicles of the peripheral zone and not in the fluid filling the vesicles (*enchylema*).

Regarding the nature of the central body Bütschli speaks positively. It is, he maintains, the homologue of the nucleus of higher forms. Zacharias had at first held this view, but withdrew it,[1] because he found that in the central body, in many Cyanophyceæ there is no nuclein, and that, further, when such cells divide, there may be no nuclein demonstrable in them, facts which are quite the reverse of those observed in the typical nuclei of other forms. Zacharias admits that in some animal and vegetable nuclei nuclein may be absent, and Bütschli points out the force of the admission, while he calls attention to the fact that the absence of mitotic phenomena is no indication that the central body is not a nucleus, for the macro-nuclei of Infusoria do not undergo mitosis, but direct division. When the cells of *Oscillariæ* were subjected to the action of artificial gastric juice the peripheral layer wholly disappeared in some cases, while, in others, portions only of it remained, but the "central body" was preserved, and resembled more markedly a nucleus, retaining also its capacity for absorbing hæmatoxylin.

Fischer,[2] in the year following the publication of Bütschli's paper, attacked the correctness of the methods of that observer, claiming that the occurrence of a peripheral layer in the cells of Cyanophyceæ and Bacteria is an artificial production, in fact due to plasmolysis caused by the fixing reagents and means used in the preparation of the organisms. Fischer's observations were made on a limited number of small bacteria and also upon unspecified *Oscillariæ*. In these the reagents employed caused the shrinkage of the cell protoplasm from the cell membrane and as the shrinkage was unequal, strands of cytoplasm were left extending between the shrunken mass and the cell wall to simulate a peripheral layer of vesiculated structure. This condition accounted for Bütschli's results. Fischer denied even the existence of a colourless central body in the Cyanophyceæ.

Bütschli's[3] answer to Fischer's objections was that, admitting some reagents do produce plasmolysis in vegetable cells, this is by no means frequent, and treatment with the reagents which he used, viz., picro-sulphuric acid with or without osmic acid. the chrom-osmic-acetic mixture,

1 Op. Cit.

2 "Die Plasmolyse der Bakterien." Berichte der k. sächs., Ges. der Wissensch., Mat.-Phys. Kl., 1891, p. 52.

3 "Untersuchungen über mikroskopische Schäume und das Protoplasma." Leipzig. 1892, p. 75-79.

and osmic acid, when properly employed, do not result in this condition. He pointed out further that the majority of the more recent investigators of the structure of the Cyanophyceæ had observed a colourless central body whose existence Fischer denies, and that the latter did not make sufficiently extended observations to justify such objections.

Deinega's[1] observations were made on *Oscillaria princeps*, *O. Froehlichii*, *Aphanizomen flos-aquæ*, *Nostoc* sp., and *Scytonema* sp., and they dealt chiefly with the question of the presence of a nucleus and of a chromatophore, and with the nature of the granules in the cells of these organisms. According to Deinega, a chromatophore is present, and consists of a more or less perforated plate, apparently applied to the inner surface of the cell wall, the trabeculæ of the plate carrying the colouring matter, and running parallel, in the greater number of cases, with the trichome.

He found only one kind of granules, and these manifested a certain special affinity for picrocarmine. In *Oscillaria* they occur chiefly in the immediate neighbourhood of the transverse walls. They readily dissolve in dilute hydrochloric acid and in chloral hydrate, while they remain uncoloured in solutions of iodine. Deinega does not accept the view of Cohn[2] and Hansgirg[3] that they are formed of paramylum, but he believes that they are composed of an isomer of starch.

In regard to the question of a nucleus Deinega is undecided. He repeated some of Zacharias' experiments with gastric juice, and found that in each cell of *Oscillaria*, after treatment with this reagent, the central body was provided with a nuclein lustre, but he attributes this to the remains of the chromatophore. He found, when examples of *Spirogyra* and other Algæ were similarly treated, their nuclei vanished, while the chromatophore remained and gave a nuclein lustre. The central body of the cell in Cyanophyceæ stained more deeply than the remainder of the cell protoplasm, and consisted chiefly of a collection of granules.

Zukal[4] regards the central uncoloured portion of the cell as the cytoplasm, and the coloured peripheral part as the chromatophore, which, under very highly magnifying powers, appears finely punctated, the

1 "Der gegenwartige Zustand unserer Kentnisse über den Zelleninhalt der Phycochromaceen." Bulletin de la Soc. impèr. des Naturalistes de Moscou, Annee 1891, p. 431.

2 "Beiträge zur Physiologie der Phycochromaceen."

3 "Physiologische und Algologische Studien" (1877).

4 "Ueber den Zellinhalt der Schizophyten." Sitzungsber. d. k. Akad. d. Wiss. zu Wien. Math.-Nat Klasse, Vol. CI. p. 301. 1892.

latter fact suggesting that the chromatophore is formed of an exceedingly delicate reticulum. The granules, according to Zukal, are nuclei, and as such divide, the divisions not being followed necessarily by division of the containing cell.

Hieronymus[1] found a thin hyaline layer enveloping the cellular protoplasm, and applied to the internal surface of the cell membrane. The chromatophore is, according to his view, of fibrillar structure, and on it are arranged fine granules which appear to contain the chlorophyll. The phycocyan is dissolved in enchylema. The central body is formed of a wound fibril, and contains all the remaining granular elements, which he regards as crystals of the regular system. The substance of these crystals he calls cyanophycin, and though he recognizes that it does not correspond in its character to nuclein, yet he looks upon it as related to the chromatin and pyrenin of the higher organisms. The central body is, further, an open nucleus, that is, a nucleus without a membrane.

In reply to Zacharias[2] who criticized his observations, Hieronymus[3] maintains that there is only one kind of granules in the cells of Cyanophyceæ, and that two kinds appear to be present because of the methods of preparation. He found that when the fixed cells were treated with ammonia vapour all the granules received a dark blue colour from hæmatoxylin, and that all the granules dissolved in diluted acid solutions, although they varied in the readiness with which they dissolved.

According to Palla[4] the cell in the Cyanophyceæ consists of a colourless "central body," a coloured peripheral layer, the chromatophore, an external investing colourless layer, and possibly also a colourless zone (Plasmaschicht) situated between the chromatophore and the "central body." The "central body" reacts with dyes like a nucleus, but it contains no granules, and is homogeneous. Its division takes place through constriction. The granules in the cell are of two kinds: one composed of a substance, cyanophycin, soluble in dilute hydrochloric acid, and which stains pure blue with hæmatoxylin, found usually in the extreme periphery of the chromatophore, and representing the first assimilation product of the latter; the other, composed of a viscous substance, insoluble in dilute acids, and staining reddish-violet with hæmatoxylin.

1 "Beiträge zur Morphologie und Biologie der Algen." Cohn's Beiträge zur Biologie der Pflanzen, Vol. V, p. 461, 1892.

2 "Ueber die Zellen der Cyanophyceen." Bot. Zeit., No. 38, 1892, and No. 15, 1893.

3 "Ueber die Organization der Phycochromaceenzellen." Bot. Zeit., 1893, p. 73.

4 "Beiträge zur Kentniss des Baues des Cyanophyceen-Protoplasts." Jahrb. für Wiss. Bot., Vol. XXV, p. 511.

The second class of granules, which he identifies with the "Schleimkugeln" of Schmitz, are found in the immediate vicinity of the "central body," but never *in* this structure, and rarely only in the chromatophore. They are identical with the "nucleolus," the "central substance," and the "red" granules of earlier observers, but their significance is unknown to Palla. He calls attention to the fact that in the living cell they are stained with methylene blue, which leaves unaffected peripherally placed granules, formed of the "cyanophycin." The chromatophore has a vesiculated structure, and the vesicular walls are free from colouring matter, which is connected with numerous small granules placed in (?) the vesicles.

In 1894 Fischer[1] reiterated his objections to Bütschli's results, basing these upon more extended studies of the structure of Bacteria.

Nadson's observations were carried out upon a large number of forms fixed and stained in various ways. He found that the coloured peripheral zone of the cell is not a chromatophore but that it is protoplasm containing phycochrome. This peripheral layer is vesiculated in the sense of Bütschli's "Wabenbau." The vesicles are filled with a plasmatic substance which is physically rather than chemically distinguishable from that forming the walls of the vesicles. Chlorophyll and phycocyan are, however, only in the walls. The central body is sharply differentiated from the coloured zone and contains vesicles, but these are less readily observable than those found in the peripheral layer, and they are filled with a strongly stainable substance. Two kinds of granules are present. Of these, one consists of those called "red" by Bütschli, or the "Schleimkugeln" of Palla and Schmidt, and according to Nadson are composed of a substance closely corresponding to chromatin. Such granules occur chiefly in the central body and in the walls of the vesicles, and their number in a cell varies very much, but whether many or few are present the cell is equally capable of division. The second kind of granules, called by Nadson, the reserve granules, correspond to the "cyanophycin" granules of Borzi and Palla, and are composed of a substance comparable to the starch of the Chlorophyceæ. They occur only in the coloured zone, particularly in the neighbourhood of the transverse walls. They colour with hæmatoxylin blue-violet like the protoplasm of the peripheral layer.

Nadson found a third kind of granules, probably of a plasmatic

1 "Untersuchungen über Bakterien," Jahrbuch für Wiss. Bot., Vol. XXVII. 1894.

2 "Ueber den Bau des Cyanophyceen-Protoplastes." (In Russian with resumé in German), Scripta Botanica, Vol. IV, St. Petersburg. 1895. I have not, unfortunately, access to this publication and have had to rely on the reference given in Botanischer Centralbl. Vol. LXIII. p. 238.

nature, in the nodal points of the protoplasm in the peripheral zone. In *Merismopedia* and *Aphanocapsa* the "chromatin" granules in division arrange themselves in the form of a figure 8, which after division falls into two circles.

The central body, in Nadson's view, is similar in many respects to the nucleus of higher organisms, and doubtless corresponds to the same. It may be regarded as the forerunner of the latter, but he doubts if all cell nuclei are derived from it.

Macallum[1] found that the stainable granules in the central body do not dissolve when submitted to artificial gastric digestion, but they disappear after treatment with a solution of potassic hydrate of 0.1 per cent. strength for twenty-four hours. This treatment also deprives the central body of its capacity of fixing colours in itself. These facts were held to indicate that a nuclein-like substance is present in the central body and in its granules, and this view was confirmed by the demonstration of the presence, in these parts, of "masked" iron. The "cyanophycin" or "reserve" granules, which stain specially with picrocarmine, may not contain "masked" iron and dissolve readily in dilute solutions of hydrochloric acid. The substance forming these granules was found to be unlike that constituting the granules of the central body, which was held to be in many respects like chromatin.

Bütschli's[2] third contribution on the structure of the Cyanophyceæ appeared in the next year and in this he defends the views which he advanced in his earlier publications on the subject, and criticizes the views and observations of Deinega, Hieronymus, Palla, Nadson and Fischer. In answer to the latter's objections he denies that the peripheral layer in the cells of the Cyanophyceæ and Bacteria in his preparations is due to plasmolysis and shows that in some at least of the blue-green forms the existence of a peripheral zone and a central body can be determined in the living cell. In these forms, and especially in some *Oscillariæ*, the two parts may be set free through rupture of the cell membranes, and then one can distinguish both parts as very distinct. Bütschli strives particularly to show that the vesiculated (Waben) type of structure prevails in both parts and in the two classes of organisms and for this purpose gives photographs of living forms in which this structure was distinctly demonstrated. He found also that the colouring matter of the peripheral zone appeared to be dissolved in the sub-

1 "On the Distribution of Assimilated Iron Compounds, other than Hæmoglobin and Hæmatins, in Animal or Vegetable Cells." Quart. Journ. Micro. Sci., Vol. XXXVIII, p. 175, 1895.

2 "Weitere Ausführungen über den Bau der Cyanophyceen und Bacterien," Leipzig, 1896.

stance forming the walls of the vesicles (Waben) and not in the contents of the latter.

Amongst the points dealt with by Bütschli were those relating to the nature of the granules and to the homology of the central body. As in his earlier observations he found two kinds of granules; one staining red-violet with Delafield's hæmatoxylin and called on this account "red" granules; the other, in *Oscillariæ* usually adjacent to the transverse septa and consequently in the peripheral layer, unaffected by hæmatoxylin but coloured red with eosin and called, after Nadson, "reserve" granules, or, after Borzi, "cyanophycin" granules. The "red" granules are, at times, as Hieronymus and Palla found, hollow bodies. They occur in both parts of the cell but they are chiefly found on or in the outer portions of the central body imbedded in the nodal points of its vesicles. This observation is opposed to the views of Zacharias and Palla, who maintain that the central body is free from granules. The substance forming them Bütschli believes to be chromatin, and the evidence in support of this view he finds in the staining properties of the granules. Hæmatoxylin usually does not stain chromatin red or red-violet, the exceptions being the granules formed of this substance in the nuclei of *Euglena* and Diatoms, but the granules in the cytoplasm of the latter and in some Protozoa give a similar red stain, a fact which tells against "red" granules in Cyanophyceæ being considered as composed of chromatin. Bütschli, however, found that in the living forms the cytoplasmic granules which stain red with hæmatoxylin colour red with methylene blue, but the nuclear granules in *Euglena* and Diatoms are rendered blue with this reagent. Now Lauterborn discovered that in living *Oscillariæ* methylene blue also gives a blue colour to the granules which, in hardened preparations, stain red-violet with hæmatoxylin. These facts, Bütschli thinks, indicate that the "red" granules are formed of chromatin.

Bütschli doubts if the "reserve" granules are formed of a carbohydrate, but he believes that the action of iodine solutions on material which has been kept for a long time in alcohol points to the presence of glycogen in the Cyanophyceæ.

The central body Bütschli holds to be a nucleus. The objections to such a view he deals with in detail and points out that the absence of indirect division occurs also in the macro-nuclei of Infusoria, in nuclei of *Amœbæ*, Dinoflagellata and *Euglena*, while he urges in answer to Zacharias, who could find no nuclein in the central body either during rest or division of the latter, that this does not diminish the suspicion concerning the poverty of our micro-chemical methods.

Zacharias[1] confirms his earlier observations, except as to the presence of nuclein in the central body, of which he is doubtful. He regards the central body as differing in important points from the nucleus of other organisms.

Fischer, in his recent publication, gives the results of a more extended series of observations on the structure of the Cyanophyceæ and Bacteria. His first statement is a withdrawal of the view which he held that the "central body" of Bütschli arose through plasmolytic contraction of the contents of the cell, brought about by the hardening reagents used. He finds, however, that Bütschli's description of the granules is far from exact. In many of the forms hæmatoxylin colours some of the granules blue, others red, in other forms all the granules may be coloured blue, while sometimes again the granules may be stained red only. In Bütschli's opinion the reserve granules, the "cyanophycin" granules of Palla, do not stain with hæmatoxylin and, therefore, the granules which colour blue with this dye, do not, according to Fischer, come into Bütschli's classification of the granules. Fischer also found that all the granules stain blue with hæmatoxylin after treatment with soda solutions. On the other hand the "cyanophycin" granules in *Oscillaria tenuis*, after fixation with alcoholic iodine solutions, do not stain with hæmatoxylin, but they will do so if hardened with a four per cent. solution of formol. The granules do not disappear after artificial digestion (in pepsin and hydrochloric acid), nor on treatment with a ten per cent. soda solution. From all these facts he concludes that the differences in the staining power of the granules are due, not to differences in chemical composition of the granules, but to their physical properties, and that the tests upon which Bütschli relied to show that the "red" granules are composed of chromatin are valueless. He regards the substance entering into the composition of all the granules as an assimilation product or a reserve material.

In regard to Palla's contention that granules do not occur in the "central body," Fischer found them in this organ as well as in its periphery. None were observed in what he calls the chromatophore, the zone of coloured protoplasm surrounding the "central body." Granules exist outside this zone and, particularly, adjacent to the transverse septa, a fact which leads Fischer to believe in the existence of a plasma zone outside the chromatophore. The independent existence of the latter organ he claims is shown by the results of treatment with hydrofluoric

1 "On the Cells of the Cyanophyceæ." Report of the British Association, Liverpool Meeting, 1896, p. 1021.

2 "Untersuchungen über den Bau der Cyanophyceen und Bacterien." Jena, 1897.

acid, which dissolves everything else in the cell. Through the chromatophore stretch radial strands of protoplasm from the central body to the plasma zone on the inner wall of the cell. In pepsin and hydrochloric acid the volume of the contents is greatly decreased, but this is not due to digestion of the peripheral portions chiefly and of the central body partly as Zacharias and others believed, but to a contraction which he terms enzymatic and which can be demonstrated in *Spirogyra* also. In the shrunken parts the peripheral as well as the central parts are present. Digestion experiments, therefore, give no certain conclusions as to the special nature of the central body. The latter is in his view simply a portion of the protoplasm enclosed by the chromatophore and containing assimilation products. There is nothing to indicate that it is a nucleus or the homologue of a nucleus. Nor is there any other organ which may be held to represent a nucleus.

II—METHODS OF STUDY AND MATERIAL EMPLOYED.

By hardening and staining highly organized animal and vegetable cells in the way that cytologists usually employ, one may obtain preparations which readily reveal the structure of these elements, but the employment of these and other simple methods in the case of the Cyanophyceæ are not at all as fruitful in results. One finds in such little more than one can recognize in the living cells. It is with such and similarly meagre methods that the majority of investigators in this field of research have contented themselves when the apparently indifferentiated character of the cells in these organisms should have suggested the employment of a multiplicity of methods. It is only in this way that one may obtain results which permit a generalization concerning the structure of these forms.

The Cyanophyceæ respond very sensitively to the conditions to which they are subjected. This fact also has been overlooked or not suspected. In a culture of them twenty-four hours will make a complete change in some of the more important features of their cells, and at the same time different parts of the same culture, not more than a few centimetres distant from each other, may present specimens of the same species in which the cell contents are markedly unlike. It is to this fact that we may attribute discrepancies in the descriptions, by the various observers, of the structure of these organisms. To illustrate particularly how important this point is, I may refer to Palla's observations on *Glœotricha pisum*. In single cells of this form he found large vacuoles, and more than one central body. The material which he used must have been in a pathological condition, for it is only when *Cylindrospermum majus* is ill-nourished that any one of its cells possesses similar vacuoles and a plurality of central bodies.

It is obvious, therefore, that a study of the cells of the Cyanophyceæ involves the employment of a large number of methods of manipulation, and a regard for material in all conditions of nutrition. The latter requisite also entails a careful attention to the various conditions in which the organisms are usually found, and an acquaintance with the modifications that a varied environment brings about. These conditions and these modifications are, at present, not fully known, but what we do know helps in determining what is the typical structure of the cell in this class.

I have, therefore, in all cases used material from each species which was found to be in an active state of growth. This is a safeguard of great value. The material which one may collect from any locality may be in the resting stage, a stage in which also, perhaps, changes analogous to those of involution in Bacteria may manifest themselves. The only material which one can confidently regard as normal is that which grows in the laboratory, and which can be examined from hour to hour, the change in the volume of the material being an indication of its active growth.

The species[1] used in these studies were *Microcoleus terrestris* Desmazières (*M. vaginatus* Gomont), *Oscillaria Froehlichii* Kützing (*O. limosa* Agardh), *Oscillaria natans* Kützing (*O. tenuis* Agardh), *Oscillaria tenerrima* Kützing (*O. amphibia* Agardh), *Oscillaria princeps* Vaucher (*O. maxima* Kützing), *Cylindrospermum majus* Kützing, *Tolypothrix tenuis* Kützing, *Tolypothrix rupestris* Kützing, *Nostoc commune*, *Rivularia* sp., *Glœocapsa polydermatica*, *Lyngbia* sp., *Scytonema* sp.

The hardening reagents employed were: corrosive sublimate in saturated aqueous solution, in saturated alcoholic solution, and in conjunction with picric acid, picric acid in saturated solution, Flemming's chrom-osmio-acetic mixture in strong and weak solution, osmic acid in one per cent. solution, alcohol absolute and of ninety-five per cent. strength. I have used also aqueous and alcoholic solutions of iodine. The best preparations were made with the picric acid and corrosive

1 Gomont, "Monographie des Oscillariées, (Nostocacées homocystées)." Annales des Sciences Nat., 7ieme Série, Botanique, Tome XV, p. 263. Tome XVI, p. 91.

Also, Bornet and Flahaut, "Revision des Nostocacées heterocystées contenus dans les principaux herbiers de France," Annales des Science Nat., Botanique, 7ieme serie. Vols. III, IV, V and VII.

sublimate reagents. The former was allowed to act for forty-eight hours, the material was then placed in seventy per cent. alcohol, which was replaced by a fresh quantity daily for a week, after which it was transferred to alcohol of ninety-five per cent. strength. The corrosive sublimate solutions were allowed to act for an hour only, and the subsequent treatment with alcohol was the same as in the case of the picric acid material. Material hardened in alcohol was used only for the iron and phosphorus reactions.

The staining reagents found to be serviceable were Ehrlich's and Delafield's hæmatoxylin solutions, Czokor's alum cochineal, safranin, eosin, picrocarmine and methylene blue. Material hardened with alcohol, picric acid or corrosive sublimate gave very valuable preparations when stained with picrocarmine solution for twenty-four hours, then for an hour with a dilute solution of hæmatoxylin. The picrocarmine specially selects the granules which Borzi and Palla term "cyanophicin," while the hæmatoxylin thus employed stains the "central body" and its granules particularly and the peripheral protoplasmic zone less distinctly. The "central body" in corrosive sublimate preparations is less clearly differentiated from the peripheral zone.

There is one advantage in the use of picric acid which does away with the necessity of resorting to transsections of the trichomes, for the reagent seems to have some solvent or disintegrating effect on the substance of the membranous sheath and of the transverse septa, the trichomes breaking up, under the slightest pressure of the cover-glass, into the separate cells which very frequently then are seen by their flat or end faces.

The method of obtaining the reactions for "masked" iron in the Cyanophyceæ I have fully described elsewhere.[1] The iron, liberated by sulphuric acid alcohol, as indicated, was converted into Prussian blue, the trichomes were then stained with a picrocarmine solution for twenty-four hours when the cyanophycin granules acquired a deep red colour which contrasts markedly with the Prussian-blue tint of the ironholding granules. (Fig. 14). Instead of acid alcohol strong solutions of hydrogen peroxide which contained traces of sulphuric acid were frequently used to liberate the masked iron.

The demonstration and localization of organic phosphorus were effected in the manner which I have indicated elsewhere,[2] but I may here briefly

1 "The Distribution of Assimilated Iron Compounds, other than Hæmoglobins and Hæmatins, in Animal and Vegetable Cells," Quart. Jour. Micro. Sci., Vol. XXXVIII, p. 175, 1895.

2 "On the Detection and Localization of Phosphorus in Animal and Vegetable Tissues," Proceedings Roy. Soc., Vol. LXIII, p. 467, 1898.

describe the method used. The material, after thorough fixation with alcohol, was washed free from the latter with distilled water, then put in the nitric-molybdate solution for three to six hours at a temperature of 35° C., and finally, after quickly washing in water, treated for a few minutes with a one per cent. solution of phenylhydrazin hydrochloride, which converts the phospho-molybdate into a bluish-green compound, this colour reaction thus indicating the original distribution of the organic phosphorus. To provide against the phosphorus demonstrated being that of lecithin, the material was extracted with hot alcohol in a Soxhlet apparatus for five hours.

The other methods resorted to included: digestion of fresh material with artificial gastric juice and with alkaline solutions of trypsin, staining of fresh material for twenty-four hours with acetic-methyl green and subsequent fixation by saturated solutions of picric acid and the treatment of fresh material with solutions of Ehrlich's hæmatoxylin. The digested material was similarly stained and all the preparations were mounted in glycerine.

III.—The Living Cell in The Cyanophyceæ.

In the larger species of Cyanophyceæ the cell substance readily reveals the existence of two zones, one, peripheral, coloured blue-green, the other, central, containing granules and, but for the shimmer of blue-green of the outer zone through which it is seen, colourless. In Fig. 1 the division of the cytoplasm is very clearly indicated. The smaller the cell the greater is the difficulty with which the central uncoloured zone is observed and in those species in which the cell is long and narrow, *e.g.*, *Microcoleus terrestris* or *Oscillaria tenerrima*, the central zone cannot be seen, it being of such minute dimensions that its presence is masked by the outer zone.

Whenever it can be distinctly seen the central zone, or, as it is usually called, the central body, is found to contain granules which vary in size and numbers, but these most frequently appear in the outer portion of the central body and in some cases the inner portion of the latter may be completely free from them. Apart from the granules the central body is uniform in structure, appearing to possess a vesiculated structure which comes out quite distinctly in *Oscillaria princeps.* The vesicles in the latter are not closely aggregated and are separated from one another by coarse trabeculæ of a colourless, hyaline, plasma-like substance in which excessively minute, punctiform appearances suggest a granulation of quite another order than that already referred to. In this species the demarcation of the central body from the coloured, peripheral zone is not sharp and definite, the one passing gradually into the other.

In the peripheral, coloured zone the details are more difficult of observation. One can indeed see granules, but their relation and the distinction between these and portions of the protoplasmic trabeculæ are difficult to determine in the fresh condition. If a fresh specimen of *O. princeps*, *O. Froehlichii* or *O. natans* is observed under the apochromatic 1.5 mm. and compensation ocular 8 or 12 with best light (that from a white cloud), one can see in the very uppermost plane of the cell the membrane studded with refracting points which, when the tube of the microscope is slowly lowered, resemble granules, but at the sides and ends of the cells they appear as elongated elements which radiate from the central body. The refracting points are, therefore, really the terminals of protoplasmic trabeculæ which connect the central body with the membrane. At certain positions of the objective these trabeculæ appear colourless, but at others they have a green tinge which may be due to the reflection of green from the colouring matter. Whether the latter is in the substance of the trabeculæ or in the fluid held between them it is impossible to say. There are, however, as will be seen afterwards in the description of the structure of the hardened cell, indications that the blue-green mixture is held in the cavities between the trabeculæ. On the other hand I have never seen granules holding chlorophyll such as Hieronymus describes. Of the occurrence of a special chromatophore in any form there seems to be not the slightest indication found in the living cell. I regard the granules, which to Palla appeared to contain a mixture of chlorophyll and phycocyan, and the granules observed by Hieronymus as optical transsections of the protoplasmic trabeculæ which extend from the central body to the cell wall. I have never found these trabeculæ formed of other than homogeneous substance and can, therefore, not support the view of Hieronymus that coloured granules are imbedded in numerous parallel fibres which run in a spiral fashion in the coloured zone about the long axis of the cell. I have never observed what Palla confidently asserts, namely, that the pigment granules are arranged in rows.

In the outer or peripheral zone there occurs a large number of granules which do not contain any colouring matter, although they may at times be so situated in the coloured zone as to appear coloured, this being due to their reflecting the blue-green of the surrounding cytoplasm. In the spores of *Cylindrospermum majus* large granules imbedded in the substance of the peripheral zone, and by their presence forming bays in central body, appear blue-green, but that they are uncoloured can be determined readily by causing the spores to burst, when the granules, becoming free, appear unpigmented. These, to a certain extent, correspond, as will be shewn below, to the "cyanophycin" granules of Palla and Borzi. "Cyanophycin" granules are usually abundant in the *Oscillariæ*, being found in a row at each end of the cell adjacent to the transverse septum, but in *Microcoleus terrestris*, in *Tolypothrix*, *Scytonema* and *Lyngbia*, they are distributed throughout the substance of the peripheral zone.

IV.—Fixed Preparations of Cyanophyceæ.

When trichomes of *Oscillaria Froehlichii* have been hardened in picric acid for several days and stained with picrocarmine and hæmatoxylin, the preparations contain isolated elements like those represented in Figs. 2 and 3. Similar preparations are obtainable from this form when corrosive sublimate is used as a fixative agent, but the vesiculation of the cytoplasm, while distinct, is less clearly demonstrated than in picric acid preparations. Like preparations may be obtained with Flemming's fluid.

The cytoplasm has the structure which Bütschli claims obtains in it. The character of the vesiculation is, however, not what he describes nor does every trichome even in a picric acid preparation present a similar vesiculation. In all, on the other hand, the vesiculation of the central body appears of a finer character than that in the peripheral zone. When the spaces in the cytoplasm are, as is the case in some trichomes, very minute it would be difficult to determine whether vesiculation obtains, were it not that some threads show all the stages between this condition and that in which the vesiculation is distinctly pronounced. In the latter the walls separating the vesicular cavities have a membranous appearance with an indefinite character to their borders.

Owing to the more minute character of the vesicles in the central body, the latter has a compact appearance, and as it stains with hæmatoxylin and other dyes somewhat deeply and uniformly it is thereby brought out sharply in contrast with the cytoplasm of the peripheral zone. There is usually not a distinct line of demarcation between them, but the vesiculation of the central body may pass almost abruptly into that of the peripheral zone. The vesicles in the latter are elongated, tending to extend from the central body to the membrane of the cell. In consequence of the peripheral layer being thicker at the sides than it is adjacent to the transverse septa, the membranous bands separating the vesicles in the neighbourhood of the septa are shorter than elsewhere. The bands terminate in a thin delicate layer closely applied to the cell membrane, which can be seen with difficulty and is most evident when, as in *Oscillaria Froehlichii*, it is, as in that part adjacent to the transverse septa, rich in granules of the "cyanophycin" class. The latter are usually at "nodal" points of the layer and membranous bands terminating in it. The layer may sometimes be distinctly seen in preparations of *Oscillaria Froehlichii* which have been hardened in alcohol and stained with hæmatoxylin. In these the cytoplasm has shrunken away from the membrane at one side of the cell in many trichomes and in this case the thin hyaline layer, stained somewhat more deeply than the enclosed cytoplasm, appears sharply contrasted with the latter.

In *Oscillaria natans*, *Tolypothrix tenuis*, *Scytonema* sp., and in the vegetative cells of *Cylindrospermum majus* the structure of the cytoplasm in the fixed condition is the same as in *Oscillaria Froehlichii*. In these forms, however, the cells are much smaller and consequently the vesiculation, which may be clearly observed in the larger form, is only rarely well seen. On the other hand the distinction in the cytoplasm of a central body and a peripheral zone is quite as readily marked as in the large forms of *Oscillariæ*. The central body also stains in hæmatoxylin more deeply than the peripheral cytoplasm, into which it is continued without any sharp transitional changes in staining or structure.

In *Microcoleus terrestris* owing to the narrow transverse diameter of the trichomes the differentiation of the cytoplasm into a central body and a peripheral zone is not perceptible. There is a difference between the most centrally placed cytoplasm and that of the periphery, but where one begins and the other ends it is impossible to say. The most centrally placed part stains more deeply in hæmatoxylin than does the peripheral part and at the same time appears denser. Vesiculation in both parts has been often observed but there is no distinction in the size of the vesicles of the two parts. In the central part more of cytoplasmic substance appears to surround each vesicle when the vesiculation is distinct. In *Oscillaria tenerrima* there is apparently no distinction between central part and peripheral layer, except in the deeper staining of the more central cytoplasm. Vesiculation was not observed in this form. (Fig. 16).

These facts support on the whole Bütschli's claim that there are two parts, a central and a peripheral, and that the character of the latter is different from that of the former. Bütschli's view that the central body is the homologue of a nucleus is another question which must be determined, not only on structural but also on micro-chemical grounds.

There is not, as already pointed out, a distinct line of demarcation between the central body and the peripheral cytoplasm. There is also nothing to indicate the occurrence of a membrane about the central body. Further, no elements can be found in the central body which correspond to the chromatin nodules or "nucleolar" structures, although as will be shown below, granules of a chromatin-like substance obtain in the more peripheral portions of the central body, but rarely in the central portions of the latter. It must also be pointed out that no observer, with the exception of Scott, has described any structures in the Cyanophyceæ which correspond to those found during mitosis in the higher organisms. This latter fact, perhaps, taken by itself does not count much against the view that the central body is the homologue of a nucleus, for, as Bütschli points out, the macro-nucleus of Infusoria never exhibits mitotic division, but, taken in conjunction with the other facts regarding the structure of the central body, renders it exceedingly hypothetical that the central body corresponds to the nucleus of the higher organisms.

From the micro-chemical point of view the evidence for Bütschli's view would appear to be somewhat stronger. I have already pointed out elsewhere[1] that the substance of the central body gives indications of the presence of a compound containing "masked" iron. Further observations on a number of the larger Cyanophyceæ confirm this. Trichomes of *Oscillaria Froehlichii*, *Tolypothrix tenuis*, *Cylindrospermum majus*, hardened in alcohol, mounted on a slide in a mixture of glycerine and ammonium hydrogen sulphide and kept in a temperature of about 60°C, gave, after some days, preparations in which one observed a somewhat dark-green tint in the central body. Very often when the preparation had not been a success the result was due to the slow penetration of the sulphide which can only act successfully when the reagent attacking the iron-holding body can be quickly renewed. The iron reaction, when it is obtained in this way, is distinct and does not occur in the peripheral zone. The iron reaction may, however, be obtained more readily in another way. If the trichomes, hardened in alcohol, are placed for two to five hours at 35° C. in sulphuric acid alcohol (acid 4 vols., alcohol, ninety-five per cent., 100 vols.), and then after washing in ninety-five per cent. alcohol, are treated with the acid ferrocyanide mixture (potassium ferrocyanide, 1.5 per cent. solution, hydrochloric acid,

1 "On the Distribution of Assimilated Iron Compounds, other than Hæmoglobins and Hæmatins, in Animal and Vegetable Cells." Quart. Journ. Micro. Science, Vol. XXXVIII, p. 175.

0.5 per cent., equal volumes) for five minutes to give the Prussian-blue reaction, or with aqueous hæmatoxylin (0.5 per cent. solution) for a few minutes, preparations are obtained which show quite distinctly that the central body contains a substance in which "masked" iron is held. At the same time one species of the granules also may show the presence of "masked" iron and this may be observed when the glycerine sulphide method is used. The Prussian-blue reaction exhibited by the central body is a uniform one and the depth of the blue colour depends on the thickness of the cell but it is unmistakable in every case. The bluish-black given by the hæmatoxylin is similarly marked. It is to be noticed, however, in all these cases that the blue of the Prussian-blue reaction and the bluish-black of the hæmatoxylin are not limited to the central body, for a lighter blue or a faint hæmatoxylin reaction may be found in that part of the peripheral zone next to the central body, and very often in such preparations it is not possible to say where the line of separation is. This is the case sometimes in *Oscillaria Froehlichii* and if the cell discs are seen from their flat surface the blue colour is marked in the centre but gradually diminishes towards the periphery and is obscure or absent in the outer part of the peripheral zone. A similar distribution of the "masked" iron in the peripheral zone is shown by the glycerine-sulphide method, but the reaction is not as decisive for minute quantities of iron.

There can, therefore, be no doubt that the central body specially, and a portion of the peripheral zone immediately about it in a very much less degree, contain "masked" iron.

The reaction for organic phosphorus is not less distinct. Treatment of trichomes, hardened in alcohol, with a nitric acid solution of ammonium molybdate for several hours at a temperature not exceeding 35° C., then with dilute nitric acid for a few minutes and afterwards with a two per cent. freshly prepared solution of phenylhydrazin hydrochloride for from three to five minutes, gave definite indications of the presence of phosphorus in the production of a dull greenish-blue reaction in the central body specially and only faintly in the cytoplasm of the peripheral zone. Certain granules also give the reaction deeply as in the case of the iron reaction. The reaction in the central body is, as stated, a marked one, and it is uniform, shading at the margins of the central body into the feeble reaction of the peripheral zone. That the reaction is due to organic phosphorus and not to inorganic compounds of this element is indicated by the fact that the nitric-molybdate reagent brings out the full reaction after two hours at the earliest, and then only gradually.

The presence of "masked" iron and organic phosphorus in the central body is at least an indication of the occurrence therein of an iron-holding nuclein, like, in some respects at least, the chromatin of the nuclei of higher organisms. This conclusion is supported by the results of the action of artificial digestive reagents in these organisms.

When fresh trichomes of *Oscillaria*, *Tolypothrix*, *Scytonema* and *Microcoleus* were digested with artificial gastric juice, made by adding a quantity of a strong glycerine extract of the mucosa of the gastric fundus of the pig to hydrochloric acid of 0.2 per cent. strength, the preparations at the end of forty-eight, seventy-two and ninety-six hours showed certain changes which were due to the digestive reaction. Zacharias found that the peripheral zone is in great part removed, while a portion of the central body disappears leaving two substances behind, one of the nature of plastin, the other having a nuclein-like character and receiving from him the name, "central substance." Fischer, on the other hand, denies that the digestive reagent has any such effect and that the diminution of the volume of the contents is due to a contracting action of the digestive ferment in the presence of hydrochloric acid, an action which he terms enzymatic. Fischer's view is incorrect for when one studies at some length the digestive action of artificial gastric juice on the cells in Cyanophyceæ, not only is there a diminution in the volume of the cell contents but there is also a disappearance of a portion of its constituents. The peripheral zone is perhaps most affected but a portion of it resists digestion, and after treatment with weak potash solution (0.3 per cent.) remains. This latter substance is undoubtedly plastin. The central body also is affected, but at first sight apparently less so than the peripheral zone. It is rarely diminished in size and it has, as Zacharias points out, specially after treatment with alcohol and ether, a nuclein-like lustre. When, however, the preparation, after prolonged treatment with alcohol and ether, is stained in a good alum-hæmatoxylin solution (Ehrlich's or Delafield's) the central body, instead of appearing homogeneous or appearing uniformly stained as in good fixed preparations, gives in the majority of cases a coarse reticular appearance in which the trabeculæ are usually deeply stained. (Fig. 8).

The stainable portion of the central body, the "central substance" of Zacharias, is soluble in weak alkalies, as may be proved by placing trichomes, acted on by gastric juice for forty-eight hours, in a 0.3 per cent. solution of potash for six or seven hours, when subsequent treatment with ether, alcohol, and Ehrlich's hæmatoxylin fails to indicate the occurrence of a stainable substance like that referred to. What remains of the central body and of the peripheral zone stains, but there is no differentiation, both parts staining feebly but uniformly. This indicates that what remains in the central body as well as in the peripheral zone is formed of plastin only.

These facts show quite clearly that artificial gastric juice does dissolve a portion of each part of the cell in the Cyanophyceæ. That which is left in the peripheral zone is largely, if not wholly, composed of plastin while a part of what is left in the central body appears to have the character of a nuclein compound. The concentrated character of the substance left in the central body and its coarsely reticular appearance can only be explained on the postulate that the reagent has removed material from the central body. What contributed to the view of Fischer that the digestive fluid exercises only a contracting, not a dissolving action, was the assumption that nothing appeared to be removed from the cell acted on by the digestive fluid. There is one feature in all digestive experiments on the Cyanophyceæ which ought to be borne in mind. The membranes in the Cyanophyceæ have a colloid character and as such they do not readily permit the diffusion through them of colloids in solution. Pepsin is much more a colloid than a crystalloid and consequently it will not penetrate the membranes in the Cyanophyceæ with the same facility as hydrochloric acid and, therefore, a slighter effect is produced at the end of twenty-four hours than is obtained when naked cytoplasmic masses, like the cells in higher organisms, are treated with gastric juice. This would account in part for the results obtained by Fischer.

There can be, therefore, very little doubt that a chromatin-like substance is present in the central body of cell of Cyanophyceæ. It is much less in amount than the chromatin of the smallest nucleus in a highly organized cell, and it does not appear to vary in amount in the various cells of a trichome nor in those of a preparation of filaments. In other words, this chromatin-like substance appears to be fixed and unchanging in amount in whatever condition the cells may be. This chromatin-like substance never appears to enter any condition resembling, in the remotest degree, that of mitosis and whenever the cell divides this substance is distributed as it is in the resting cell, that is, uniformly throughout the central body. It is impossible, then, to regard the central body, with Bütschli, as the homologue of a nucleus. From its structure and its chemical character it is rather to be regarded, as Fischer claims, as a more active portion of the cytoplasm.

When trichomes of *Oscillariæ*, *Tolypothrix*, *Scytonema*, *Microcoleus terrestris*, are digested for twenty-four or forty-eight hours with artificial gastric juice and then stained for twenty-four hours with picrocarmine, what remains of the central body is coloured red and at times the peripheral zone is given a green stain. A similar result has sometimes been obtained with Ehrlich's hæmatoxylin in dilute solution, but in this case the central body takes a blue violet colour. When alcohol and ether were employed after the gastric juice the green reac n was not obtained, and this was the case also when the digested trichomes were treated with weak alkaline solutions, this showing that the substance which stains green is soluble in alcohol and alkalies. Far oftener, however, another condition was observed. Digestion of trichomes for two or three days resulted in the production of somewhat irregular masses of brownish material placed frequently adjacent to the transverse septa. In *Oscillaria tenerrima* there may usually be only one such mass in each cell, being flattened and situated next to either the lateral membrane or one of transverse septa. In *Microcoleus terrestris* the corresponding brown substance is in the form of granules, many of which are distributed through the cell. In all cases the substance forming these masses is soluble in alcohol and in weak alkalies. The masses may also take, after a prolonged stay in picrocarmine solutions, a dull green or bright green colour. Their solubility in alcohol and weak alkaline solutions, their absence when the whole of the peripheral layer stains green with picrocarmine, and their reactions with the latter dye, appear to indicate that they are derived from a constituent uniformly distributed throughout the peripheral zone in the living cell. The green reaction under the influence of picrocarmine indicates a chromogenic character and it is probably a derivative, through digestive action, of one of the constituents which form the "blue-green" of the peripheral zone.

The occurrence of such a pigment, if it is derived from the colouring matter of the cell, unsoluble as it is in water, renders it probable that the colouring matter during life is dissolved for the most part in the cavities of the vesicles of the peripheral zone. If it were dissolved in the cytoplasmic framework it would be difficult to explain its occurrence, after digestion, in masses.

The question of the occurrence of a chromatophore has been dealt with in various ways by the majority of investigators of the structure of the cell in Cyanophyceæ. Whatever is meant by the term chromatophore, it is necessary to point out that such an organ as it obtains in the more highly specialized Algæ can never be found in Cyanophyceæ. All who have claimed that a chromatophore is present in the Cyanophyceæ are not agreed as to its character. According to Deinega it is a perforated plate, the trabeculæ of which carry the colouring matter and run parallel, in the greater number of cases, with the trichome. In Zukal's view the coloured, peripheral zone is the chromatophore which he claims is finely punctated, while Hieronymus maintains that it is of fibrillar structure and on it are arranged fine granules which contain the chlorophyll, the phycocyan being dissolved in the enchylema. Palla, on the other hand, defines, without further reference, the coloured peripheral layer as the chromatophore, which Nadson does not accept, but according to Fischer the chromatophore is an independent organ which is perforated to allow the passage of protoplasmic strands from the central body to the plasma zone outside the chromatophore. Fischer in his figures of stained preparations of *Oscillaria Froehlichii* illustrates such a radial disposition of protoplasmic strands from the central body but there is in them no indication of the existence of a chromatophore and the only evidence which he advances for believing that the latter exists is the result of the action of strong hydrofluoric acid on specimens of *Oscillaria princeps*, which dissolves out the central body, leaving a ring of material undissolved corresponding in position to the coloured zone of the cell. I have tried the action of hydrofluoric acid on specimens of *Oscillaria Froehlichii* and have not been successful in obtaining the results that Fischer obtained. Giving full importance, however, to his observations on this point one cannot but at the same time question whether the structure observed after the action of such a drastic reagent as strong hydrofluoric acid, is not simply an artifact. As he describes and illustrates it, it is a compact solid body without structure, and this is a suspicious fact, for, in his view, the protoplasmic strands which penetrate it are numerous. Observing also his illustrations of transsections of stained *Oscillaria Froehlichii* one must ask also how such an organ could be accommodated in the peripheral zone, the greater part of the space of which is taken up by the protoplasmic strands.

There is, as I have already pointed out, no evidence for the existence of a specially organized chromatophore to be found in the living cell. When a cell of *Oscillaria princeps* in the living state is ruptured the substance of the peripheral zone is found to have a much more fluid character than that of the central body. This shows that, whatever the chromatophoric substance may be, it is not distinct from the substance of the peripheral zone, nor has it the physical character of a chromatophore as found in the green Algæ.

Considering the fact that there is in the Cyanophyceæ no nucleus it is reasonable to believe that the other structures in the cell are as little differentiated, and therefore, one should not expect to find in these forms a highly organized chromatophore. This view is the most consistent, moreover, with all the observations which have been made on the Cyanophyceæ.

V.—THE GRANULES IN THE CYANOPHYCEÆ.

The granules, according to Bütschli, Palla and Nadson, are of two kinds, one which stains red-violet with Delafield's hæmatoxylin and situated, according to Palla, on the periphery of the central body, according to Bütschli on the central body or in its more peripheral portions, according to Nadson, in the central body only; the other which stains blue or blue-violet, to be found chiefly adjacent to the transverse septa. The latter class of granules Bütschli claims is not affected by hæmatoxylin staining, and he usually demonstrated their presence with eosin. Zacharias also has described the occurrence of two kinds of granules, and the writer showed that one kind, those which are described by Bütschli as staining red-violet with hæmatoxylin, contain a "masked" iron compound, while the other kind of granules are, as a rule, free from "masked" iron. Hieronymus, Deinega and Fischer, however, claim that there is only one kind of granules present. The first-named observer holds that two kinds of granules appear to be present because of the methods of preparation, but that if fixed cells are treated with ammonia vapour all the granules colour dark blue with hæmatoxylin and further that all dissolve in dilute acids although not equally readily. Fischer, on the other hand, maintains that the granules do not disappear in artificial digestion (with pepsin and hydrochloric acid) and further that, if they are treated with dilute soda solutions, all stain blue with hæmatoxylin. He also finds that in some forms all the granules are stained either blue or red, while in other preparations some of the granules stain blue, the remainder red. He claims that the metnod of fixation employed greatly varies the capacity of some of the granules, notably those which stain blue with hæmatoxylin, to absorb the staining compound, and he concludes that staining is due to differences, not of chemical properties, but of physical condition produced by the fixing reagent. The granules which Deinega found were soluble in acids and stained specially with picrocarmine.

I have made a lengthy examination of the granules which occur in the Cyanophyceæ and I find that while in some species one kind only may be present, yet in other forms two distinct types of granules occur. Illustrations of these two types may be found in the *Oscillariæ*, in *Tolypothrix*, *Scytonema* and *Microcoleus terrestris*. The best method of demonstrating them is to harden the material in picric acid or corrosive sublimate, or even in alcohol alone, and then stain first with picrocarmine and afterwards with dilute Ehrlich's hæmatoxylin. The latter reagent gives granules in the peripheral portions of the central body a deep reddish-violet stain and these correspond to the "red" or red-violet granules of Bütschli. These may be, for the present, called the granules of the first type. The granules of the second type stain bright red with picrocarmine and correspond to those which Deinega found and to the granules which, according to Palla and Nadson, stain blue with hæmatoxylin.

The granules of the first type vary very much in size. They are usually situated in the outer sections of the central body although occasionally a single one may be found in the more central portion and in the inner zone of the peripheral layer. The granules, as Hieronymus, Palla and Bütschli found, are, at times, hollow bodies, while to Zacharias their peripheral substance appeared to have a greater density than their centre possessed and the author found that all the larger granules, at least, are formed of an outer zone or coat which takes the hæmatoxylin deeply, with a central cavity containing a fluid substance which is indifferent to staining reagents. Methylene blue deeply stains these granules and in consequence their hollow character in such preparations is not evident. Acetic-methyl green gives them in fresh preparations a stain much deeper than that taken by the central body, while it leaves unaffected the granules of the second type.

The granules of the second type correspond to the "cyanophycin" granules of Borzi and Palla and, as they have a special affinity for picrocarmine, their presence can always be readily demonstrated. In the fresh cells they stain deep blue with Ehrlich's hæmatoxylin. They are in the *Oscillariæ* more abundant adjacent to the transverse septa and they appear to be situated in the thin cytoplasmic layer which is applied to the septum. In picric acid preparations of *Oscillaria Froehlichii* stained with picrocarmine, views of the flat faces of the discs frequently show a somewhat radiate arrangement of the granules, the larger ones of which are found near the junction of the lateral membrane with transverse septa. The granules in such cases are not exactly round, as they appear slightly elongated in the radial direction. In *Microcoleus terrestris*, *Tolypothrix*, *Scytonema* and *Lyngbia*, these granules are distributed throughout what corresponds to the peripheral zone in these forms.

It is not in staining alone that I would base the classification of these granules. A far stronger distinction lies in the chemical reaction of the granules and in the action of digestive fluids upon them.

The granules of the second type very quickly dissolve in hydrochloric acid solution of 0.5 per cent. strength, and in very dilute nitric acid and sulphuric acid, while those of the first type are unaffected. As a rule they have no special affinity for iodine over that of the cytoplasm of the peripheral zone. When material, hardened in alcohol, was treated with the nitric-molybdate reagent for several hours and then with a solution of phenylhydrazin hydrochloride, these granules gave no reaction and were consequently not visible, while in the granules of the first type the outer coat, which stains deeply with hæmatoxylin, gave a strong reaction for phosphorus. As this reaction required time to develop, the phosphorus demonstrated must be present in organic form, that is, in the form which characterizes the nucleins and nucleo-proteids.

When material, hardened in alcohol, was treated at 35° C. with sulphuric acid alcohol to set free organic iron, and the iron, thus set free, demonstrated by either the Prussian-blue or the hæmatoxylin method, one found a distinct reaction in the granules of the first type but not in the second. When the granules were large, as represented in Figs. 11-14, the outer coat only gave the reaction, but when a granule was very minute the iron appeared to be uniformly distributed through it. The iron reaction was also obtained in these granules by placing the broken-up trichomes on a slide in a drop of the glycerine-ammonium sulphide mixture and covering the preparation with a cover glass, after which it is placed in a warm oven kept at a temperature of 60° C. for a week, during which the preparation was examined from time to time. The only obstacle to success in these preparations is the presence of the thick membrane or sheath of the trichome which, as already pointed out, prevents a free diffusion of the sulphide into the cells which may consequently not exhibit any reaction, but, in those portions of the trichomes freed from the investing sheath, the reaction comes out quite distinctly in from three to five days. The threads of *Microcoleus terrestris* are most readily freed from their membranes and if granules of the first type are present, which is the case if the form is growing vigorously, they give the dark-green reaction of ferrous sulphide in about three days, and it is distributed as it is found after treatment with acid alcohol, that is, in the outer portions of each granule. No reaction was obtained in granules of the second variety.[1]

The iron demonstrated in this case can belong only to the "masked" form, and as such is most usually associated with a nuclein or nucleo-proteid. This and the fact that the granules in question contain organic

1 An exception must be made in the case of those preparations referred to in my former paper, "Quart. Journ. Micro. Sci.," Vol. XXXVIII, p. 266. As I have never since succeeded in obtaining a similar preparation I have concluded that in that case the granules were not of the normal composition.

phosphorus indicate very decidedly that the substance forming the outer portion of the granules belongs to the nuclein class of compounds. As this same substance has an affinity for hæmatoxylin and acetic-methyl green, it is difficult to resist the conclusion that it is true chromatin.

If, however, trichomes containing these granules are submitted to digestion with artificial gastric juice, the granules in from eighteen to twenty-four hours disappear. The granules of the second type disappear during the first hour. The absence of granules of the first type is not apparent only, as Bütschli claims, who holds that they are still present, although they have lost their capacity to take up stains, but is due to actual solution and disappearance of their substance, for by no method of staining or impregnation can they be brought into view. Bütschli's contention, therefore, is incorrect. It is the recognized property of nucleins to resist gastric digestion and if this is universally true the substance forming the granules cannot be regarded as true nuclein compounds or as a true nucleo-proteid. It must be noted, however, that some forms of nucleic acid are soluble in artificial gastric juice and it is possible that the substance forming the essential portion of the granules in question contains one of these soluble forms. It must be recognized, also, that the substance in question, while possessing many of the characters of chromatin as it is found in highly organized animal and vegetable cells, does not fully represent the latter, and the true representative of chromatin in the Cyanophyceæ is to be found in the substance, holding "masked" iron and organic phosphorus, obtaining in the central body.

What the chemical composition of the granules of the second type is it is not possible to say definitely. The substance forming them has by some been regarded as an isomer of starch, but its capacity for absorbing picrocarmine and staining blue-violet with slightly diluted Ehrlich's hæmatoxylin in the fresh trichome indicates that it is rather related to the proteid class of compounds. This is confirmed to a certain extent by evidence of the presence of organic sulphur in the granules. When preparations of *Oscillaria Froehlichii*, hardened in alcohol, are carefully heated for about ten minutes in a mixture of glycerine and solutions of potash and lead acetate the granules in question exhibit a light brown tint due to the presence of lead sulphide. Except in one instance they have not given any indication of the presence of organic phosphorus and they cannot, therefore, be regarded as formed of a nucleo-proteid compound. They are extractable with boiling water and their substance is not coagulable with heat. On the whole, the facts suggest that they are constituted of a substance which has the characters of one of the lower proteids. As they are abundant in the rapidly growing and assimilating forms it is possible that their substance represents the first assimilation stage of the proteids synthesized in these organisms. As the granules disappear in trichomes which are not assimilating freely, they would appear to represent the reserve material of the cell, as Nadson and others have claimed.

In *Cylindrospermum majus* only one kind of granules is present and these are usually very large and homogeneous. They resemble the granules of the first type in that they have given evidence of the presence of "masked" iron[1] and also those of the second type in their capacity for absorbing and retaining picrocarmine. I am unable to say whether they contain organic phosphorus, since I have not had at my disposal, during the last two years, any specimens of the organism to determine this point.

In *Nostoc commune* and *Oscillaria tenerrima* only one kind of granules is present. In the latter they are comparatively large and usually hollow in the centre. (Fig. 16).

VI.—The Heterocyst.

The development of the heterocyst depends on degenerative changes in the cell which at the outset is free from granules. The first evidence of the change occurs in the disintegration of the central body, which appears to be constituted of a coarse network in which ill-defined granular swellings are seen. This network stains deeply in hæmatoxylin and as the change progresses it fills the whole of the cytoplasm (Fig. 17, two lowest cells). At the same time a large granule or mass develops at one pole of the cell which quickly acquires a marked affinity for picrocarmine (Fig. 15) like that exhibited in the granules of the second type. Very often the cell which is to form a heterocyst is incompletely separated from its neighbour on division, and in the connecting strand of cytoplasm which extends through an opening in the transverse septum, the mass in question develops as a pear-shaped body with its terminal points in the two cells. (Fig 17). This structure has been referred to by Borzi, who believes that it is formed of cyanophycin. When the developing heterocyst is intercalary there may be such a mass at each pole of the cell, but there is only one when the cell is terminal.

In the next stage the structures of the central body dissolve completely

1 The extent of the reaction for iron obtained is indicated in Fig. 8, Plate 10, "Quart. Journ. Micro. Science." Vol. XXXVIII.

in the cytoplasm which now attains a light greenish-yellow colour. The mass of picrocarmine-staining substance persists, but otherwise the cytoplasm is homogeneous, and it does not stain with hæmatoxylin, picrocarmine, or with any of the aniline dyes. It gives a feeble but uniform reaction for "masked" iron, a slightly more marked reaction for phosphorus and it is not affected during prolonged action of artificial gastric juice, which also does not dissolve the mass at the pole of the cell. The latter gives a distinct reaction for "masked" iron. This result indicates that the substance forming the mass is not related to the substance, cyanophycin, forming the granules of the second type, and that, therefore. Borzi's supposition as to the composition of the mass is incorrect. The heterocyst is, therefore, a degenerated cell. It may also possibly represent more than this. Its formation next to the spore in *Cylindrospermum majus* and other forms, as well as its development beside the cell out of which arises the lateral trichome branches in *Tolypothrix* would appear to suggest that the heterocyst may be the result of some rudimentary sexual process.

VII.—CELL DIVISION.

Ordinarily the first sign of cell division in the Cyanophyceæ is the growth inward from the lateral wall of a septum which appears thus to separate, not only the cytoplasm as a whole, but also the central body, into two equal parts. It is, however, only in such genera as *Tolypothrix* and *Scytonema*, in which the cells are, in comparison to their length, very long, that one is able to ascertain what are the earliest phenomena of cell division. In preparations of trichomes from quickly growing cultures one may find a cell in which the deeply stained central body has a constriction which gives it a slight hour-glass appearance. In some other cells, perhaps in the same trichome, the constriction may be greater and at the same time the ingrowth from the lateral membrane to form the transverse septum may be found. The constriction of the central body, before the appearance of a trace of a septum, must be held to indicate that the central body initiates division.

The mode of the formation of the transverse septa explains the central perforation or opening in the septa which Borzi saw. In old septa I have never observed these passages or perforations. They are really due to incomplete formation of the septa.

In the division the granules are apportioned to the daughter cells according to their distribution. There is no rearrangement, no grouping of them, nor any change so far as can be determined in their chemical reaction. It may happen, as it often does in *Microcoleus terrestris*, that while the granules of the second type are equally divided between the daughter cells, one of the latter may receive all the granules of the first type. When, however, these granules are very large in proportion to the cell which contains them, such granules are divided when the cell divides. Instances of this were seen in some preparations of *Oscillaria natans* found in a rapidly growing condition and treated with artificial gastric juice for from eight to ten hours. In these there were very large granules, or rather spherules, of the first type, which occupied a large portion of the cell space and which stained deeply in hæmatoxylin. In the undividing cell they were spherical, or nearly so, but in those dividing as well as in those which had divided, they exhibited a constriction in the plane of the transverse septum formed but not completed, while in other cases where the septum was fully formed, each daughter cell had its half of the original spherule or granule. (Fig. 19). It is obvious that in such cases the division of the spherules was not physiological but mechanical and that it followed the division of the cytoplasm.

Such instances of division of the granules are rare and would not, it must be believed, occur in the large-celled *Oscillariæ* if the granules or spherules were not correspondingly large, a condition which does not occur. *It is, however, interesting to note that in one form of the Cyanophyceæ, at least, the substance in the cells which represents chromatin in these organisms, when present in abundance is divided between the daughter cells in a mechanical way and after the daughter cells are formed.*

SUMMARY.

1. In the living cells of Cyanophyceæ, with the exception of those in which the transverse diameter of the trichome is very minute, two zones can be readily made out: one central, uncoloured, the other peripheral, holding the pigment. The cytoplasm forming the central zone, or body, is denser than that present in the peripheral layer.

2. The pigment is dissolved in a fluid which occupies vesicles in the cytoplasm of the peripheral layer. There is no evidence of the presence of a special chromatophore.

3. The central body is finely vesiculated and, except in its periphery, almost free from granules. In it obtains a small quantity of a chromatin-like substance which resists the action of artificial gastric juice and contains organic phosphorus and "masked" iron. This substance is uniformly diffused throughout the cytoplasm of the central body.

4. The cytoplasm of the peripheral layer is, compared to that of the central body, always somewhat coarsely vesiculated. It gives a very faint reaction for "masked" iron and a feeble reaction for organic phosphorus. In the part immediately adjacent to the central body the reactions for both are slightly deeper than that demonstrated in the outermost part of the peripheral layer.

5. The granules present are usually of two types, one of which is formed of a substance staining with hæmatoxylin and containing "masked" iron and organic phosphorus and, therefore, resembling chromatin. They are, on prolonged digestion with artificial gastric juice, dissolved. Granules of this, the first type, when large, are found to be hollow spherules. These granules are usually found in the peripheral portions of the central body, but they are not confined to that part, for they may rarely be observed in the central parts of the central body and also in the inner zone of the peripheral layer in some forms.

6. The granules of the second type are to be found in the peripheral layer and chiefly adjacent to the cell membrane. Rarely are they hollow spherules. They are constituted of a substance which stains deeply with picrocarmine and is free from organic phosphorus and "masked" iron. This substance dissolves very quickly in weak acids. As it gives a reaction for sulphur when treated with plumbic acetate in alkaline solution, it is probably a proteid.

7. In one form, *Cylindrospermum majus*, only one kind of granules is

present and these are found in the peripheral layer. The substance which forms these stains deeply with picrocarmine and with difficulty with hæmatoxylin. It appears to contain "masked" iron.

8. The heterocyst is a degenerated cell in which all distinction between the central and peripheral parts is lost. The chromatin-like substance of the central body diffuses throughont the cytoplasm when the heterocyst is forming. When fully developed the cytoplasm gives a feeble reaction for iron. A small mass at one or either pole of the cell gives a distinct reaction for "masked" iron and stains deeply with picrocarmine. Further, as it does not dissolve in acids, it is not related to the substance which forms the granules of the second type.

9. There is no nucleus, nor any structure which resembles a nucleus, in the Cyanophyceæ.

10. Division of the cell is direct, the central body first showing the effects of this process. When a large spherule of chromatin-like substance is present it may pass into a daughter cell, or it may be mechanically divided between the two daughter cells.

BEGGIATOA.

LITERATURE.

The structure of *Beggiatoa* is to a great extent recognized as affecting the question of the structure of Bacteria in general, and consequently in the literature on the subject one finds frequent reference to the structure of various species of *Beggiatoa*. Some of these references are, however, of a very brief character and deal only with the external form. The more important observations bearing on the internal structure are those of Bütschli,[1] Mitrophanow[2] and Fischer.[3]

According to Bütschli in *Beggiatoa*, as in other sulphur Bacteria and in the Cyanophyceæ, the cytoplasm of every cell has a central body and a peripheral zone. These two structures are quite distinct in properly made preparations. In the central body are frequently large lacunar spaces which in the living cell are occupied by the sulphur granules. The central body also contains minute granules which in position and staining properties correspond to the "red" granules of the Cyanophyceæ. In some preparations of *B. alba* the peripheral zone was very narrow, so much so that the central body appeared to come almost in contact with the membrane of the cell. In *B. mirabilis* the central body is extraordinarily large and in it is a large vacuole in the interior of which, in the living cell, are small pale corpuscles in molecular movement. On the surface of the central body is a single layer of vesicles (Waben). Minute "red" granules are also found in the central body.

Bütschli holds that the central body, thus described, is the analogue of the nucleus of more highly specialized cells and that consequently the peripheral zone of cytoplasm corresponds to the ordinary cell protoplasm of higher organisms.

Mitrophanow describes as nuclei of the Sulphur Bacteria structures of the most diverse form and character. In some cases, in *Chromatium* and in *Rhabdochromatium* for example, it is an irregular, centrally placed mass, elongated parallel to the long axis of the cell. In other cases it

1 "Ueber den Bau der Bacterien und verwandter Organismen," Leipzig, 1890. Also, "Weitere Ausführungen über den Bau der Cyanophyceen und Bacterien," Leipzig, 1896.

2 "Études sur l'organisation des Bacteries," Intern. Monatsschr. für Anat. und Physiol., Vol. X, p. 475, 1893.

3 Untersuchungen über den Bau der Cyanophyceen und Bakterien," Jena, 1897.

contains a collection of granules of chromatin which stain differently from the substance in which they are held, and more deeply. Not unfrequently there may be several masses sometimes completely separate from each other, in other cases connected by narrow strands of the same substance. In some cells also the granules which Mitrophanow terms "nucleolar" are uniformly distributed throughout the cytoplasm of the cell. In such no nucleus is visible. In *Ophidomonas jenensis* the central elongated mass reminds one of the central body of Bütschli, the peripheral cytoplasm corresponding to the peripheral layer of that author. This mass may appear divided into a number of smaller vesiculated irregular clumps of substance. In *Beggiatoa* the masses are always spherical, and, to judge from Mitrophanow's figures, homogeneous in composition. Several of these may be present in the cell, though as a rule there are not more than two large ones.

Mitrophanow's terminology is very obscure. He applies the term nucleus to the large elongated, centrally placed mass and the term nucleoli to the granules which it may contain, or to those which may be distributed throughout the cytoplasm. In the case of *Beggiatoa* the granules found are loosely described by him as nucleoli. He has advanced nothing, except, perhaps, facts in regard to staining capacity, which justify the application of the term nucleus to these structures.

In neither *Chromatium* nor *Beggiatoa* could Fischer find a differentiation of the cytoplasm into central body and peripheral layer, such as Bütschli describes. In *Chromatium* there may at times be a condensation of the cytoplasm in the centre of the cell, brought about by the arrangement and disposition of the sulphur droplets which it contains. There may be in each cell a number of spherical grains of a deeply stainable substance which Fischer hesitates to regard as chromatin, for after the use of some chromatin-fixing reagents the granules formed of it are not to be seen. In *Beggiatoa* Delafield's hæmatoxylin brings out the presence in each cell of "red" granules such as Bütschli describes. In subsequent treatment of these preparations with safranin the central portions of the cells stain a little more deeply than their periphery, but this is due to condensation of the cytoplasm through the disposition of the sulphur granules. In cells free from sulphur this result is not obtained. There is no nucleus and the granules cannot definitely be regarded as formed of chromatin.

The writer[1] pointed out that the "masked" iron compound is dis-

1 "On the Distribution of Assimilated Iron Compounds, other than Hæmoglobin and Hæmatins, in Animal and Vegetable Cells," Quart. Journ. Micro. Sci., Vol. XXXVIII, p. 258.

tributed uniformly throughout the cytoplasm and that this distribution corresponds with the diffuse stain given by hæmatoxylin. In the "comma" forms granules which stained with hæmatoxylin gave a reaction for "masked" iron.

MATERIAL AND METHODS OF STUDY.

The forms used were *Beggiatoa media*, *B. alba* and *B. mirabilis*. The cultures of the two former in water containing sulphuretted hydrogen in solution were always kept in the actively growing condition. These cultures could in twenty-four hours be got to yield myriads of the spirillum-like elements, the "comma" forms, and the "cocci," which, according to Zopf[1] are different stages in the development of *Beggiatoa*.[2]

One method of fixation was to place a drop of the culture on a cover glass, allow the water to evaporate, and then to float the cover, preparation surface downwards, on a saturated solution of corrosive sublimate, where it was left for a couple of hours, after which it was passed successively through alcohols of fifty, seventy and ninety per cent. strengths. Cover glass preparations were made with ninety-five per cent. alcohol, without the employment of any other reagent. Picric acid in saturated solution was also employed on cover preparations as well as on quantities of the material in various stages. Material in bulk was hardened in ninety-five per cent. alcohol alone.

In staining, methylene-blue, safranin, eosin and Ehrlich's and Heidenhain's hæmatoxylins were employed. The first three dyes, each used alone, give results of no value, but they may individually be employed with one of the hæmatoxylins and thereby a more marked demonstration of the vesicular structure of the various forms may be obtained. If, however, the iron-alum hæmatoxylin method alone is carefully employed it will give preparations which in distinctness leave nothing to be desired.

The material from *B. mirabilis* was hardened, part in absolute alcohol and part in picric acid in saturated aqueous solution.[3]

1 "Znr Morphologie der Spaltpflanzen," Leipzig, 1882. Also "Die Spaltpilze," Breslau, 1883.

2 These forms are, according to Winogradsky ("Beiträge zur Morphologie und Physiologie der Bacterien," Leipzig, 1888), not geneticallv related to *Beggiatoa*. He was unable to find a transformation of the *Beggiatoa* threads into the "cocci" forms, an experience which befell Engler ("Ueber die Pilz-Vegetation des weissen oder todten Grundes in der Kieler Bucht," Vierter Bericht d. Commission zur Wiss. Untersuchung der deutschen Meere in Kiel, p. 185, Berlin, 1884).

3 For this material I am indebted through Dr. E. C. Jeffrey to Mr. Billings.

General Cell Structure.

In fresh actively growing specimens of *B. alba* the cytoplasm of the filaments is crowded with minute sulphur droplets, and it is difficult to determine the presence of any other structures. One can, with very high powers and good illumination of the microscopic field, see the transverse septa marking the thread off into cells, and at the same time find the cytoplasm next these septa free from granules.

In the fixed preparations which have been passed through alcohol and stained the result is different. In Fig. 60 are represented three cells of a thread of *B. alba.* The sulphur has been removed by the alcohol and the places occupied by the sulphur are shown as clean vacuoles. The protoplasm near the transverse septa appears denser than elsewhere, although because of the aggregation of the vacuoles around the centre sometimes the cytoplasm at the latter point gives an appearance of condensation. The stain taken by the cytoplasm is uniform throughout the cell, but fine granules may not unfrequently be observed. I am, however, unable to corrobrate Mitrophanow regarding such large granules as he illustrates. When the threads become less rich in sulphur and therefore, ill nourished, large granules may be found, not quite so often indeed, as he observed, but still much more frequently than in the preparations from actively growing cultures. I am inclined to believe that Mitrophanow's preparations were made from ill-nourished cultures, and an examination of his illustrations (Figs. 28 and 30) convinces one of this, for in them is an utter absence of such vesiculation as would be present, had the cells, when prepared, contained sulphur droplets.

There is no evidence whatever of the presence of any nuclear structure. The cells of well-nourished threads in no case show a differentiation of their cytoplasm into central and peripheral parts according to the views of Bütschli. It is rare even to get, as Fischer did with hæmatoxylin and safranin, a slightly deeper stain in the central part, and when this does appear it is due to the fact that the central part of the cell is seen through a greater quantity of cytoplasm than is the periphery of the cell.

In *B. mirabilis* hardened in alcohol the cell frequently contains a slightly denser portion of cytoplasm placed adjacent to one of the transverse septa, but an examination of this mass shows that it is really a shrunken portion of the cytoplasm which filled the whole cell. When the preparations are made with picric acid the frequency of these shrunken masses is greatly reduced. The cytoplasm then usually appears vesiculated throughout and it stains uniformly with hæmatoxylin, showing an absence of granules.

When the threads of *B. alba* and *B. mirabilis*, after being hardened in alcohol, were treated with the nitric-molybdate reagent for two to three hours and then acted upon with a solution of phenylhydrazin hydrochloride of two per cent. strength, in order to demonstrate the distribution of organic phosphorus, the latter was found to be uniformly diffused throughout the cell. In *B. mirabilis* the condensed portions observed in some cells, as already described,gave a marked indication of the presence of "masked" phosphorus, but it appeared so because in the shrunken condition to which these masses are due more cytoplasm is gathered into a smaller volume than in cells with unshrunken cytoplasm. Fig. 61 illustrates this. In *a* and *b* are observed two shrunken masses of cytoplasm, in these are aggregations simulating granules, while in *c* the cytoplasm shows the organic phosphorus uniformly distributed throughout the cell. In *B. alba* the phosphorus is distributed uniformly with the cytoplasm and the method did not reveal the presence of granules.

The reaction for iron derived from the "masked" condition, is in *B. alba* and *B. mirabilis* found to be uniform with the distribution of the cytoplasm. When sulphuric acid alcohol is used to set the organic iron free in the threads and the preparation is washed free from acid with absolute alcohol and stained with a pure aqueous solution (one per cent.) of hæmatoxylin, the result is decided enough to determine definitely that there are no specialized chromatin-holding structures like nuclei or like Bütschli's central body. Granules sometimes found distributed in the peripheral portion of the cytoplasm give the reaction.

The distribution of the "masked" iron being then like that of the organic phosphorus, it follows that the substance containing these elements, the analogue of the chromatin of more highly specialized cells, is contained, not in any nucleus however rudimentary, but diffused in the cytoplasm, and sometimes, also, localized in granules.

Somewhat different are the results of observations on the spirillum-like form, and on the "cocci," and comma-shaped organisms. Here, as little as in the thread or "leptothrix" forms, is there any evidence of the existence of a nucleus, rudimentary or otherwise. In these, the vesicles occupied by the sulphur droplets, are all crowded about the centre, or about the central axis, leaving the peripheral layer as a thin, homogeneous structure applied to the membrane. In the "spirillum" form the vesicles are separated from each other by a thin film of cytoplasm, and here and there, and especially at the nodal points in these films, one observes, in hæmatoxylin preparations, granules which are more deeply stained than the rest of the cytoplasm. Sometimes these granules are more or less drawn out in the films between the vesicles, and then the central cytoplasm may take on the character of the central body of Bütschli. Of the actual existence of such a central body there is not the slightest evidence.

In the "comma" forms the granules are very much fewer, and frequently smaller. In the "cocci" they are rarely visible, and minute lightly stainable granules make their appearance at the periphery of the vesicles (Fig. 59, *a*, *b*, and *c*.).

In the "spirillum," as well as in the "comma" form, the compounds of "masked" iron and organic phosphorus are, apart from the granules, faintly diffused throughout the cytoplasm, sometimes apparently less abundant in the central portions of the cells, and definitely indicated in the peripheral layer. The granules give a slightly more marked reaction for "masked" iron as well as for organic phosphorus, and this fact, combined with their capacity for taking up hæmatoxylin, would seem to indicate that they are formed of a compound analogous to chromatin.

The difference between the structure of the threads, and that of the "spirilla" and the "comma" forms in regard to granules, may be due to some inherent difference in the process of nutrition in the two different types, but it may also be explained on the view of Winogradsky that these types are not genetically connected, that they belong to different species of Sulphur Bacteria.

Whether this is correct or not does not affect the question that, in all these types of structure, there is nothing to simulate a nucleus, even of the most rudimentary description. It can scarcely be contended that the granules, the affinity of whose substance to chromatin is shown by their containing, in a small degree, "masked" iron and organic phosphorus, are morphologically of the value of nuclei, or even of nucleoli, as Mitrophanow appears to claim.

SUMMARY.

1. In *Beggiatoa alba* and *B. mirabilis* there is no differentiation of the cytoplasm, as Bütschli finds, into a central body and a peripheral layer The centrally placed portion of the cytoplasm contains, in the well-nourished fresh cell, a number of sulphur droplets, and frequently the cytoplasm between the droplets may be more condensed than at the periphery of the cell, but usually both portions stain equally deeply.

2. The compounds of "masked" iron and organic phosphorus are uniformly and equally diffused throughout the cytoplasm in the threads of *B. alba* and in *B. mirabilis*, and the organic phosphorus is found uniformly distributed in those cells which contain unshrunken cytoplasm. When granules which stain with hæmatoxylin occur, they are found to contain "masked" iron and organic phosphorus.

3. In the "spirilla," in the "comma" forms and in the "cocci," the cytoplasm shows characters like the cytoplasm of the threads, but there are, in addition, granules which give slight reactions for "masked" iron and organic phosphorus, and which, therefore, are constituted of a substance analogous to chromatin.

4. There is, in all these forms, no specialized chromatin-holding structure in the shape of a nucleus of any kind.

THE YEAST CELL.

I.—LITERATURE.

The structure of the Yeast Cell, and more especially the question whether it has a nucleus or not, has been the subject of investigation by a large number of observers since 1844, when Nägeli[1] affirmed the existence of a nucleus in this organism. Chief amongst these were Schleiden[2] (1849), Brücke[3] (1861), Schmitz[4] (1879), Strasburger[5] (1884, 1887), Zalewski[6] (1885), Krasser[7] (1885 and 1893), Hansen[8] (1886), Zacharias[9] (1887), Zimmermann[10] (1887), Raum[11] (1891), Moeller[12] (1892 and 1893), Hieronymus[13] (1893), Janssens[14] (1893), Dangeard[15] (1893 and 1894), Macallum[16] (1895 and 1898), Buscalioni[17] (1896), Wager[18] (1897

1 Zeit. für Wiss. Botanik, Vol. I, p. 45, 1844.

2 "Grundzüge der Wiss. Botanik," 1849, p. 207.

3 "Die Elementar-organismen." Sitzungsber. der K. Akad, d. Wiss. zu Wien, Math-Nat. Classe, 1861, Vol. XLIV, Abth. 2.

4 "Untersuchungen über den Zellkern der Thallophyten," Sitzungsber. der Niederrhein. Gesell. für Natur-und Heilkunde zu Bonn, Sitzung am 4 Aug., 1879.

5 "Das Botanische Practicum," p. 339. 1887. Also edition of 1884.

6 "On Spore Formation in Yeast Cells." Transactions of the Scientific Academy of Cracow. (Polish). Vol. XIII, 1885. Abstract in Bot. Centralbl., Vol. XXV, p. 1, 1886.

7 "Ueber das angebliche Vorkommen eines Zellkerns in den Hefezellen." Oestereich. Bot. Zeits., 1885; also: "Ueber den Zellkern der Hefe:" ibid., 1893, p. 14.

8 "Recherches sur la Physiologie et la Morphologie des Ferments Alcooliques." Meddelser fra Carlsberg Laboratoriet, Vol. II, p. 152, 1886.

9 "Beiträge zur Kentniss des Zellkerns und der Sexualzellen." Botanische Zeitung, 1887, Nos. 18-24.

10 "Die Morphologie und Physiologie der Pflanzenzelle." Breslau, 1887, p. 25.

11 "Zur Morphologie und Physiologie der Sprosspilze." Zeitschr. für Hygiene, Vol. X, p. 1, 1891.

12 "Ueber den Zellkern und die Sporen der Hefe." Centralbl. für Bakt. und Parisitenkunde. Vol. XII, p. 537, 1892; also: "Weitere Mittheilungen über den Zellern und die Sprosse der Hefe:" ibid., Vol. XIV, p. 358, 1893.

13 "Ueber die Organization der Hefezellen." Ber. d. deutsch. Bot. Gesell., Vol. XI, p. 176, 1893.

14 "Beiträge zu der Frage über Kern der Hefezelle." Centralbl. für Bakt, und Parasitenkunde, Vol. XIII, p. 639, 1893.

15 "Sur la structure histologique des levures et leur développement." Comptes Rendus, Acad. d. Sciences, Vol. CXVII, p. 68, 1893; also: "La structure des levures et leur développement." Le Botaniste, 1894, p. 282.

16 "On the Distribution of Assimilated Iron Compounds, other than the Hæmoglobin and Hæmatius, in Animal and Vegetable Cells." Quart. Journ. Micro. Sci., Vol. XXXVIII, p. 243, 1895; also: "On the Detection and Localization of Phosphorus in Animal and Vegetable Tissues." Proc. Roy. Soc., Vol. 63, p. 467, 1898.

17 "Il Saccharomyces guttulatus Rob." Malpighia, Vol. X, 1896.

18 "The Nucleus of the Yeast Plant." Report British Association, Toronto Meeting, 1897, p. 860; also: ibid., Bristol Meeting, 1898, p. 1,069, and Annals of Botany, Vol. XII, p. 499, 1898.

and 1898), Janssens and Leblanc[1] (1898), and Bouin[2] (1898), a fairly full account of whose observations, as of those of others, is given by Wager (1898) to which the reader may be referred. Many of the observations, especially those of more than ten years ago were made with imperfect means and methods, and although there is amongst the older observers almost an unanimous agreement on some points, as for example, the presence of a nucleus, it must be now recognized that with the employment of the simple methods alone used by them, no observer can maintain with the same degree of certainty that he can see the structures which they found, or can admit that what they found is what they claimed it to be. I propose here, therefore, to limit any discussions of the observations to those made within the last seven years, and particularly to those of Moeller, Buscalioni, Wager, Janssens and Leblanc and Bouin, for these observers not only gave thorough attention to the structure of the yeast cell, but also used very much improved methods of fixation and staining. I may add in justification of my not giving an account of the earlier observations that in 1895 I discussed these at some length.[3]

Moeller in his first paper claimed that the yeast cell contains a nucleus which is homogeneous and without a membrane. This nucleus changes its shape readily, and, therefore, its position in the cell varies. Owing to this property it may assume a thread-like form when budding occurs, a portion of which is thus enabled to pass into the protoplasm of the bud through the narrow connecting tube. The part which projects into the bud breaks off and separates with the bud, assuming finally the rounded form of the mother nucleus. In the spores, however, Moeller could not find any evidence of the presence of a nucleus, but in his later communication he states that he found the nucleus in the spore element, and he describes its character. The nucleus of the cell, at the beginning of spore formation, enlarges and becomes elongated and constricted at the middle. The constriction deepens, the ends separate to the opposite poles of the cell, and the fine thread joining the two parts breaks, two daughter nuclei being thus formed. A second and similar division follows. The division is a direct one.

Janssens found in *S. cerevisiæ* and in *S. Ludwigii* a nucleus provided with a homogeneous nucleolus and membrane, the diameter of the nucleolus being one-third that of the nucleus. The nucleus divides

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1 Recherches cytologiques sur la cellule de levure." La Cellule, Vol. XIV, p. 203. 1898.

2 "Contribution à l'étude du noyau des levures." Arch. d'Anat. Microscopique, Vol. I, p. 135 1898.

3 Quart. Journ. Micro. Sci., Vol. XXXVIII, p. 243.

in the mitotic fashion, and Janssens claims to have observed the equatorial plate and dyaster stages. In spore formation the nuclear membrane disappears, and the plane of the second division is at right angles to that of the first, the two spindles also being at right angles to each other. Each spore is provided with a nucleus.

Later Janssens, in conjunction with Leblanc, published a fuller and somewhat different account of the structure of the cell. They found in *S. cerevisiæ* and *S. Ludwigii* a nucleus with a distinct nuclear membrane, caryoplasm, and a nucleolus constituted of nuclein. The caryoplasm is formed of a fine network of fibrils intimately connected with each other and applied to the nucleolus. When, however, the cells are put in a fresh culture medium, the nucleus becomes vacuolized, but the nucleolus maintain·· its shape and central position, and the protoplasm remains homogeneous. The vacuolated condition ceases at about the thirteenth hour. In a longer stay in the medium the protoplasm becomes granular. Ordinarily the cytoplasm is formed of a typical reticular structure, the meshes of which contain granules. Both the contents of the meshes as well as the reticulum and its nodal points, in some cases, manifest a strong affinity for colouring matters, and it is evident that this is due to a nucleo-albuminous substance dissolved i· this structure. When the cells are grown on plaster blocks the granules may become very large and refracting, but when sporulation begins these granules disappear, presumably contributing a portion of the material which constitutes the spores. Glycogen in the cell ordinarily is dissolved in the enchylema, but when it is very abundant it localizes itself in vacuoles which may fill the cell. When the cell buds, the nucleolus elongates and divides, but the two parts remain united by a strand of substance apparently like fibrils, which may slightly resemble a spindle. The two nucleoli pass toward that part of the cell which is giving rise to the bud. The nuclear membrane and the caryoplasm disappear, leaving the nucleoli nude. A structure which resembles, to a certain extent, a cell plate, makes its appearance in the cell between the two nucleoli. The process up to this point is a rudimentary form of kinesis. One of two nucleoli slips into the bud, and now, if not before, the nuclear membrane re-forms about both. The bud thus constituted is, in all respects, like the mother cell.

In the formation of the spores, the authors find that early in the spore mother cell the nucleolus divides, as already described, but the nuclear membrane does not disappear. This is not accompanied by any division of the cell. After some hours, however, only one nucleus with a large nucleolus is observed. The authors believe that the two nucleoli originally present have fused or conjugated, that is, fecundation has taken place. This is followed by division of the large nucleolus, the elongation taking place in the long axis of cell. In each of the two nucleoli thus formed a second division occurs, immediately following the first, the elongation of the two daughter nucleoli being at right angles to each other. When the four nucleoli are fully formed the membrane develops about each, and around each of the nuclei thus constituted the protoplasm collects, a membrane finally forming about each mass, which becomes a spore.

According to Buscalioni, whose observations were made on *S. guttulatus*, the yeast cell contains a nucleus which ordinarily is homogeneous, and its division is by constriction. This obtains when budding occurs, the two daughter nuclei remaining connected by a thin fibril until one of them enters the bud. This is simple fragmentation. In the formation of spores, however, the nucleus undergoes a slightly different species of division which may be looked upon as a rudimentary kind of kinesis.

Bouin found a sharply defined nucleus which, during fermentation, sends prolongations into the cytoplasm. The latter are less sharply defined the further they proceed from the centre of the nucleus. The nucleus ordinarily may be granular, or may contain in its interior irregular, deeply stainable masses. In some cells a nucleus would appear to be absent. In these an intense stain may serve to show a nucleus poor in chromatin; but cells which do not appear to have a nucleus have lost it by its transference, without division, into the bud. The nucleus may, under certain conditions, divide and re-divide, while the cell may remain undivided, and Bouin holds that this multiple division of the nucleus accounts for the number of chromatin granules found in some yeast cells. The granules are, in this case, nuclei, and the cell containing them, multinucleate. The division of the nucleus ordinarily is amitotic, that is, there is elongation of the nucleus with constriction, the thread uniting the two ends becoming more and more delicate till rupture occurs. One of the two daughter nuclei thus formed passes through the canal between mother cell and bud, and into the latter, where it becomes spherical. No striation of the cytoplasm between the two daughter nuclei was observed, nor was any evidence of an equatorial plate and of chromosomes found. In the formation of spores the nucleus divides into two chromatin masses, which separate, then become rounded, and constitute the nuclei of the spores. This mode of division is intermediary between mitosis and amitosis.

Wager, from his first observations, claimed that in *S. cerevisiæ* a spherical homogeneous nucleus is to be found placed between the cell wall and the vacuole, which, after digestion in pepsin-glycerine solution, reveals a granular structure. From this he concludes that it consists of deeply stainable granules imbedded in a less stainable matrix. The granules are probably formed of chromatin. In budding, the nucleus divides directly, and this occurs in the narrow passage between the mother cell and the bud. When division is to take place, the nucleus places itself opposite the opening and proceeds to make its way into the bud, until about half of it has passed through, when it divides completely, the products constituting nuclei for the mother cell and the bud. In the cell about to sporulate the large vacuoles disappear, the protoplasm is beset with small ones, and the homogeneous nucleus is centrally placed. In it, granules, however, soon make their appearance, which accumulate in the centre, and look like a nucleolus. In division, the outline of the nucleus becomes irregular, and the granules arrange themselves in the form of a short rod, surrounded by other portions of the nucleus, which stain differently, and appear to form a structure like a spindle. The granules form two groups, each of which constitutes a nucleus, and each of the two nuclei divides in the same way, forming thus the nuclei of the spores. Around each of these nuclei protoplasm accumulates and a membrane forms. This form of nuclear division Wager regards as a simple form of karyokinesis. In *S. Ludwigii*, he found a nucleus with membrane, and a nuclear network and nucleolus the latter containing all the chromatin. In division, the nucleolus increases in size, and divides, each part becoming a nucleus.

In the paper detailing his later observations, Wager gives a fuller, and, in some respects, a considerably different account of the yeast cell. In the fresh, actively growing organism the cell contents are clear and homogeneous, with sometimes one or more bright refracting granules. In this condition a vacuole or vacuoles can be seen, and in each occurs at least one refracting particle which is in a state of movement. The vacuoles disappear in a later stage of fermentation, and the protoplasm then appears homogeneous and clear; but, when the culture medium becomes exhausted, the contents become granular and possess fat globules, the protoplasm shrinks from the cell wall, and the cell presents an appearance of disintegration. In compressed yeast, on the other hand, the cells are rich in refracting granules, which are sometimes uniformly distributed through the protoplasm, sometimes located around the vacuoles, or grouped together at one side of the cell.

In regard to the nuclear apparatus, Wager distinguishes two structures: one of which he calls the nuclear body, while he terms the other the nuclear vacuole. The nuclear body, which is the nucleus of Moeller, and of his own earlier observations, is homogeneous, but surrounded more or less completely by granules, and which, with low powers of magnification, give it a granular appearance. It is, in actively growing cells, usually in close contact with the cell wall, but it may, in a few cells, be more centrally placed. In relation frequently to this nuclear body there are granules, first described by Hieronymus, some of them of an oily nature, others of a proteid character, sometimes grouped about the nuclear body, sometimes in its immediate neighborhood or distributed throughout the cell. At times these form a coiled thread. The nuclear vacuole, which is in contact with the nuclear body in growing cells, contains chromatin, sometimes in the form of granules, sometimes in the form of a network, sometimes as an irregularly shaped mass attached to the wall of the vacuole by fine threads. In some cells all the chromatin substance appears to reside in the vacuole; in others it is diffused through the protoplasm, and in some cells again it appears in the nuclear body. The vacuole Wager regards as the nucleus of Janssens and Leblanc, and the nucleolus of these observers constitutes his nuclear body. The nuclear vacuole may persist but for a short time. After fermentation has proceeded for some hours it disappears, and its place is occupied by a granular network in contact with the nuclear body. The vacuoles seem to arise by fusion of minute vacuoles which develop in connection with what appears to be chromatin granules.

In regard to division, Wager found that the nucleolus (the nuclear body) is separated from the bud by the vacuole, which, as the bud develops, begins to pass into it. At the same time, the nucleolus makes its way to the base of the opening, and there, or in the neck, at once begins to elongate and constrict for division. The vacuole at this time divides, but not completely or equally, the smaller portion being found in the daughter cell, both parts remaining connected by a granular thread. The divisions of the nuclear body are nearly or quite equal, and one of them makes its way into the daughter cell. When the nucleolus is in the neck, the constriction takes place with the ends in the mother and daughter cells. When there is no vacuole, the granular network in contact with the nuclear body undergoes division into two more or less equal portions, either in the mother cell or in the neck of the bud. The granules which the young bud thus receives seem to develop, in some way, the vacuoles which form the single large nuclear vacuole.

In sporulation the nuclear vacuole disappears, or its place is taken by two or more smaller ones which in turn are replaced by many others and, as a consequence, the protoplasm acquires the foam structure of Bütschli. The nuclear body moves towards the centre, the protoplasm condenses about it, and on the periphery of this condensed zone deeply stainable granules collect. The nuclear body now appears to take up from the surrounding cytoplasm all the stainable material, and to deposit it in its centre as a granular mass. The division of the nuclear body occurs as Wager describes it in his earlier paper.

In regard to the nature of the nuclear apparatus, Wager regards it as a simple form of a nucleus, although he admits the possibility of it being either a primitive structure representing an early stage in the organogeny of the nucleus, or a degenerated form of nucleus. The division of the nuclear body, he thinks, may be regarded as a case of direct division, but, in his opinion, it may also be a very simple case of karyokinesis.

In my own studies on the distribution of assimilated compounds of iron, I pointed out that, in *S. cerevisiæ* and *S. Ludwigii*, chromatin is to be found distributed throughout the cytoplasm of the cells and, sometimes, also in the latter in the form of granules; but, in *S. Ludwigii*, it may be found chiefly at the periphery of each large vesicle, when only a few large vesicles are present in the cell. In this form also there is a substance constituting corpuscles of a nucleolar character, the nuclei of Moeller, which stains with eosin, and gives a marked reaction for iron, but differs from chromatin in remaining unstained after treatment with hæmatoxylin. My conclusion was that there is no nucleus, although such an organ may occur in other stages of this organism. In a later contribution embodying the results of observations made to determine the distribution of organic phosphorus in animal and vegetable cells, I pointed out that in the yeast cell the phosphorus-holding substance, or nucleo-proteid, although sometimes in the form of granules or spherules which have been taken for nuclei, is frequently dissolved in the cytoplasm.

It will be seen from this abstract of the more recent literature on the yeast cell, that there are some discrepancies in the views of various investigators of the subject. An agreement is indeed found as regards the division of the nuclear body or nucleolus, but not as to the manner of this division. The most radical difference, perhaps, exists between Wager, on the one hand, and Janssens and Leblanc on the other, as to what constitutes the nucleus, and as to its structure apart from the nuclear body or nucleolus.

II.—METHOD OF STUDY, AND SPECIES STUDIED.

The fixing reagents which I used were corrosive sublimate and picric acid, each in saturated aqueous solutions, the chrom-osmio-acetic mixture of Flemming, and a one per cent. solution of potassic iodide saturated with iodine. Undoubtedly for yeast cells the best of these, in my experience, are corrosive sublimate and Flemming's fluid. They produce less alteration in structure than any other, and they do not, when properly used, alter the staining power of any part of the yeast cell. The most satisfactory method of employing them was to allow them to act in bulk on a large number of yeast cells, separated from the actively growing cultures by centrifuging the latter. After the reagents had acted sufficiently long the fluid was decanted, distilled water was poured upon the cells, which were immediately subjected to centrifuge action and thus separated, when they were treated with alcohols of gradually increasing strengths. With these reagents also I obtained reliable cover-glass preparations, in which drying of the cells was not a factor, by spreading a film of the yeast culture on the cover-glass, and then, with this face downward, placing it floating on a quantity of the solution, to remain there for from one to twenty-four hours. The fluid, at the moment of touching, removed very many of the elements, but enough were left adherent to make a good preparation. Afterwards the cover-glass so treated was placed in alcohol of 30, 50, 70, and 90 per cent. strengths successively.

The cover-glass method of preparation could not be employed with the other reagents except to some extent in the case of iodine, as these remove from the cover all the cells. The only safe way of fixing with these solutions was to allow them to act on the yeast cells in the test tube. They were separated completely from the fluid, after the required time for complete fixation, by centrifugalizing the fluid. The hardening in these cases was completed by the use of alcohols of 30, 50, 70, and 90 per cent. strengths successively. The cells were completely separated in these cases by gravity. In the case of the iodine solution the method employed by some of allowing a film of yeast cells to dry on a cover-glass, and then placing it in the reagent, has no advantage over the one described, and I am not sure that it is free from objection. It is difficult to believe that yeast cells can be unaffected when the fluid about them is completely removed by evaporation. I have, therefore, avoided this method of preparation, as well as that in which heat alone is used for the purpose of fixation.

With regard to iodine solutions more particularly, it is necessary to use a word of caution. The prolonged action which is required with this reagent affects the proteids of the cell, and must change consequently the reactions of the cellular structures to staining solutions. I have found that it alters and changes the staining capacity of the cell in *Spirogyra*, as well as of various animal tissues, and it can scarcely be admitted that it has no effect on the cytoplasm of the yeast cell. I find that it greatly diminishes the affinity of the chromatin distributed throughout the cell for hæmatoxylin and other dyes which, in the case of corrosive sublimate preparations, select only the chromatin. The reagent does, indeed, assist in fixing the yeast cells in such a way as to single out for special demonstration a spherical, more or less homogeneous body, known to certain investigators as the nucleus, and to others as the nucleolus or nuclear body; but this property depends on the power of the iodine to change the chemical character of the cytoplasm in a greater degree than that of the nuclear body which is homogeneous and dense.

Amongst the staining reagents which were used were hæmatoxylin, safranin, eosin, and acetic-methyl green and methylene-blue. The solutions of hæmatoxylin gave the best results and, more particularly, Delafield's, Ehrlich's, and Meyer's (hæmalum). The solutions were made very dilute, so much so that it required always from sixteen to eighteen hours' application of the fluid to bring out the full stain. The iron-alum hæmatoxylin of Heidenhain was also employed, and it is of value in revealing the structure of the cytoplasm of the yeast cell, but it is of no value as a micro-chemical reagent, and it does not show any sharp distinction between chromatin-holding and chromatin-free cytoplasm. Eosin was used as a counter stain to hæmatoxylin. Acetic-methyl green was employed on the fresh cells, and methylene-blue on the cover-glass preparations.

The organic iron and phosphorus compounds were demonstrated in the manner described in the case of the Cyanophyceæ. The yeast cells were, for this purpose, always hardened in alcohol. To reveal the distribution of organic iron the cells were mounted on a slide under a cover-glass, in a mixture of glycerine and fresh ammonium hydrogen sulphide, and the preparation kept at a temperature of 60°C. for a week. To demonstrate the organic phosphorus, the cells were kept in a solution of ammonium molybdate in nitric acid for five hours, after which they were washed in distilled water for a few minutes, and then subjected to the action of a 2 per cent. solution of phenylhydrazin hydrochloride, which converted the molybdic portion of the phospho-molybdate into a greenish-blue compound. The cells, washed with distilled water and dehydrated, were mounted in balsam.

The species studied were *Saccharo myces cerevisiæ*, *S.Ludwigii*, and two found in cultures obtained from the throat in suspected cases of diphtheria. The specimens of *S. cerevisiæ* and *S. Ludwigii*, employed for the purposes of preparation, were in the actively growing condition in Pasteur solutions, from which a quantity of the cells, separated by centrifugalization, was taken hourly, starting with the commencement of growth, up to the twentieth hour, and treated as indicated above. Cultures of *S. Ludwigii*, in the sap of the iron-wood tree, *Ostrya virginica*, and of the maple, gave very valuable and instructive preparations. For the study of sporulation *S. cerevisiæ* was used, the sporulation having been brought about by cultivation in a 5 per cent. solution of sugar, as indicated by Wager.

III.—General Cell Structure.

In the fresh yeast cell at the beginning of fermentation, even with the highest powers of magnification, very little can be made out, except the occurrence of granules and vacuoles. These are grouped irregularly in the cell and their number and character may vary, although as a rule there is but one large vacuole. In some young, actively growing yeast-cells, that is in those which are observed two hours after the commencement of fermentation, there may be no vacuoles observable. In such, however, one or more granules may be found. This condition may be observed also in cultures of from sixteen to twenty hours.

Many of these granules appear to possess a fatty nature. When the yeast cells of this stage are hardened in Flemming's fluid for twenty four hours the granules take a dark tinge, due apparently to the reduction of the osmic acid derived from the solution. They are not nearly as numerous in preparations hardened in alcohol as they appear to be in the fresh cell. At a later stage of fermentation the granules present are of a different composition. They do not react, or at most react but slightly, with the osmic acid of Flemming's fluid. They seem to be of a purely proteid character, for when the hardened cells are heated with a solution of potassic plumbate the granules acquire a light brown colour, this fact indicating the presence of organic sulphur. These granules were found to react also with freshly made Millon's reagent in from eight to ten hours without the application of heat.

It is of course possible that granules which give the reaction with osmic acid do not consist wholly of fat, for the reaction in all cases is not intense enough to suggest a purely fatty composition. The basis of apparently all the granules seems to be a proteid substance which may vary in its particular character from stage to stage in the process of fermentation, and in these granules the fat which may be demonstrated is deposited.

The structure of the cytoplasm varies. When the cells of *S. Ludwigii* of early stages of fermentation are hardened in Flemming's fluid and stained in Heidenhain's hæmatoxylin, we get an appearance like that illustrated in Figs. 36, 37, and 38. In these the cytoplasm is shown to contain a reticulum whose meshes are delicate and whose nodal points are thickened. In some cells, as for example in Fig. 38, the reticulum forms a ring around a cospuscle, whose nature will be discussed below. In other cases the reticulum is in intimate connection with the corpuscle. In corrosive sublimate preparations a reticulum is not readily observable, and this is due to the property the reagent has of fixing not only the reticular portion of the cytoplasm, but all the proteids in its meshes, whereas the acetic acid of Flemming's fluid dissolves out some of these. Indications, however, of a reticulum can be found if the stain of the iron-alum hæmatoxylin is carefully decolourized with weak iron-alum solutions.

When the cells have been prepared with iodine solution and stained with iron-alum hæmatoxylin the reticulum shown is coarser as a rule than in Flemming's fluid preparations, the meshes are larger and the trabeculæ thicker. I am inclined to regard this result as due to the iodine reagent which fixes the cytoplasm slowly, and consequently may permit plasmolytic alterations.

The presence of vacuoles affects only slightly the reticular structure, merely condensing the cytoplasm in their immediate neighbourhood.

In corrosive sublimate preparations which have been carefully stained with Delafield's or Ehrlich's hæmatoxylin or with Meyer's hæmalum, the cytoplasm gives unmistakable evidence of the presence of chromatin diffused through it as well as localized at particular points. This diffuse distribution causes the whole cell to be deeply stained when one employs the ordinary staining reagents, in the concentrated form which is usual in the case of other cytological preparations. It is the most striking point that one finds when one for the first time makes preparations of yeast cells, and this being so it is surprising that little attention has been given to it in the literature of the subject.

In the cytoplasm as Errera[1] has shown, may be found glycogen, and it occurs in abundance in the cells of the later stages of fermentation. When iodine solution is applied to the cells from Pasteur solutions in the *first nine hours after fermentation begins, very rarely only does it show* the presence of glycogen, and then only in the form of minute granules. The slight brown tint which the cytoplasm in general at this time gives is due to the absorption of iodine by the cytoplasmic chromatin, and is not due to dissolved glycogen. In cells of from ten to thirteen hours of *cultivation in Pasteur solutions the glycogen occurs in small masses in* the cell. These masses, of which there is usually one to each cell, vary in size, and are more or less irregular in outline and placed adjacent to the cell membrane. In later stages the glycogenic mass may be so large as to occupy the greater part of the cell.

IV.—THE CHROMATIN-HOLDING STRUCTURES.

In yeast cells which have been hardened in Flemming's fluid or in corrosive sublimate solutions, and stained with very dilute solutions of Ehrlich's or Delafield's hæmatoxylin applied for from sixteen to twenty hours, one finds, as already pointed out, a slight colour, due to the presence of chromatin in the cytoplasm generally, and a very deep stain at one or more points in the cell. The latter may also be demonstrated by employing the iron-alum hæmatoxylin method for staining, but as it is not selective its action is less clearly indicative of the presence of chromatin, or of substances allied to chromatin, than that of the staining reagents mentioned. The diffuse stain which is given to the cytoplasm may serve to obscure the presence of a structure or structures which may be present.

One frequent type of this structure is, ordinarily, a spherical mass like that represented in Figs. 36, 37, and 38, and, as in these cases, varying somewhat in size. This body, which I may term, for the sake of brevity, the corpuscle, is, in the great majority of cells, homogeneous and dense, and it stains much more deeply than the cytoplasm generally. It is not, however, always present, for it appears to be absent in cells in the different stages of fermentation, and no method of hardening and staining the cells will demonstrate its presence in all. This has been admitted by Bouin and Buscalioni. The former observer tried by deeply restaining cells which at first appeared to be free from corpuscles, to bring out the presence of the latter, but succeeded only in

1 Report British Association, Bristol Meeting, 1898, p. 1068.

a few of such cells, in which the corpuscles were found to be deficient in chromatin. Buscalioni believes that yeast cells exist which are free from these bodies. Sometimes, on the other hand, one finds yeast cells also which contain not only one but several corpuscles, each, however, smaller than the single corpuscle of other cells.

Very rarely in preparations of *S. cerevisiæ* but very frequently in those of *S. Ludwigii* as cultivated in the sap of the ironwood tree (*Ostrya virginica*), the corpuscle instead of being spherical and homogeneous, is irregular in contour and consists of one or more deeply stainable, dense granules, imbedded in a substance which constitutes the greater part of the corpuscle, and which is less markedly affected by dyes. Sometimes the irregularities in the contour may be so great as to give the corpuscle a stellate appearance. Bouin observed corpuscles of similar shape and structure in *S. cerevisiæ* and *S. pastorianus*.

The corpuscle is the nuclear body of Errera and Wager, and the nucleus of Moeller, Bouin, Buscalioni and others. As these authors describe it, it divides by a process which is a simple form of karyokinesis, and, therefore, it is in their view a fully developed chromatin-holding organ. According to Janssens and Leblanc the corpuscle is a nucleolus of a nucleus which can, by appropriate methods, be revealed as surrounding and containing the nucleolus. This nucleus further is provided with a membrane which becomes invisible when division of the nucleolus takes place, the caryoplasm also disappearing.

In preparations hardened with iodine solution and stained with dilute hæmatoxylin, a body like the nucleus of Janssens and Leblanc can be observed surrounding the "nucleolus," but it is found only in a small number of cells, whereas in the greater number the "nucleolus" or corpuscle lies free in the cytoplasm. In preparations also made with Flemming's fluid and stained with iron-alum hæmatoxylin, the corpuscle is rarely found to be included by a structure like that described by these authors, and when the latter is observed it contains no chromatin and does not give any evidence of structure in its interior. It is as such quite different from the corpuscle already referred to, to be found in *S. Ludwigii* when cultivated in sap. What it is I am not certain, but I am inclined to regard it as a vacuole which, placed above or below the corpuscle, may with the latter strongly resemble a nucleus and nucleolus. In iodine preparations stained with iron-alum hæmatoxylin, the structure in question may be absolutely unstained while the "nucleolus" or corpuscle, and the cytoplasm are deeply coloured. On the other hand, one may find a vacuole, whose wall is rich in stainable material, overlie or underlie a corpuscle, giving exactly one of the conditions described and illustrated by Janssens and Leblanc.

The corpuscle does not in the fresh cell react with acetic-methyl green like a chromatin body. Preparations of this reagent, which would bring out clearly in fresh animal and vegetable cells the chromatin-holding structures, left the corpuscles of the yeast cell, even after hours, unaffected, while the cytoplasm stained readily. Another point of contrast is to be found in its affinity for eosin, which is more readily absorbed and retained by it than is hæmatoxylin.

In the throat yeast the corpuscle was, in the great majority of instances, more or less irregular in outline, always excentrically placed, and in the great majority of cells, in close contact with a vacuole. Sometimes it was crescentic in outline, the vacuole fitting into its concavity. In this form very little chromatin was found in the cytoplasm and as a consequence the corpuscle stood out quite clearly.

In *S. Ludwigii* as it grew in the sap of the iron-wood tree, fixation with Flemming's fluid and staining with iron-alum hæmatoxylin and eosin demonstrated the corpuscle frequently as a reddish body, having at times a tint of blue-violet and surrounded by a garland-like structure formed of deep blue-violet-stained chromatin. This structure, on closer analysis, is found to be formed of granules and elongated masses of chromatin. Sometimes it appears open or discontinued at one side, and, especially if the corpuscle is pear-shaped, its prolongation extends beyond the limits of the chromatin structure. Usually, however, in these preparations the structure is closely applied to the corpuscle. When there are two corpuscles in the cell there is a structure in question about each of them. Rarely the corpuscle appears separated from the cytoplasm, and, consequently, from the garland-like structure, by a zone of clear space. (Fig. 28).

I regard this garland-like structure formed of chromatin as quite the same as the membrane of fine granules closely applied to, and completely surrounding, the "nucleolus," as described by Wager, who found that the granules and nucleolus stained differently. In my preparations of *S. cerevisiæ* the membrane does not appear as uniform and as regular as Wager figures it; and its irregularity, and sometimes the absence of close contact between it and the corpuscle, remind one strongly of the conditions in *S. Ludwigii*. The point to note specially is the contrast in staining presented by the corpuscle and the structures surrounding it. The latter has a marked affinity for hæmatoxylin, while the former absorbs eosin readily. Sometimes, in corrosive sublimate preparations stained with very dilute solutions of hæmatoxylin, the corpuscles may be unstained, or stained no more deeply than the cytoplasm generally. (Fig. 28).

In ordinary cultures of *S. Ludwigii* the garland-like structure may be so infrequently present in its typical form as to be overlooked. Then in many cells granules like those found by Wager and Bouin in *S. cerevisiæ* may be observed. This illustrates how much, as regards structure, is dependent on the mode of cultivation of the yeast cell.

When yeast cells, hardened in alcohol, were submitted at 37°C. to digestion in artificial gastric juice, made by dissolving some glycerine extract of pepsin in a 0.2 per cent. solution of hydrochloric acid, after forty-eight, seventy-two, and ninety-six hours there were very few evidences of the occurrence of corpuscles remaining, nor was there any stainable substance left in the cytoplasm. The corpuscles seem to be affected very much by the digestive solution, for even when the cells were deeply stained with the iron-alum hæmatoxylin, corpuscles were only rarely found, and then they appeared with a large vacuole in their interior (Figs. 39 and 41), or to have lost their stainable substance (Fig. 40). These traces of the corpuscle also disappeared after treatment of the preparations for 24 hours with a 0.1 per cent. solution of potassic hydrate. The results of the treatment with artificial gastric juice seem to indicate that the stainable substance in the cytoplasm and in the corpuscles is different from the chromatin of the nuclei of other organisms, which is unaffected by this fluid.

Similar results were obtained when fresh cultures of *S. cerevisiæ*, in Pasteur solution, were digested for forty-eight hours or more in artificial gastric juice, after which the cells were fixed with iodine solutions and hardened in alcohol. Only very rarely in these, even after the most careful application of the various methods of staining, and especially of the iron-alum hæmatoxylin process, did I succeed in finding traces of a corpuscle. The cells of such preparations seem to have lost their power to stain with Ehrlich's and Delafield's hæmatoxylin solutions, but to have increased their affinity for eosin.

The micro-chemical reactions are quite decisive as regards the relationship of the stainable substance. When the glycerine-ammonium sulphide method is employed to demonstrate the organic iron in cells of *S. Ludwigii* and *S. cerevisiæ*, the results obtained after ten days at the latest distinctly demonstrated the presence of "masked" iron in the one o more corpuscles which may be present in each cell in the walls of the vacuoles, and in the cytoplasm generally (Figs. 42-49). The reaction is usually intense in the corpuscles, so much so that they may appear not dark green but black from the excess of ferrous sulphide developed in them by the reagent. The reaction in the cytoplasm is much less marked but distinct. It may be diffuse, but if the preparation, though successful, has been only a few days in the reagent, one may observe, in a majority of the cells, that the reaction is limited to the cytoplasmic network (Figs. 50 and 51). In some cells a series of granules constituting a membrane about the corpuscles like those already described, gives a very distinct reaction (Fig. 46). Sometimes the number and size of the corpuscles thus demonstrated suggest the character of granules, but there is, in the majority of such cases, one at least which is of the usual size (Figs. 45, 46, 47, and 49). The reaction in the wall of the vacuole may be very distinct, and especially in granules located in it. (Figs. 42, 43, 44, and 48).

On applying the method to demonstrate the presence of organic phosphorus, the later is found to be localized in the same manner as the organic iron. The corpuscle is rich in it, and the wall of the vacuole in contact with the corpuscle gives a distinct reaction for it, and at times specially in the granules found in it. Portions of the cytoplasm, which appear to correspond to the nodal points of the reticulum, give a deep reaction (Fig. 56).

It is evident from the presence of "masked" iron and organic phosphorus, both distributed in the yeast cell to an extent parallel with the distribution of the substance which stains with hæmatoxylin, that the organism contains in its corpuscle or corpuscles, in its cytoplasm, as sometimes in the wall of its vacuole, a substance closely related to the chromatin of higher organisms, but differing from the latter in the effect exercised on it by artificial gastric juice. The stainable substance found in the corpuscles further differs from ordinary chromatin in that it has no affinity for acetic-methyl green.

There remain now to be described structures which are, so far as my observations go, to be found only in *S. Ludwigii*, when cultivated in the sap of the iron-wood tree. The character of these structures is seen by an examination of Figs. 21-27, and 29, in which they are illustrated. They are not all of the same type. As in Figs. 21 and 29 one may observe a large nucleus-like body in which a network, somewhat like that found in a fully typical nucleus, exists. There may also be a corpuscle in this structure which simulates a nucleus. In some cases the structure in question may resemble a nucleus in the stage preparatory to the formation of the chromosomes (Fig. 23). In other preparations, one may obtain cells in which a series of vacuoles is found in close contact with each other, and all surrounded by a substance which stains deeply in hæmatoxylin (Figs. 22 and 24). Rarely one sees structures like those illustrated in Figs. 26 and 27. In Fig. 25, there are in mother and daughter cells structures allied in general form to those found in Figs. 22 and 24.

A somewhat similar instance of vacuolation of chromatin-like masses may be observed in mycelium-like threads developing sometimes with the cells of *S. Ludwigii* in sap cultures. In these the vacuoles vary from an almost infinitesimal size to that of extraordinary dimensions (Fig. 58). The largest ones appear to be formed of a large number of vacuoles fused through the rupture of the more centrally placed partitions (Fig. 58*d*). In a few cases the fused vesicles may form a very large structure, presenting some resemblance to a nucleus (Fig. 57).

Whether these structures are formed of that variety of chromatin which is to be found in yeast cells cannot be decided as yet. The cells containing them are so few in any preparation made with the glycerine-ammonium sulphide method to show the distribution of organic iron, or with the nitric-molybdate reagent to determine the occurrence of organic phosphorus, that they must only very rarely be observed. In only one sulphide preparation did I see a cell which appeared to contain a structure like one of those in question (Fig. 52). In this case the iron reaction of the substance forming the structure was quite marked. It would seem to indicate that these structures are formed of yeast chromatin.

There can be no question about the nature of these structures. They certainly are not nuclei, either normal or degenerated. They owe their form and arrangement to a property of chromatin which, I believe, has not hitherto been regarded as characteristic of it. In the Cyanophyceæ, as already described, the chromatin-like substance not dissolved in the "central body" forms spherules, in the centre of each of which may be found a vacuole (Figs. 4, 6, and 11). In the Foraminifer, *Calcituba polymorpha* Roboz,[1] the nuclear chromatin before division, at first homogeneous, undergoes extensive vacuolation, and upon this process division depends. Indeed the structure of the nucleus ordinarily would appear to depend on the inherent power of chromatin to produce vesiculation or vacuolation, with the formation ultimately of a reticular

[1] F. Schaudinn, "Untersuchungen an Foraminiferen. I. Calcituba polymorpha Roboz," Zeit. für Wiss. Zool., Vol. LIX, p. 191, 1895.

arrangement. This vacuolation may sometimes be observed, in a marked degree, in the masses of chromatin from chromatolysed nuclei in higher animal and vegetable organisms; and it is manifested even in chromatin nucleoli in normal nuclei. This indicates that chromatin secretes fluid in certain conditions, and that vacuoles are formed by this secretion. In the cells of *Saccharomyces* under consideration, it is not certain, as was pointed out, that the structures which simulate nuclei are formed of a chromatin-like substance, but it is probable that they are constituted of it, and this would explain their appearance, although in plasmolysed chromatin a like richness of vacuolation has not yet been observed. I would regard these structures as caused by extensive vacuolation of chromatin-like masses formed in the cytoplasm.

V.—BUDDING AND SPORULATION.

In the process of budding a portion of the cytoplasm is forced into a diverticulum of the cell membrane, the quantity at first forced out being small, but eventually the bud may contain from one-third to one-half of the cell contents. It is only in this way that we can explain the "streaming out" appearance of the cytoplasm in the neck of the bud. We may see vacuoles elongated and extending into the bud (Figs. 30, 32, 42, 44 and 48), or one or more of Raum's granules having extended dumb-bell shapes, the extremities of which lie in the mother and daughter cells. Sometimes also one may find one of the peculiar reticulated, chromatin-like masses, described above, occupying, as a dumb-bell shaped figure, the neck of the bud. The pressure to which the cytoplasm of the mother cell is subjected and the narrow passage of the neck of the bud tends to draw out and elongate all the structures which are forced through the narrow neck.

These conditions are responsible for the elongation and constriction of the corpuscle as described by Bouin, Janssens and Leblanc, Wager and others, who regard these phenomena as constituting evidence of nuclear division. I have found in many instances that the corpuscle is thus divided between the mother and daughter cells. When the corpuscle is found in the neighbourhood of the commencing bud, it is, with the cytoplasm surrounding it, forced to the opening, which is rarely large enough to permit its passage, and if the diameter is large enough the cytoplasm that is driven, with it prevents the corpuscle from passing through the opening. The corpuscle, being plastic like the cytoplasm, may completely fill the passage and project into the interior of the bud, its dumb-bell form being then quite marked. The constriction may deepen until only a fine strand connects the two terminal spheres, and when the bud further develops there may be a complete separation of the two parts, one remaining in the mother cell, the other forming the corpuscle of the daughter cell. Sometimes, however, the whole corpuscle is forced through the neck into the bud. This is to be found not rarely in the sap cultures of *S. Ludwigii* and rarely in *S. cerevisiæ*. Buscalioni believes that this happens sometimes in *S. guttulatus*, and Bouin found that it does occur in *Mycoderma cerevisiæ*. The latter author would thus explain the absence of a nucleus from some cells. It is in this way, I believe, that the complete absence of a corpuscle in the mother cell and the presence of a large one in the daughter cell may be explained. I have also found the bud in a few cells of *S. Ludwigii* grown in sap to contain two small corpuscles, while the mother cell gave not the slightest evidence of the presence of a corpuscle. In these cases one of the daughter corpuscles, after their formation by constriction of the parent structure in the manner described, which should, as is usually the case, remain in the mother cell, is carried with the cytoplasm into the bud.

In *S. Ludwigii* buds may develop and separate without the constriction and division of the corpuscle of the mother cell. This is specially the case when the corpuscle is in a part of the cell remote from the commencing bud. Wager states that in this case the nuclear body (the corpuscle) makes its way to the opening of the mother cell into the bud and then begins to divide. This may happen, but I have found in a number of instances the bud full grown, while the corpuscle remained undivided in the remote part of the cell.

There can be but one interpretation of these facts. The elongation and constriction of the corpuscle are the results of purely physical forces and conditions, such as operate on the cytoplasm in the neighbourhood of the bud, and the constriction and resulting division of the corpuscle are not absolutely necessary factors in the development of the bud. The formation of two corpuscles out of one in this way can scarcely be regarded as a case of direct division or simple karyokinesis, as some observers have claimed it to be.

In *S. Ludwigii* many of the buds contain cytoplasm richer in "masked" or organic iron than that in the parent cell. This would indicate that the cytoplasm of the bud is richer in chromatin, and the results of staining with hæmatoxylin seem to support this view. It is not infrequently found that the cytoplasm lining that part of the membrane of the bud remote from the neck stains deeply and gives a deep reaction for organic iron with the glycerine-sulphide method. Perhaps this distribution may be explained by supposing that the first cytoplasm to pass out into the developing bud is richer in chromatin-like substance.

Quite different is the action of the corpuscle in sporulation. Here, however, the cytoplasm also acts differently. When the cell is ready to sporulate the chromatin dissolved in the cytoplasm begins to concentrate in a zone about the corpuscle, the diameter of the zone diminishing as this stage advances, while the corpuscle appears to lose its distinctness. The concentration advances until all of the cytoplasmic chromatin is collected in a very narrow zone about the corpuscle which, in some cases, may appear very finely granular. At this stage occurs an elongation of the corpuscle and its enclosing body of cytoplasmic chromatin, the elongation rarely being to the full length of the cell. The central portion constricts or becomes more and more slender, until separation of the more or less rounded extremities occurs. Thus two corpuscles are formed, each with a very narrow enclosing zone of cytoplasmic chromatin. Each of these now elongates and divides as the parent structure does. In the second division, however, the cytoplasmic chromatin seems to disappear, or perhaps is taken up into the corpuscle.

My observations on the whole agree with those of Wager, but I have never been able to find the granules which form in the corpuscle or nucleolus immediately before and during its elongation, as described and illustrated by that observer. Nor can I corroborate his view that the nuclear vacuole, which exists in the cell previous to sporulation, divides and redivides many times, thus distributing the chromatin through the cytoplasm, which has, in consequence, a delicate foam-like structure. So far as my observations go, the chromatin in the cytoplasm before the stage of sporulation commences, is not different in its character or distribution from that found in the ordinary yeast cell, for example, during budding.

According to Janssens and Leblanc, the act of sporulation is preceded by a division of the nucleus and its nucleolus, followed by a fusion of the two nuclei thus produced. These authors believe that this fusion or conjugation constitutes sexual fertilization. They find that the two nuclei formed disappear, and in their place, one only, whose nucleolus is large and distinct, is observed. It is rather difficult to accept this interpretation. What they claim to have observed as constituting a nucleus may, as I have pointed out, be found in some cells only, and their nucleolus is the corpuscle, two or more examples of which may sometimes be found in the cell. It is, therefore, not impossible to find frequently in cells in cultures beginning the sporulation stage two small corpuscles. It is, however, another matter to prove that these corpuscles fuse to constitute a single large corpuscle, such as may be found in other cells of the same preparation in which no evidence of fusion having occurred can be observed.

According to these authors, a spindle formed of very fine parallel threads constitutes the connecting strand in the division of what they term the nuclei in sporulation. I have never been able to observe such a structure, but it is possible that what is found in the varieties of yeast used for observing it by Janssens and Leblanc, may permit the demonstration of such a spindle more readily than in the forms I employed. I must say, however, that in *S. Ludwigii*, employed by them also for this object, I was unable to find anything resemble a spindle of fine threads.

I found in a number of cells of *S. cerevisiæ*, a structure which resembles very much that described by Janssens and Leblanc, and compared by them to a cell plate. It was a line formed of delicate, closely placed granules running transversely to the strand connecting the two developing corpuscles and completely dividing the cell into two halves. The dotted line was in the majority of cases so fine and so difficult to see properly that it required the best illumination and the highest available magnification to bring it out. Whether it is to be regarded as a cell plate cannot at present be determined.

The division found in sporulation can scarcely be described as a simple form of karyokinesis. It is rather to be compared to the division of a chromatic filament in the formation of two chromosomes. A more analogous case is that of the division of the nucleolus in *Euglena viridis*, as described by Blochman and Keuten[1, 2]. In this form the nucleolus, at the commencement of division, does not disappear as it ordinarily does in other cells, but remains in all the stages. When the chromosomes which are formed in the normal way begin to constitute the dyaster stage, the nucleolus elongates into a dumb-bell figure, the constriction first observed deepening, until complete separation of the spherical ends takes place. Each of these passes into the corresponding daughter nucleus. In this case, while the ordinary chromatin of the nucleus undergoes division by the karyokinetic method, the nucleolus undergoes direct division. In sporulation in *Saccharomyces* it is difficult

1 "Ueber die Kerntheilung bei *Euglena*." Biol. Centralbl., Vol. XIV, p., 194. 1894.

2 "Die Kerntheilung von *Euglena viridis* Ehrenberg." Zeit. für Wiss. Zool., Vol. LX, p. 215, 1895.

to believe that anything more complex occurs than this nucleolar division.

If, on the other hand, the division in sporulation is regarded as karyokinetic, it must be also held to be an exceedingly rudimentary type of that process. It would in fact have to be admitted as differing so little from what is called direct division as to be almost indistinguishable from it.

SUMMARY.

1. In *Saccharomyces* the cytoplasm is usually finely reticulated, and contains one or more vacuoles. It takes a diffuse stain with hæmatoxylin, and gives a diffuse reaction for "masked" iron and organic phosphorus.

2. In addition to the chromatin-like substance diffused throughout the cytoplasm, there is usually a more or less homogeneous, spherical body in the cell, the corpuscle, the "nucleus," "nucleolus," and "nuclein body" of various observers, which stains specially with hæmatoxylin, and gives the reactions for "masked" iron and organic phosphorus, but does not stain with acetic-methyl green. This body is neither a nucleus nor a nucleolus. Several examples of it, though of small size, may be present in a cell. On the other hand, cells are found without a trace of a corpuscle.

3. The chromatin-like substance differs from the chromatin of higher animal and vegetable cells in being soluble in artificial gastric juice.

4. When budding begins, the corpuscle, if placed adjacent to the point where the bud is developing, becomes elongated and constricted in its middle portion. One end of the elongated structure may be forced into the neck of the bud, and when the constriction is completed by separation of the two halves, the daughter cell may thus receive a corpuscle. Both daughter corpuscles may pass into the bud, leaving the mother cell without a corpuscle. A complete bud may be formed without such a division of the corpuscle taking place, and thus the daughter cell may commence independent life without a corpuscle.

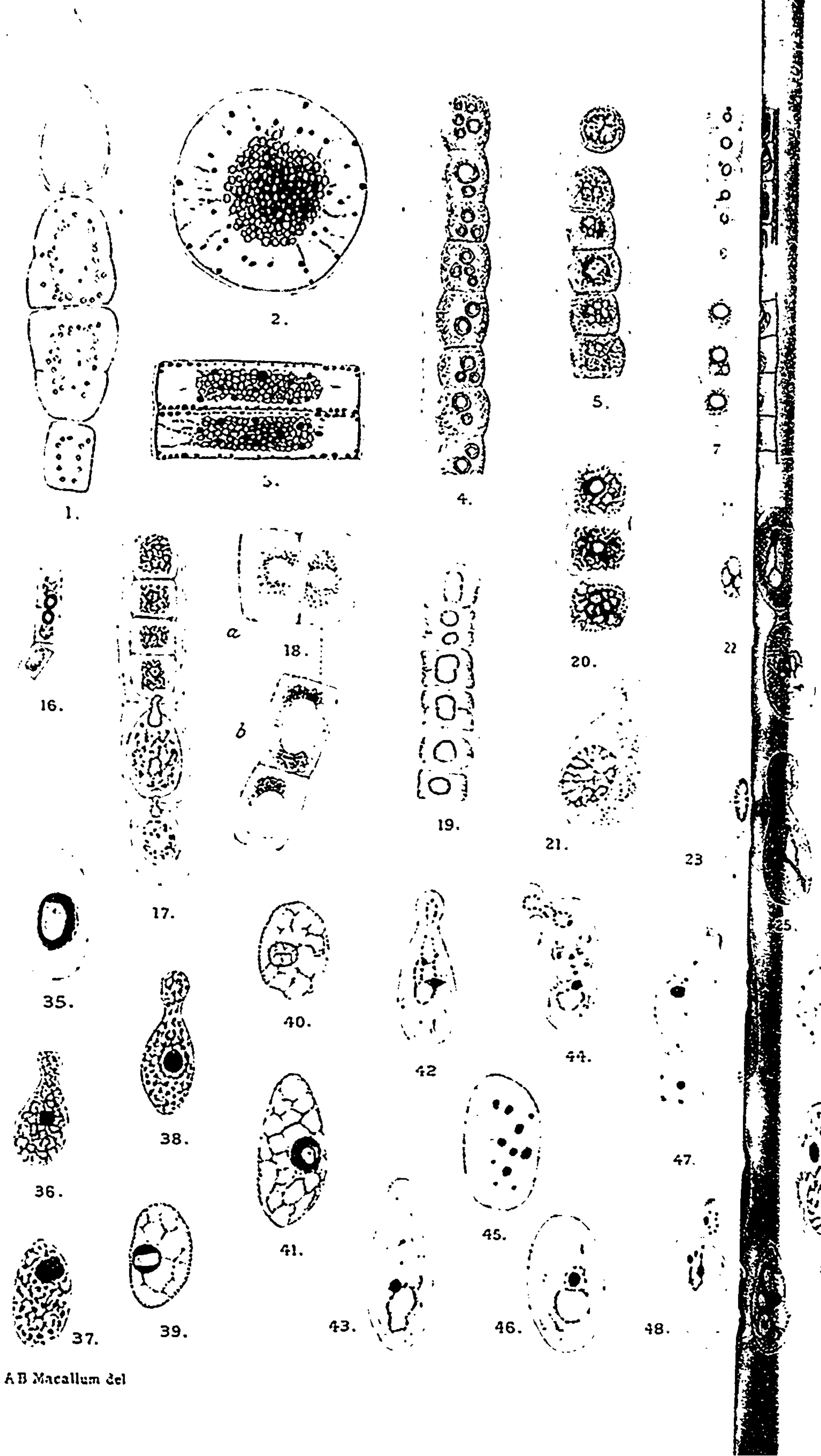
5. In sporulation the cytoplasmic chromatin collects in the immediate neighborhood of the corpuscle, which also undergoes certain granular changes, then elongates with constriction in its central part. Each of the two daughter corpuscles thus formed repeats this process of division one or more times, the daughter corpuscles resulting ultimately forming the corpuscles of the spores.

6. The division of the corpuscles in budding is a purely mechanical result, and is not essential to the formation of the bud. The division preparatory to sporulation is apparently a functional act. It is not of the nature of true karyokinesis, and it may be compared to the division of the nucleolus in *Euglena viridis*.

7. In cells of *Saccharomyces Ludwigii*, from a culture in sap, one finds, rarely, structures which strikingly remind one at times of a nuclear organ. These structures are apparently formed of a chromatin-like substance, and their existence is due to a property which chromatin possesses of forming vacuoles in itself. When the vacuoles are fully formed, the portions of chromatin-like substance separating the vacuoles may be so delicate as to suggest the occurrence of a network like that of a nucleus.

Since the foregoing paper was written, the results of an investigation by Ascoli,[1] conducted in Kossel's laboratory on plasmic acid, a variety of nucleic acid, have been published. The preparation of plasmic acid examined was obtained from yeast cells, and was found to contain about 1 per cent. of iron in a "masked" or organic form. This confirms what I have hitherto advanced, and what I have described in this paper, regarding the presence of "masked" iron in combination with a nucleic or chromatin compound in yeast cells.

1 "Ueber die Plasminsäure." Zeit. für Physiol. Chemie, Vol. XXVIII, p. 426, 1899.



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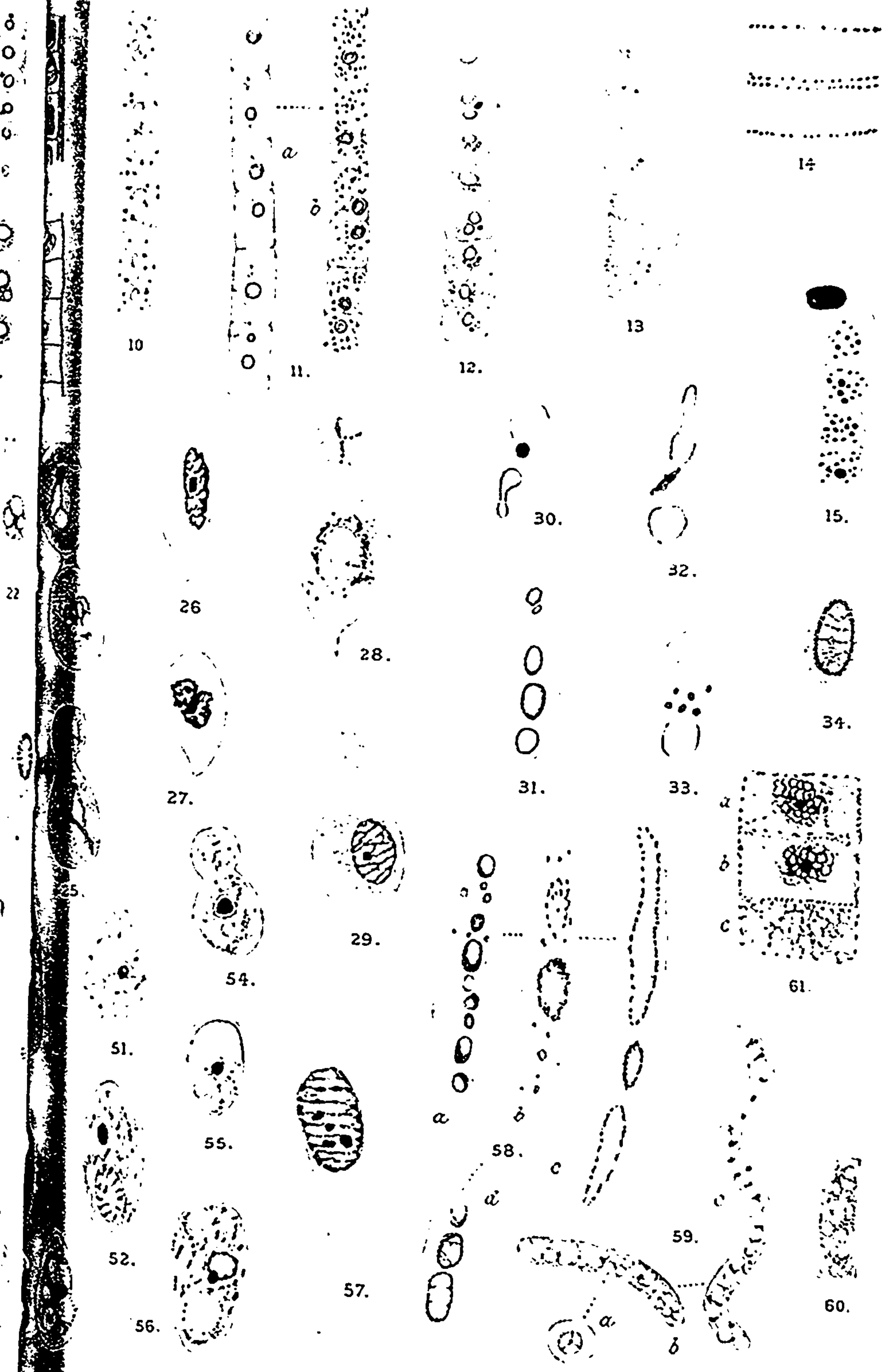

F Huth, Lith^r Edin^r

EXPLANATION OF PLATE.

All the Figures were outlined from the objects with an Abbe camera lucida and as viewed with a 3mm., 2mm., or 1.5mm. apochromatic oil immersion objective, and an 8, 12 or 18 compensation ocular (Zeiss).

FIG. 1.—*Cylindrospermum majus.* Fresh, 48 hour's culture in the laboratory. × 2,000.

FIG. 2.—*Oscillaria Froehlichii.* A cell viewed from the flat surface. Picric acid, picrocarmine, hæmatoxylin. × 3,000. The transition from the central body to the peripheral zone, as represented in the figure is, unfortunately, rendered too abrupt.

FIG. 3.—*Oscillaria Froehlichii.* View of two cells from the side, optical section. Picric acid, picrocarmine, hæmatoxylin. × 3,000.

FIG. 4.—*Tolypothrix* sp. Corrosive sublimate, hæmatoxylin. × 1,500.

FIG. 5.—*Tolypothrix* sp. Digestion with artificial gastric juice three days, extracted with alcohol and ether, Ehrlich's hæmatoxylin (dilute) 24 hours. × 1,500.

FIG. 6.—*Tolypothrix* sp. Strong Flemming's fluid 24 hours, Delafield's hæmatoxylin. × 1,500.

FIG. 7.—*Tolypothrix* sp. Corrosive sublimate, Delafield's hæmatoxylin. × 1,500.

FIG. 8.—*Oscillaria natans.* Digested with artificial gastric juice 6 days, alcohol 1 day, alcohol and ether 8 hours, hæmatoxylin. × 1,500.

FIG. 9.—*Oscillaria Froehlichii.* Digested with artificial gastric juice 6 weeks, alcohol and ether, KHO 0.3 per cent. 24 hours, picrocarmine. × 1,360.

FIG. 10.—*Microcoleus terrestris.* Digested with artificial gastric juice 3 days, hæmatoxylin, glycerine. × 1,500. The dye has given a greenish-blue tinge to the cytoplasm in the central part.

FIG. 11 a and b.—*Microcoleus terrestris.* Alcohol, *a*, hydrogen proxide 3 hours, acid ferrocyanide solution, balsam ; *b*, hæmatoxylin, glycerine. × 1,500.

FIGS. 12 and 13.—*Tolypothrix* sp. Alcohol, hydrogen peroxide 3 hours, acid ferrocyanide solution, glycerine. × 3,000.

FIG. 14.—*Oscillaria Froehlichii* (?). Alcohol, hydrogen peroxide 3 hours, acid ferrocyanide solution, picrocarmine, balsam. × 3,000.

FIG. 15.—*Lyngbia* sp. Picric acid, picrocarmine. × 1,000,

FIG. 16.—*Oscillaria tenerrima.* Picric acid, picrocarmine, hæmatoxylin. × 3,000.

FIG. 17.—*Tolypothrix* sp. Picric acid, hæmatoxylin, balsam. × 1,334.

FIG. 18 *a* and *b*.—*Cylindrospermum majus.* Old culture, acetic-methyl green. × 3,000.

FIG. 19.—*Oscillaria natans.* Fresh culture, artificial gastric juice 48 hours, picrocarmine, glycerine. × 2,250.

FIG. 20.—*Tolypothrix* sp. Alcohol, nitric-molybdate 10 hours. Phenylhydrazin hydrochloride, balsam. × 1,334.

FIGS. 21-29.—*Saccharomyces Ludwigii.* Corrosive sublimate 8 hours, alcohol, Delafield's hæmatoxylin (very dilute) 17 hours. × 3,000.

FIGS. 30-33.—*Saccharomyces Ludwigii.* Alcohol, Delafield's hæmatoxylin (very dilute) 48 hours, balsam. × 2,400.

FIGS. 34-35.—*Saccharomyces Ludwigii.* Corrosive sublimate, alcohol, Delafield's hæmatoxylin (very dilute) 18 hours. × 2,400.

FIGS. 36-38.—*Saccharomyces Ludwigii.* Flemming's fluid, iron-alum hæmatoxylin, balsam. × 2,000.

FIGS. 39-41.—*Saccharomyces Ludwigii.* Artificial gastric juice, 96 hours, iron-alum hæmatoxylin, eosin, balsam. × 2,000.

FIGS. 42-49.—*Saccharomyces Ludwigii.* Alcohol, glycerine and ammonium hydrogen sulphide 10 days. × 3,000.

FIGS. 50-51.—*Saccharomyces Ludwigii.* Alcohol, glycerine and ammonium hydrogen sulphide 6 days. × 2,250.

FIGS. 52-55.—*Saccharomyces Ludwigii.* Alcohol, glycerine and ammonium hydrogen sulphide 10 days. × 2,250.

FIG. 56.—*Saccharomyces Ludwigii.* Alcohol, nitric-molybdate 5 hours, phenylhydrazin hydrochloride, balsam. × 3,000.

FIGS. 57-58 *a-d.*—Mycelial forms growing with *Saccharomyces Ludwigii* in sap cultures. Corrosive sublimate, hæmatoxylin, balsam. × 3,000.

FIG. 59 *a-c.*—*Beggiatoa alba.* "Cocci," "Comma," and "Spirillum" forms. Corrosive sublimate, hæmatoxylin. × 3,000.

FIG. 60.—*Beggiatoa alba*, "Leptothrix" forms. Picric acid, picrocarmine, hæmatoxylin. × 3,000.

FIG. 61.—*Beggiatoa mirabilis.* Alcohol, nitric-molybdate, 5 hours, phenylhydrazin hydrochloride, balsam. × 1,334.

THE ANATOMY OF THE ORANG OUTANG (SIMIA SATYRUS).

AN ACCOUNT OF SOME OF ITS EXTERNAL CHARACTERISTICS: AND THE MYOLOGY OF THE EXTREMITIES.

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(Read March 4th, 1899).

A brief note concerning the external features of the Orang Outang was read by me before the Canadian Institute on December 18th, 1897. Since that time I have had an opportunity of dissecting the animal, and of consulting the literature on the subject. I propose, in this paper, to give a detailed account of some of its external features, and then to deal at some length with the anatomy of the muscles of the extremities. The musculature in the anthropoid apes is of great interest when studied from the comparative standpoint, and in the Orang, which I have been fortunate in securing, some unusual conditions present themselves which make the enquiry of special interest.

The anatomy of the anthropoid apes has excited the interest of scientists for very many years. The old anatomist Tyson[1] described the Chimpanzee two centuries ago. Whilst his paper is entitled "The Orang Outang, or the Anatomy of a Pygmie," it would appear that the creature which he dissected was in reality a Chimpanzee. Many anatomists since the time of Tyson have been interested in the anatomy of the anthropoid apes, and the reason the subject possesses so much fascination for the scientific enquirer was well expressed by Owen[2] more than half a century ago, when he wrote: "In tracing the successive stages by which the lower animals approximate the structure of man, the interest increases as we advance, and becomes most exciting when we arrive at the highest term of the brute creation. At this point every deviation from the human structure indicates with precision its real

1 Edward Tyson, M.D., "Orang-Outang, sive Homo Sylvestris or the Anatomy of a Pygmie compared with that of a Monkey, an Ape, and a Man." London, 1699.

2 Richard Owen, "On the Osteology of the Chimpanzee and Orang Utan." Transactions of the Zoological Society of London, Vol. I, 1835. p. 343.

peculiarities, and we then possess the true means of appreciating those modifications by which a material organism is especially adapted to become the seat and instrument of a rational and responsible soul."

Owen states that "the Orangs, or tailless apes of Africa and Asia, have long been recognized as the mammalia which make the closest approach to man; and their organization has therefore been studied with more or less care and detail by many distinguished physiologists and comparative anatomists." This statement indicates the interest which had been manifested in the study of the anthropoid apes, more than half a century ago.

In addition to the Orang Outang, the group of anthropoid apes includes the Gorilla and the Chimpanzee, which inhabit chiefly the west coast of Africa, and the Gibbon, which is found in the Indian Archipelago and some parts of the adjoining mainland.

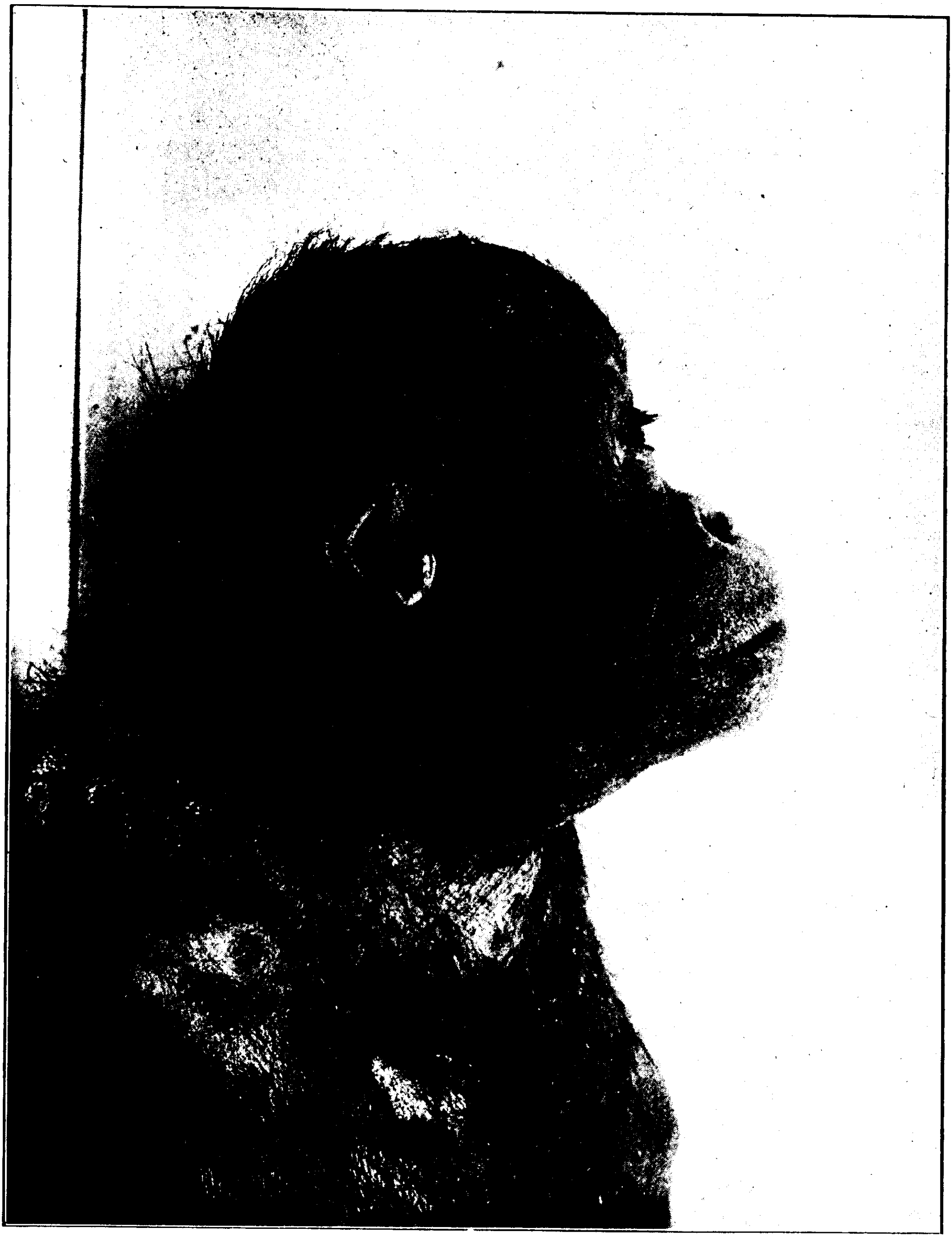
The Orang Outang is found in the islands of Borneo and Sumatra. It would appear that the creature never attains a great size. Huxley remarks that there is no evidence that they exceed 4 feet 4 inches in height. On the other hand, Rudolf Fick states that Clark Abel is reported to have found a species of Orang in Sumatra which reached the height of two metres; this, however, Fick considers a gross exaggeration.

The specimen which I am about to describe was that of a young male animal (reproductions from photographs of the animal are published herewith). It measured 57 cm. in height. No history of its previous life and habits could be obtained. The shape of the cranium approaches, in many particulars, the human type. As has been pointed out by Hartmann[1] and others, the young apes approach more closely to the human type of skeleton than do the aged apes. Thus the great bony crests which are so characteristic of the skull of an aged male Gorilla are absent in young specimens. In all the smaller and middle-sized monkeys the general surface of the calvaria is oval and smooth, and remains so throughout life, whilst in the larger Baboons and Orangs there are well-marked supraorbital, sagittal, and occipital ridges.[2] These are said to attain their greatest development in the aged male Gorilla, where, as Flower asserts, they completely mask the original form of the cranium. In my specimen (a young animal) the surface of the cranium was perfectly smooth, and in this respect resembled the skull of a man, as there were no indications of crests.

It would appear, however, that the bony crests develop in connection

1 Robert Hartmann, "Anthropoid Apes." New York, 1886, p. 107.

2 W. H. Flower, "An Introduction to the Osteology of the Mammalia." London, 1885, p. 162.



From a photograph of the Orang Outang, taken after death.

From a photograph of the Orang Outang, taken after death.

with the skull fairly early. Thus Delisle[1] observes that many crania exhibit well-developed sagittal crests, whilst as yet osseous union has failed to occur between the basioccipital and the basisphenoid. In man this union occurs about the twentieth year. Delisle describes the skull of an Orang, which exhibited this and other signs of youth, in which the crests were apparently in an early stage of development; the frontal crests, instead of uniting at the bregma to form the sagittal crest, passed backwards close to the superior border of the parietal bones, on each side of the sagittal suture, quite independently of each other, being separated by an interval of 2 cm. until they reached the occipital crest. This interparietal ridge may rise, according to Owen,[2] in the adult animal, to the height of one-third to two-thirds of an inch above the general surface. These crests give a massive appearance to the skull, but as Owen[3] long ago showed in his description of the skull of a Gorilla, the skull may be actually lighter than it is in man. This unexpected result is due to the greater size and extent of the air cells. Owen found that these extended in the Gorilla backwards from the tympanum, along the base of the occipital crests, as far as their junction with the parietal crest, and forwards also to the sphenoidal sinuses; the frontal sinuses, and the antrum, were also developed to an unusual extent.

The dental formula in the Orang is similar to that of man. In my specimen none of the permanent teeth had as yet erupted, and the formula was as follows:—

$$\text{Milk teeth} \ldots\ldots \left\{ \text{I} \frac{2-2}{2-2} \ \text{C} \frac{1-1}{1-1} \ \text{M} \frac{2-2}{2-2} = 20 \right.$$

One finds that the dental formula in all the anthropoid apes is the same as that of man, and, in fact, such is the case in all the Old World apes, with the exception of the Lemurs; whilst, on the other hand, among the American apes there is considerable variation.

The lips are very wide and possess a wonderful degree of mobility. The mouth, in the living Orang, is said to be closed as a rule; but, when the animal is taking food, the lips are used in a very curious

1 Delisle, "Sur l'ostéologie des Orang-Outans." Comptes Rendus de l'Académie des Sciences. Paris, 1894, Vol. CXIX, p. 241.

2 Loc. cit., p. 356.

3 R. Owen, "Osteological Contributions to the Natural History of the Chimpanzees, etc." Transactions of the Zoological Society of London, Vol. III, 1848, p. 412.

fashion. Thus, Fick[1] states that the lower lip may be protruded so as to form a kind of natural cup, so that if, for example, milk be given to the creature, he can fill this cup formed by the protruded lip, and then proceed to sip or lap the milk out of it Darwin[2] refers to the protrusion of the lips in discussing the expression of the emotions in animals. He states that the lips of young Orangs and Chimpanzees may be protruded to an extraordinary degree; they thus act, not only when angered, sulky, or disappointed, but when alarmed at anything and likewise when pleased.

The eyelids are wrinkled, so that a series of grooves, parallel to the free margin, exists both in the upper and the lower lid. From the palpebral margin project well developed eyelashes. The eyes are never widely open in the Orang. They are placed very close together; Fick found, in the adult Orang that the pupils were only separated 5.7 cm., whilst in the emmetropic human eye they were separated 5.9 cm.

One of the most characteristic forms of expression in man is produced by the wrinkling of the forehead. Apparently the Orang does not possess this power to the slightest degree, although several observers have found the corrugator supercilii muscles present—muscles which produce the wrinkling of the forehead in man. It would appear, therefore, that the Orang has lost the power of using these muscles much in the same manner as man has lost the power of moving the ears. This lack of power of moving the auricle may be commonly noted in man, although the muscles in connection with it are developed. The facial muscles of expression in general in the ape are poorly developed in comparison with the same group in man. Bischoff is no doubt correct when he states that man differs from all animals, and from the highest apes very essentially, in the strong development and isolation of the facial muscles of expression. He concedes that the apes are excellent face-makers, but their emotions are expressed by distorting the whole face. The nose of the Orang is extremely short and depressed. There is no bridge and no point. The anterior nares look upwards and forwards. The shape of the ear in the Orang is remarkably like that in man. It possessed, in my specimen, the Darwinian pointed tip. This point, to which Darwin directed attention, consists of a small blunt process which projects inwards from the in-folded margin (the helix). In many monkeys the upper portion of the ear is slightly pointed, and the margin is not

1 Rudolf Fick, "Vergleichend anatomische Studien an einen erwachsenen Orang-Utang." Archiv für Anat. und Phys. Anat. Abth., 1895, p 1.

2 Charles Darwin, "The Expression of the Emotions in Man and Animals." London, 1872, p. 140

3 Charles Darwin, "The Descent of Man." London, 1871, Vol. I, p. 22.

at all folded inwards. This condition, according to Darwin, occurs in monkeys which do not stand high in the order, as Baboons and some species of Macacus. When, however, the whole ear is pressed permanently backwards, and the margin is infolded, as in the higher apes, the point persists as the process mentioned. Darwin's point is found very frequently in the human ear, and whilst it is often absent in man, it is also not infrequently absent in the anthropoid apes.

In my specimen, the lobule of the ear was entirely absent. This peculiarity, too, is often found in man. The ears projected in a fairly well-marked fashion from the side of the head, although not more so than is the case in many human ears.

There was no prominence in the region of the chin in my Orang, and in this particular, it agrees with other anthropoid apes; in fact, the forward projecting chin may be looked upon as a fairly distinctive human characteristic; although Huxley[1] states that in certain of the Gibbons (the Siamang) he found something approaching a chin. He says, however, that this "is the only ape which has anything like a mental prominence." Again, Huxley remarks that whilst the chin in the European is either straight or projects beyond the level of the incisor teeth, in the lower races it retreats somewhat, although this recession appears greater than it really is, because of the prominence of the teeth.[2] In my Orang the recession of the lower jaw was such that a continuous curve was formed, which extended, without interruption, from the margin of the lower lip above to merge below in the outline of the neck.

The short thick neck of my Orang is a characteristic common to all anthropoids. The shortness of the neck is developed to a remarkable extent—to an extent seldom approached in man. It is due, not to shortness of the cervical spine, but, as Langer[3] has pointed out, to the shortness of the fibres of the levator scapulæ, and of the descending part of the trapezius muscles. The result is that the shoulders of the Orang are raised considerably above the level of the sternum, and the head seems to be sunken literally between the shoulders. This brings about an oblique position of the scapulæ, and a peculiarity of shape of these bones as compared with man.

1 Huxley, "The Structure and Classification of the Mammalia." The Medical Times and Gazette, Vol. I and Vol. II, 1864, p. 618.

2 Ibid. Vol. I, p. 309.

3 C. Langer, "Die Musculatur der Extremitäten des Orang als Grundlage einer vergleichend-myologischen Untersuchung." Sitz. der math-natur. Classe der kais. Acad. der Wissenschaften, Vol. LXIX, Wien, 1879, p. 178-9.

In the cheek of man there exists what is called the buccal fat pad. This is a circumscribed mass of lobulated fat lying upon the buccinator muscle and the anterior margin of the masseter muscle, closely surrounding the duct of the parotid gland. It is particularly well developed in the cheek of the infant, and has been called the "sucking pad" on account of its supposed function in connection with the act of sucking. Symington[1] has demonstrated the relations of this pad of fat in the cheek of the child, and has figured the pads as they appear in coronal section through the cheek. Ranke[2] states that the existence of this pad was first described by Heister in 1732, who, however, mistook it for a gland, and called it the "glandula molaris;" and later anatomists followed this erroneous view. Ranke showed that it was surrounded by a connective tissue envelope, through which it was connected to the underlying buccinator muscle, and that a deep process of the mass passed backwards and upwards into the spheno-maxillary fossa under the ramus of the jaw and the lower part of the temporal muscle. It was found well developed in a four months' old fœtus, and, while it persists throughout life, it is more noticeable as a well-defined structure in the infant. A peculiarity of this cheek pad is that, according to Ranke, it withstands the destructive processes which destroy the subcutaneous fat in many wasting diseases. Macalister[3] is apparently in error in making a statement to the contrary. These pads become unduly prominent when the neighbouring subcutaneous fat of the cheek wastes away. This sucking pad in my Orang was remarkably well developed. It formed an isolated mass completely separated from the subcutaneous fat, and presented all the features described as characteristic of it in the human infant.

In the Orang, as age advances, enormous masses of fat develop in the cheeks and in the neck. It is not certain whether or not these cheek pads are developed from the sucking pad already described—probably they are rather developed from the subcutaneous fat. At all events, in the old Orang, these later developments of fat attain great dimensions. They are fully described and figured by Fick.[4] According to his statement, they had not been previously described, but we find that Huxley[5] mentions them as occurring in an adult male Orang. The extreme

1 Johnson Symington. "The Topographical Anatomy of the Child." Edinburgh, 1887, p. 14.

2 H. Ranke. "Ein Saugpolster in der menschlichen Backe."
Virchow's Archiv. für Path. Anat. und Phys. Vol. XCVII, 1884, p. 527.

3 A. Macalister. "A Text book of Human Anatomy." London, 1889, p. 566.

4 Loc. cit., p. 2.

5 Loc. cit., Vol. I, p. 564.

ugliness of the old Orang is largely due to the existence of these cheek and neck pads. They form on each cheek semi-lunar appendages covered by the skin. In the dead Orang, Fick described them as triangular in shape. The free apex of the triangle was at the level of the malar bone, whilst the attached base of the triangle extended from the top of the frontal bone downwards to the lower margin of the lower jaw and face. Fick suggests that it occurs only in old age and in the male sex. These masses of fat are, to some degree, mobile; and Fick figures an Orang lying asleep, in which the cheek pad having fallen forwards, forms a cushion for the creature to rest its head upon. A similar development of fat occurs in the neck of the old Orang. Deniker and Boulart[1] describe similar voluminous pads of fat in the Orang—one 6 cm. thick, extended under the occiput and the nape of the neck; two others, in the form of semilunar crests 18 cm. long and 11 cm. wide existed on the side of the face and upon the jaws, and gave the animal a most singular appearance. This development of fat in the Orang appears to be connected with the age of the animal, and Fick suggests that it is comparable to the accumulation of fat which is apt to occur in man after a certain age is reached.

In my Orang there were no such free appendages of fat, but a mass of fat existed beneath the jaw, extending down over the hyoid bone and the larynx. Embedded in this were two thin walled sacs which were found to communicate with the air passages. They were in fact diverticula from the larynx, and were pyriform or egg shaped, attached above in the neighbourhood of the thyro-hyoid membrane; they diverged from one another, passing out under the sterno hyoid muscles and after appearing in the neck on either side at the posterior border of this muscle, they came forwards towards the middle line. The sac upon the left side measured 5 cm. in its long axis and 2.3 cm. in its greatest width. The right sac measured 2.5 cm. long and 1.5 cm. wide. The sacs were very readily separated from the mass of fat in which they were embedded. It would appear that these sacs occupied an unusual position in my Orang in their relations to the muscles. In the descriptions which I have been able to consult they are figured as appearing in the middle line of the neck between the infra hyoid muscles, whilst in my Orang they passed out behind these muscles and appeared at the posterior border of the muscles in the manner described. It is in the median position that Vrolik[2] describes and figures them in the Chimpanzee, as do also Deniker and

[1] Deniker and R. Boulart. "Sur divers points de l'Anatomie de l'Orang-Outan." Compte Rendus de l'Academie des Sciences. Vol. CXIX, 1894, p. 236.

[2] W. Vrolik, "Recherches d'Anatomie comparée sur le Chimpansé." Amsterdam, 1841, p. 44 and Plate.

Boulart[1] in the Orang. In former descriptions it has been assumed that these sacs are found only in the older animals; the great development of them in my young specimen disproves this statement. It would seem that *they are seldom developed symmetrically, but one sac is always larger than the other.* This disparity in size may be great; thus Deniker and Boulart found in one Orang the left sac measured 11 cm. long, whilst the right sac in the same animal was only 41 mm. The larger sac also often overlaps the smaller, and may completely conceal it lying in the middle line of the neck; this probably accounts for the circumstance that some anatomists have been led to describe the sac as a single azygos structure. Careful search in cases where the sac appeared single has led to the discovery that both sacs were present, one being of very diminutive proportions. Huxley[2] describes the great development of these sacs in a Gorilla in the following terms:—"The larynx in its general characters resembles that of man and the Chimpanzee, connected with it in the adult Gorilla is a system of great cavities, developments of the two laryngeal sacculi, each of which is equally dilated, and produced into large caecal sacculated pouches, extending all over the sides of the neck in the interspaces between the muscles, from the rami of the lower jaw to the axillae. As age advances the sacs of the two sides coalesce in the middle line over the trachea, and form an elongated bag, the upper end of which fits into the hollow of the body of the hyoid bone. The use of this immense and complex apparatus" Prof. Huxley adds "is not known."

The most extensive development of the laryngeal pouches is found in Duvernoy's[3] description of the Gorilla. In an adult male Gorilla a large median portion situated in the middle line of the neck was found, from which three pairs of lateral prolongations passed. Two superior ones, one on either side, passed upwards behind the angle of the lower jaw, passing back beneath the sterno hyoid, the omo hyoid and the sterno mastoid muscles; these superior branches of the median sac had the most direct communication with the ventricles of the larynx into which they opened, immediately between the hyoid bone and the thyroid cartilage. *These two superior branches also communicated* each by a large aperture with the great median sac which descended anteriorly over the thorax and gave off a second and a third pair of lateral branches, with each of which its cavity freely communicated. The second pair (median)

1 Deniker and Boulart. "Les Sacs Laryngiens des Singes anthropoides." Journal de l'Anatomie et de la Physiologie, Paris, 1886, p. 51.

2 Loc. cit., Vol. I, p. 538.

3 M. Duvernoy. "Des caractères anatomiques des grands singes pseudo-anthropomorphes." Archives du Museum d'Histoire Naturelle, Paris, 1855-56, pp. 201, 202, 203.

descended to meet the clavicle, lying over its upper border as it passed outwards beneath the sterno mastoid muscle to the upper part of the shoulder. The third (inferior) pair were by far the largest. They appeared to be derived as a bifurcation of the great median sac at its lower extremity. They extended downwards among the muscles of the anterior wall of the chest, each branch passing out laterally under the clavicular portion of the deltoid and downwards under the tendon of the great pectoral muscle and, whilst under this, insinuating itself between the two portions of the small pectoral muscle (superior and inferior) into which that muscle divided in the animal, passing even to the axilla, and lying there upon the lateral wall of the chest.

Huxley[1] in his description of the Orang states that the laryngeal saccules attain still more enormous dimensions in the adult than in the Gorilla; he describes them as constituting a great median bag covered by a strong layer of muscular fibres from the platysma and sending caecal prolongations backwards beneath the trapezius muscle as far as the occiput, beneath the scapula and into the axilla. The cavity communicated by two distinct canals with the ventricles of the larynx. Hnxley tells us that among the Gibbons there is only one species—the Siamang—in which a laryngeal pouch at all similar to that found in the other anthropoids exists. One finds a description of laryngeal sacs in the Chimpanzee by Gratiolet and Alix[2] in which the left pouch extended down between the sterno mastoid muscles a centimetre beyond the upper margin of the sternum. Cunningham determined the relations of the laryngeal sac in a Chimpanzee and in an Orang by means of frozen sections. In the Chimpanzee it extended downwards in front of the sternum to the lower border of the manubrium; it stretched in an upward direction until it reached the hollow posterior surface of the hyoid bone. In the Orang the laryngeal pouch, although it was prolonged down to the top of the sternum, was not continued on to the anterior aspect of that bone.

The occurrence of these sacs in the lower apes has been mentioned by Huxley, who found that among monkeys and baboons of the old world the sacs exist in many species; they are not a development of the laryngeal ventricle in these animals, however, but grow out from the thyro-hyoid membrane, and have only a single aperture of communi-

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1 Loc. cit., Vol. I, p. 596.

2 Gratiolet and Alix, "Recherches sur l'Anatomie du Troglodytes Aubryi," Nouvelles archives du Museum d'Histoire Naturelle, Paris, Vol. II, 1866, p. 232.

3 D. J. Cunningham, "The Topographical Anatomy of the Chimpanzee, Orang-utan and Gibbon," Cunningham Memoirs, Royal Irish Academy, 1886, p. 138.

cation with the laryngeal cavity. In the apes of the new world some extraordinary variations occur in the development of these air sacs. In the spider monkey (Ateles) Huxley describes a single median sac which is developed at the back of the trachea, opening into the air passages between the upper ring and the cricoid cartilage. Then, again, in the howling monkey (Mycetes), according to the same authority, the hyoid and the laryngeal apparatus is exceedingly developed and modified. "The body of the hyoid bone is expanded into a great rounded drum with thin osseous walls, the larger cornua projecting backwards from it, though the lesser pair are quite obsolete. The thyroid cartilage is also exceedingly large, and the epiglottis undergoes an extraordinary development and changes in form. The cavity of the glottis presents several prolongations; one long and narrow tube in front communicates with the chamber in the body of the hyoid bone, the two lateral sacculi are prolonged upwards on each side, and are only separated from each other above the larynx by a thin membranous septum, and in some species there is, in addition, a small inferior pair of sacs."[1] The howling monkey, as its name implies, is capable of uttering loud and discordant sounds, and no doubt the complicated apparatus just described has something to do with the production of these sounds. It is difficult to understand how the mechanism acts, and we are not aware that anyone has succeeded in solving the problem.

We have thus given an account of the laryngeal sacs as they are found in the anthropoid apes and in apes lower in the scale. They are undoubtedly developed in connection with the laryngeal ventricles structures which are present in the human larynx. These ventricles—the "ventricles of Morgagni"—lie in the lateral walls of the larynx, one on each side. The ventricle may be described as a recess which exists between the false cords above and the true cords below; it there forms a diverticulum from the lateral wall of the larynx, presenting an elliptical opening, the length of which is a little shorter than the true cords. The ventricle is about 5 mm. in depth, and, in man, from the anterior part a secondary diverticulum proceeds, the so-called "laryngeal pouch" which extends upwards for about 12 mm. towards the upper border of the thyroid cartilage; it is apparently this laryngeal pouch which assumes such enormous proportions in the Orang. According to Testut[2] this pouch is sometimes found considerably enlarged in man; whilst it usually terminates at the upper border of the thyroid cartilage, it may proceed upwards as high as the hyoid bone, or even sufficiently high to appear under the mucous membrane of the base of the tongue.

1 Loc. cit. Vol. II, p. 123.

2 L. Testut. "Traité d'Anatomie humaine," Troisième édition, Paris, 1895. Vol. III, p. 259.

The function served by the laryngeal sac, as we have said, is a problem not yet solved. Fick observed a slight bellowing of the sac in the Orang when the animal was howling, and he also noticed a slight blowing up of the sac in the second or expiratory act of yawning. In coughing, on the other hand, no effect was noticed upon the sac. Sandifort long ago suggested that the sac permitted the storing up of air which was brought into use in prolonging the loud roar of the animal, but, as Huxley pointed out, the position of the sac above and not below the vocal cords is inconsistent with this theory.

The great length of the arms in the Orang is a striking feature in comparing the animal with man. The lower extremities in man exceed the upper in length; the reverse is true of the Orang. The measurements in my orang were as follows:

Upper extremity	46 cm.
Lower extremity	24 cm.

The measurements were taken in the case of the upper extremity from the tip of the shoulder to the end of the middle finger, and in the lower extremity from the perineum to the heel, thus following, for the sake of comparison, the method adopted by Fick. We find, therefore, that the upper extremity measured 80.7 per cent. of the total length of the body, whilst the lower extremity measured 42.1 per cent. of the height. The following table will give the percentages in a comprehensive manner, the figures indicating percentages of the total length of the body from the head to the heel:

	Upper Extremity.	Lower Extremity.
The present specimen of the Orang	80.7	42.1
Fick's Orang "Jumbo"	75.2	58.3
Fick's Orang "Anton"	73.6	57.9
Man	45	47.5

Fick's measurements were taken from adult animals, whilst my Orang was quite young.

The remarkable elongation of the upper extremities in proportion to the body length is not characteristic of the Orang only, but of all the anthropoid apes. In the Gibbon this feature is even more marked than in the Orang or than in all other apes. It is interesting to note in this connection that the arms of negroes are proportionately longer than in the white races, this being, however, chiefly due to the increased length of the hand and forearm. Huxley tells us that the native Australians and other low races resemble the negro in this respect. One must note also that in this peculiarity anthropoid apes differ in a marked degree from the lower apes. Thus, in the lower apes, with very few exceptions, one finds that the lower extremities exceed in length the upper. In the Lemurs the hind limbs exceed the fore limbs to a very marked degree.

The hind limbs of the Orang are always bent; it is impossible to straighten them completely. This is mainly due to the arrangement of the muscles at the hip and the knee. On the other hand, the fore limbs may be straightened out perfectly. We leave for consideration in another part of this paper the question as to whether the Orang is four handed or not, but in the meantime we shall speak of the "hand" of the fore limb, and the "foot" of the hind limb. The hand of the Orang is very much longer and narrower than the human hand. This is largely due to the great elongation of the metacarpal bones, but, in addition, the phalanges too are proportionately longer than they are in man. Fick states that the Orang grasps things by preference with the right hand and that in all other manipulations they are decidedly right handed, as is common in most apes. The thumb is very short and rudimentary; it does not project as far as the head of the metacarpal bone of the index finger, and the ball of the thumb can hardly be said to exist. Much more remarkable, however, is the foot of the Orang. Like the hand, it is very long and narrow, but it has a well developed opposable hallux and is evidently modified as a grasping organ. The four outer toes are greatly elongated and remain separate, so that they resemble the fingers of a hand rather than the toes of a foot. It would appear that the Orang never stands erect without some support from the arms. Thus it may stand upright whilst it supports itself by grasping the limb of a tree overhead, or it may rest the fore limbs on the ground. Mayer[1] and others have observed that whilst resting on the fore limbs the Orang, like other quadrumana, does not place the palm of the hand on the ground when walking, but rests upon the outer margin and the back of the wrist and fingers. Whilst standing the foot is supinated and the toes bent, the foot resting upon its outer margin. This differs from the Gorilla, which is able to stand erect without the support of the arms, and is capable also of bringing the sole of the foot to the ground.

The lines upon the integument of the palm of the hand and of the sole of the foot in the Orang may be compared with the markings which exist upon the integument of the human sole and palm. If the palm of the hand in man be examined (see photograph) one may readily observe that the markings upon the palmar aspect of the fingers themselves are

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1 Mayer. . . "Zur Anatomie des Orang-Utang und des Chimpanse." Archiv. für Naturgeschichte. Berlin, 1856, p. 285.

From a photograph of the palm of the hand of an adult man, showing the mar[illegible] on the palm of the human hand.

[illegible] a photograph of the palm of the hand of the Orang Outang, showing the [illegible] on the integument of the palm.

obviously associated with the flexion or bending of the digits, the grooves existing opposite the joints at which the movement in question takes place. These grooves are converted into deep clefts when the fingers are fully bent. In the palm proper, similar markings on the skin are observed. Two very noticeable ones run almost parallel to one another from near the base of the index finger inwards towards the inner border of the palm. These grooves are about 1 cm. distant from each other. They do not run transversely across the palm, but their course is very oblique, the inner extremity of each line being much nearer the wrist than the outer extremity. These markings are associated with the flexion of the fingers upon the palm, and are converted into deep fissures when the fingers are folded in upon the palm. Certain markings run in a more longitudinal direction. These begin near the wrist. One is clearly associated with the movements of the thumb towards the palm; it curves forwards from the mid-point of the wrist, around the base of the ball of the thumb, to terminate on the outer border of the palm, sometimes joining the nearer of the two oblique lines already described. This curved line is converted into a cleft when the thumb is opposed to the palm or to the other digits; it is therefore clearly associated with the movement of opposition of the thumb to the palm or the other digits. Other longitudinal markings are associated with the adduction or abduction of the fingers. Occasionally the ball of the little finger is also marked off by a more or less distinct curved line.

Now, if we compare the foregoing with the markings which are observable in the photograph of the palm of the hand of our Orang (see reproduction of photograph) we find a corresponding series of markings. We notice, however, that the ball of the very rudimentary thumb in the Orang is not developed to anything like the proportions attained in man. The curved line at the base of the thenar eminence is present, but what is more marked is the cleft which indicates *adduction* of the thumb rather than *opposition*. Then one observes a very marked difference in the markings running across the palm. These are remarkable in being transverse rather than oblique in direction. We observe also certain less clearly marked longitudinal lines associated with adduction and abduction of the fingers. Let us now consider the significance of the difference in the markings in the human hand compared with those of the Orang. Professor Goodsir, of Edinburgh, long ago[1] well indicated a distinctive difference between the hand of man and that of the ape when he stated that the hand of man could grasp a sphere whilst the hand of the ape could grasp a cylinder.

[1] "Goodsir's Anatomical Memoirs," Edited by Prof. Wm. Turner. Edinburgh, 1868. Vol. I. p. 259.

Clearly the oblique grooves in man indicate that the fingers are not bent in a perfectly straight direction into the palm, but are directed somewhat obliquely towards the thumb, hence the line associated with that movement of flexion is oblique, in other words it is at right angles to the line of movement—the fingers are opposed to the thumb. In the Orang, on the other hand, the fingers are flexed directly into the palm, and the animal is thus better able to grasp a cylindrical object, such as the branch of a tree, whilst it is not so well adapted to grasp a sphere, as the hand of man. The development of the ball of the thumb in man is due to the presence of a well-developed group of muscles which have to do with adduction and opposition of the thumb. These muscles are by no means so well developed in the hand of the Orang. It must be noted, however, that the groove of opposition is present in the Orang, and that the feeble thumb can be opposed. In the Orang, too, there is a marking off of the ball of the little finger ; this is sometimes, but not always, present in the hand of man.

One would readily suppose that the lines in the palm of the hand were produced after birth when the muscles of the hand had brought about the various movements, but such is not the case. Professor Sir William Turner[1] makes an interesting observation regarding this when he says : "These grooves are present in the infant's hands at the time of birth; and I have seen them in an embryo, the spine and head of which were not more than 90 mm. (three and a-half inches) long. They appear in the palm months before the infant can put its hand to any use ; though it is possible that the muscles of the thumb and fingers do, even in the embryo, exercise some degree of action, especially in the direction of flexion. These grooves are not, therefore, acquired after birth. It is a question how far the intra uterine purposeless movements of the digits are sufficient to produce them ; but even, should this be the case, it is clear that they are to be regarded as hereditary characters transmitted from one generation of human beings to another. They are correlated with the movements of the digits, which give the functional power and range of movement to the hand of man."

It may be remarked here that the grooves on the palm differ somewhat in the different anthropoid apes ; thus Hepburn[2] shows that the lines across the palm in the Gorilla are decidedly oblique, and the hand

1 W. Turner, "Some Distinctive Characters of Human Structure," Report of the British Association for the Advancement of Science, 1897, p. 768.

2 David Hepburn, " The Integumentary Grooves on the Palm of the Hand and the Sole of the Foot of Man and the Anthropoid Apes," Journ. of Anat. and Phys., Vol. XXVII, 1892-93, p. 112.

of the Gorilla in this respect more closely resembles the hand of man than does the hand of the Orang.

The great length and narrowness of the hand has been referred to; it is quite obvious, however, that the fingers of the Orang are disproportionately short as compared with the greatly elongated palm. The cause of this is demonstrated by Langer[1] in his dissection of an interdigital membrane which spreads out over the upper fourth of the proximal phalanx of the four inner digits. This membrane is not present in man, and in the Orang, therefore, more of the proximal phalanx is sunken into the palm than is the case in man. The result is that the fingers of the Orang appear proportionately short. Another effect will be observed by reference to the photographs here reproduced, namely, that the integumentary grooves are further separated from the interdigital clefts in the Orang than they are in man.

Dr. Blake,[2] in his observations on the study of the hand for indications of disease, has noted the remarks made by Dr. Harry Campbell regarding the curious resemblance between the acquired bone and skin changes in the acromegalous subject, and the condition normal in the hand of the Gorilla. It would appear that many of the morbid changes in this disease bring about conditions of the character referred to, and Blake would view such as examples apparently of reversion to a primitive arboreal type. Whilst we are not prepared to seriously entertain this idea, there is no doubt of the fact, at all events, that in this disease the hand of man comes to present a curiously close resemblance, in appearance, to the hand of the Gorilla.

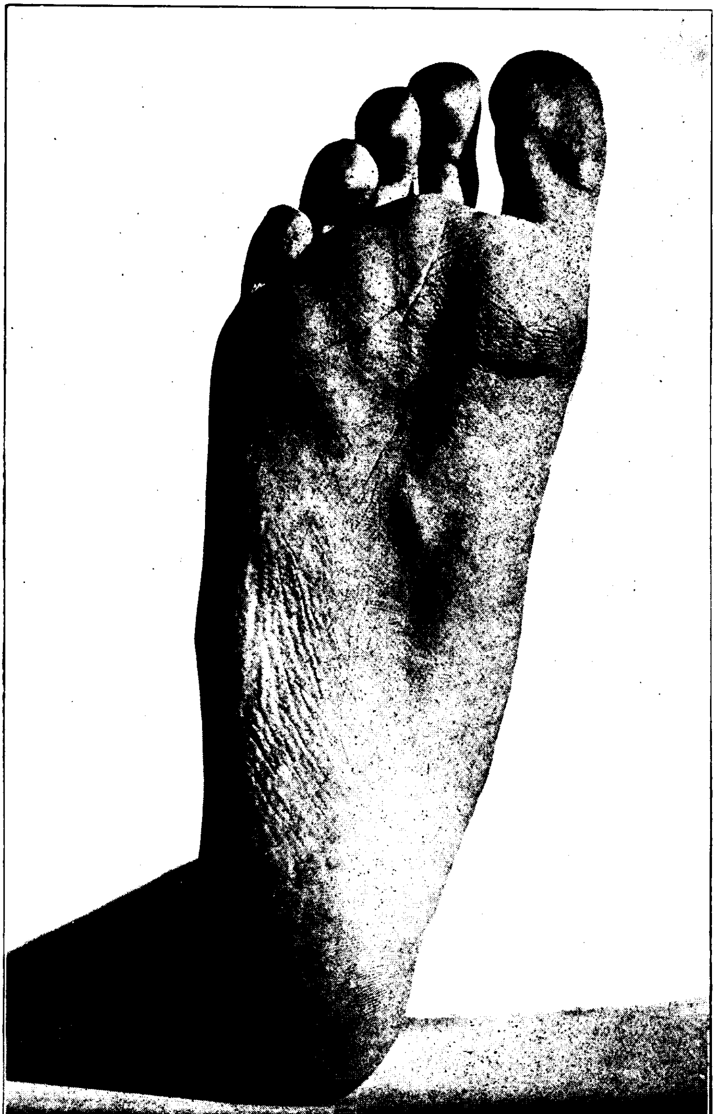
Turning now our attention to the markings in the sole of the foot, we find that in the human foot these are largely obliterated after the individual has walked about, and pressure has been brought to bear upon the sole, the skin becoming as a result thick and indurated. Some interesting observations on these integumentary markings, as they appear in the foot of the infant, have been made by Dr. Louis Robinson[3] in the "Nineteenth Century." He looks upon the markings on the infant's foot as giving some evidence of the evolution of the human foot from a structure which at one time was able to grasp an object after the manner of the human hand or the foot of an anthropoid ape Robinson states that these lines are scarcely visible at fourteen months and are only present in a few cases after two years of age,

1 Loc. cit., pp. 182 and 185.

2 Edward Blake, M.D., "On the Study of the Hand for Indications of Local and General Disease," London, 1889, p. 36.

3 Louis Robinson, M.D., "The Meaning of a Baby's Footprint." The Nineteenth Century, Vol. XXXI, 1892, p. 795.

whilst in the adult they disappear. I have, however, photographed the sole of a child's foot aged nine years (see reproduction of photograph), and find well marked, all the lines described and figured by Robinson in the foot of the infant. We shall proceed to describe these lines and to enquire into their significance. In the child of nine years one is able to distinguish the lines which correspond to the oblique lines across the palm. In comparing the foot with the hand, however, one must bear in mind that the great toe (unlike the thumb) is parallel in position to the other digits, and that its metatarsal bone is closely united to the other digits by an extension of the transverse metatarsal ligament, whilst in the hand there is no such connection of the metacarpal bone of the thumb to the index finger. The hallux is therefore not free to move about in the manner characteristic of the thumb. Moreover the hallux cannot be opposed to the sole or to the other digits, and if we examine the musculature in man we find there is no opponens hallucis. On examining the markings in the sole of the foot of the child (see photograph) we find a line strongly curved starting at the inner border of the foot at the base of the first digit, and passing outwards and forwards to terminate immediately external to the cleft between the first and second digits, its point of termination separated 1.5 cm. from that cleft. This line marks off what is commonly called the ball of the great toe, but observe that the so-called ball of the great toe does not correspond with the ball of the thumb, in that the soft structures forming the ball of the great toe are related to the plantar aspect of the proximal phalanx of that digit; whilst the ball of the thumb is formed by structures related to the palmar aspect of its metacarpal bone. This curved marking in the sole is therefore opposite the metatarso-phalangeal joint, and corresponds to the marking on the palmar aspect of the thumb opposite the metacarpo-phalangeal joint of that digit, and not to the curved marking at the base of the thenar eminence. This curved line in the sole therefore is produced by flexion of the hallux at the metatarso-phalangeal joint. If we look for any marking in the sole produced by opposition or adduction of the great toe in man we look in vain. There is no such marking, and therefore the characteristic mark found in the palm bounding the thenar eminence is wanting in the sole. We find, however, a curved line across the sole beginning at the base of the second digit and running at first somewhat longitudinally for a short distance and then curving outwards to end at the outer border of the foot. This curved line is often interrupted in the sole, but can always be readily distinguished. *It is frequently spoken of as limiting the ball of the little toe*, but it too is opposite the metatarso-phalangeal joint and is therefore merely an indication of the flexion of the smaller toes at that



From a photograph of the sole of the foot of a girl nine years of age, showing the markings on the sole of the human foot.

From a photograph of the sole of the foot of the Orang Outang, showing the markings on the integument of the sole.

point. It frequently joins the curve described at the base of the great toe. The great obliquity of this groove in the human foot is due not to the fact that the toes flex towards the great toe (compare the description of the hand) but to the fact that the metatarsal bones of the toes become progressively shorter as we proceed to the fifth digit, the groove in question lying over the heads of the metatarsal bones.

Let us now compare the foot of the Orang with that of man. The markings in the sole of the foot in the Orang are more distinct than in man because the animal does not obliterate them in walking, during which the outer margin of the foot alone comes to the ground, the outer margin is in consequence smoother than the remaining portion of the sole. We are at once struck by the great length of the four outer toes, they are long, and are separated from one another so as to resemble fingers rather than toes. The great toe in the Orang's foot, however, presents a remarkable difference from the hallux in man. Thus in the Orang it is very much shorter than the other toes, and its long axis forms a marked angle with the long axis of the remaining part of the foot. It is capable in fact of being placed at right angles to the long axis of the sole. The metatarsal bone of the great toe is not connected by a transverse metatarsal ligament to the second digit, and in this respect also differs from the human foot. The ball of the great toe in the Orang (as observed in the photograph) is marked off by a well marked groove, but this groove is not opposite the metatarso-phalangeal joint but opposite the tarso-metatarsal joint and marks off the mass of muscular tissue which lies in relation to the plantar aspect of the metatarsal bone. In other words the line is associated with adduction and opposition, and in this respect entirely corresponds to the line described in connection with that movement in the human hand or in the hand of the Orang itself. The lines running across the sole at the bases of the other digits are oblique and very similar in their position and characteristics to those observed in the palm of the hand. The obliquity here may partly be accounted for by the gradual diminution in length of the digits as we proceed from the second to the fifth digits, but is also accounted for by the fact that the Orang flexes its toes not directly into the sole, but somewhat towards the hallux; the mark being at right angles to the line of movement in flexion. The lines corresponding to the flexion of the digits themselves are well marked opposite the metatarso-phalangeal and the interphalangeal joints. Note that in the Orang the line indicating flexion of the hallux at the metatarso-phalangeal joint is well marked, but is separated from the sole proper and lies upon the plantar aspect of the hallux itself, differing thus in its position and relation to the sole as compared with the condition on the human foot but nevertheless corresponding to the curved line at the base of the so-called ball of the great toe in man. A few longitudinal grooves are observable on the sole of the Orang, these are due to adduction of the digits towards one another.

It will thus be observed that in studying the foot of the Orang it bears more resemblance to a hand than a foot. In fact as an instrument for grasping objects it is much more serviceable than the hand of the same animal. The hallux is more strongly developed than the pollex, and the movements of opposition and adduction are much more strongly carried out by the foot than by the hand. The Orang could grasp a sphere with the foot much more readily than with the hand. If, therefore, we were to restrict our considerations to the markings in the integument, as indicating the use to which the member is put, we might be led to conclude that the posterior extremity of the ape ended in a hand and not in a foot. On the other hand, as we shall observe later, when we proceed to describe the dissection of the creature we shall be forced to admit that morphologically the structure in question is a foot and in no sense a hand. We shall take an opportunity of referring again to this subject after the anatomy of the soft parts has been described.

Concerning the manner in which the Orang uses its hands and feet in progression one may quote Huxley's remarks. He says: "it very unwillingly assumes the erect posture, perhaps never in its native haunts. When it walks upon the ground it swings itself along by its very long arms as with crutches, not resting exactly on the knuckles, as the great African apes, but with the inner edge of the index finger on the ground and the thumb spread out. The hind foot does not come flat to the ground, but rests upon its outer edge with the toes close together and curved. Even when passing from bough to bough of the trees among which its life is chiefly spent, it observes a remarkable slowness and caution in its movements."[1]

THE MYOLOGY OF THE EXTREMITIES.

The *Trapezius* arose from all the dorsal spines, from the ligamentum nuchae and, by an origin 2 cm. wide from the occipital bone. It was inserted into the outer third of the clavicle, the acromiom process and

1 Loc. cit. Vol. I, p. 564.

2 My colleague, R. D. Rudolf. M.D., Edin., dissected the rightside of the Orang, and noted in detail the connections and relations of the muscles of the fore and the hind limbs. I have noted throughout my paper those points in which Dr. Rudolf's account differed from the results obtained by me in the dissection of the left side of the animal.

the spine of the scapula. A branch of the spinal accessory nerve was traced to the muscle. The shortness of the fibres of the trapezius muscle in that part of it which extended from the spine of the scapula to the occiput, and also of the fibres of the levator anguli scapulæ, has already been noted as accounting to some extent for the shortness of the neck in the Orang.

The *Latissimus dorsi* arose from the spines of the lower four dorsal vertebræ and the supra spinous ligament, also from the lumbar aponeurosis and from the iliac crest extending as far forwards as the anterior superior iliac spinous process. There was thus no "triangle of Petit" as the latissimus dorsi overlapped the external oblique muscle of the abdominal wall at its insertion into the iliac crest. The muscle was inserted into the humerus in front of the teres major, but at a somewhat higher level than that muscle. From the latissimus dorsi, near its insertion, there arose from its tendon a strap-like muscle band (1.5 cm. wide), which proceeded down the arm to be inserted into the fascia attached to the internal condyle and the supra condyloid ridge of the humerus. This has been called by Bischoff the *latissimo-condyloideus*. Another muscular slip derived from the latissimus dorsi passes on a plane posterior to the main part of the muscle, and also behind the slip passing to the internal condyle, to be inserted along with the lower part of the teres major muscle into the humerus. This slip to the teres major muscle was found by Hepburn[1] in both the Chimpanzee and the Orang. The latissimo-condyloideus or *Dorso-epitrochlearis*, as it has been designated by some authors, occurs in all apes, not only in anthropoid apes, but in all apes lower in the scale. It is therefore a characteristic muscle of the ape and is always present in these creatures, whilst in man it is absent, or only occurs occasionally in a very rudimentary form. Thus in man one finds that a muscular slip is occasionally given off from the latissimus dorsi and passes downwards to the long head of the triceps, to the fascia, or to the internal intermuscular septum of the arm (Quain[2]); this, it is claimed, corresponds to the latissimo-condyloideus of the ape.

The *Rhomboideus* muscle in the Orang formed a continuous sheet arising from the dorsal spine as low as the sixth vertebra, and from the ligamentum nuchae, also receiving a very definite slip of origin from the occipital bone—the occipital attachment was 2.5 cm. wide. This occipital portion, although showing a continuous line of origin with the part

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[1] David Hepburn. "The Comparative Anatomy of the Muscles and Nerves of the Superior and Inferior Extremities of the Anthropoid Apes," Journ. of Anat. and Phys., Vol. XXVI, 1892, p. 152.

[2] "Quain's Elements of Anatomy," edited by Schäfer and Thane, Vol. II. part 2, 1892, p. 205.

arising in the middle line of the back, was somewhat separated from the latter by a narrow interval, which is indicated in the drawing (plate III, fig. I, *rhom*): The two portions, occipital and spinal, united to form a continuous insertion into the whole of the vertebral border of the Scapula, the upper part lying on the dorsal aspect of the levator anguli scapulæ where the latter muscle was inserted into the scapula. The occipital origin is not constant in the Orang, as Fick[1] found that in his specimen the muscle did not arise higher than in man. On the other hand, Bischoff, Owen and others have described an occipital origin in the Orang, and it appears to occur also in the lower apes. Macalister failed to find it in a young female Gorilla dissected by him. There was no occipital attachment described by Duvernoy in the Gorilla. In man one finds that the occipital attachment occurs as an occasional variety.

The *Levator anguli scapulæ* (plate III, fig. I, *l.a.s.*), arose by three slips from the transverse processes of the upper three cervical vertebræ, and was inserted into the upper angle of the scapula and into its vertebral border, lying there in the deep aspect of the rhomboid muscle. At its insertion it was closely incorporated with the serratus magnus muscle. In an Orang dissected by Fick[3] the origin of the muscle extended as low down as the transverse process of the seventh cervical vertebra.

The *Serratus Magnus* arose by eleven digitations from the upper eleven ribs, taking its origin from the anterior extremities of the osseous ribs, and in its lower portion interdigitating with the external oblique muscle of the abdomen. It passed backwards to be inserted into the whole of the vertebral border of the scapula, blending there with the levator anguli scapulæ as already described.

The two muscles last described are closely related to one another. It will be observed that when the levator anguli scapulæ arises from the complete series of cervical vertebræ (as in Fick's Orang), the muscle becomes necessarily almost continuous at its origin with the serratus magnus, and as we have already observed they are united at their insertion. Thus an almost continuous sheet of muscle is formed. In man the muscles are wholly separate, the one in the neck and the other in the thorax. These observations led Bischoff[4] to conclude that in the

1 Loc. cit., p. 19.

2 Loc. cit., p. 76.

3 Rudolf Fick, 2. "Beobachtungen an einem zweiten erwachsenen Orang-Utang und einem Schimpansen." Archiv. für Anat. und Phys., Anat. Abt., 1895, p. 297.

4 Bischoff. "Beiträge zur anatomie des Hylobates leucisus und zu einer vergleichenden Anatomie der Muskeln der Affen und des Menschen." Abhandl. der math. phys. Classe der könig bayer. Akad. der Wissenschaften Vol. X, 1870, p. 207.

ape we had definite proof that the two muscles belong to one another and form one single great muscle going from the ribs in the chest and from the cervical vertebræ in the neck to be inserted into the whole length of the vertebral border of the scapula. Bischoff states that in Macacus and other lower apes, this continuity of the two muscles is even more complete than in anthropoids; in these a bundle arises from the first rib, which unites immediately with that arising from the seventh cervical vertebra, whilst in anthropoids a space exists between the two portions as a rule. One must remember, however, that the extensive origin described from the cervical vertebræ does not always exist in the Orang, as in my specimen there were only three slips of origin from the three upper cervical vertebræ. Hepburn[1] describes four slips in the Orang dissected by him. In man there occasionally occurs partial union between the two muscles in question (Quain), whilst the origin of the levator may be extensive, receiving aponeurotic fibres even from the first and second ribs (Testut).

It would therefore appear that, as a rule, the two muscles are distinct in man; they are continuous in the lower apes, and the higher (anthropoid) apes occupy an intermediate position where there is a partial continuity.

The *Omo-cervicalis* (plate III, fig. I, *m.o*), is an interesting muscle which Bischoff asserts is not found in man,[2] at all events of similar character to that occurring in apes. It arose in my Orang from the anterior aspect of the arch of the atlas vertebra and from its transverse process; it was inserted into the clavicle on its posterior aspect at the junction of the middle and outer thirds of the bone, the attachment to the clavicle being 1.5 cm. wide. The muscle has been described in the anthropoid apes and in the lower apes by Huxley,[3] whilst in the various anthropoids it has been found by Cuvier.[4] Vrolik,[5] Owen,[6] Chapman,[7] Macalister,[8] and others. Its attachment to the shoulder girdle varies in apes and

1 Loc. cit., p. 153.

2 Loc. cit., p 207.

3 Loc. cit., Vol. I, pp. 428, 456, 528, 596, 647, and Vol. II, p. 40.

4 Georges Cuvier. "Anatomie comparée recueil de planches de myologie." Paris, 1849.

5 Loc. cit., p. 13.

6 R. Owen. "Myology of Simia Satyrus." Proceedings of the Zoological Society of London, Part I, 1830-31, p. 29.

7 H. C. Chapman, "On the Structure of the Orang-Outang." Proceedings of the Academy of Natural Science of Philadelphia, 1880, p. 161.

8 Alex. Macalister. "The Muscular Anatomy of the Gorilla." Proceedings of the Royal Irish Academy, Sr. 2, Vol. I, 1870-74, p. 501.

hence Bischoff suggested the name of "Omo-cervicalis" and abandoned the old names of "Cleido-cervicalis" and "acromio-trachealis" which had been applied to it. Tyson called it "Levator claviculæ." Bischoff asserts that in all four anthropoids it always arises from the clavicle whilst in Cynocephalus it has been found arising from the acromion process and in Macacus from the spine of the scapula. Deniker[1] demonstrated the muscle in a foetal Gorilla of the fifth or sixth month of gestation, and in a foetal Gibbon of the seventh or eighth month; in both instances passing from the atlas vertebra to the clavicle. It would appear that the atlantal attachment of this muscle is very constant in anthropoid apes, although Champneys[2] described the dissection of a Chimpanzee in which the muscle arose "from the occipital bone in a line with the occipital condyles and was inserted into the acromial or external half of the clavicle anterior to the insertion of the trapezius." Huxley states that in man[3] a separate muscle has been seen to pass from the mastoid process to the extremity of the acromion, detached from the trapezius, and representing, to a certain extent, in man the trachelo-acromial. Testut[4] mentions a muscle described by Gruber under the name of "trachelo-clavicularis imus" arising from the transverse process of the sixth cervical vertebra, and inserted into the clavicle. This Testut considers a variety of the omo-cervicalis. In Quain's Anatomy[5] is mentioned a detached bundle of the levator anguli scapulæ passing from the transverse process of the upper one or two cervical transverse processes to the outer end of the clavicle; this would apparently represent a true omo-cervicalis in man.

We may conclude, therefore, that the muscle in question is found invariably in the ape, whilst in man it occurs as a very rare variety.

The *Omo hyoid* muscle was present and possessed similar attachments and relations to those in man. The supra scapular artery and nerve passed over the superior border of the scapula anterior to the omo hyoid insertion. There was no indication of a transverse ligament which exists over the supra scapular notch in man. In Fick's[6] Orang the omo hyoid was weak and there was no intermediate tendon.

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1 J. Deniker. "Recherches anatomiques et embryologiques sur les singes anthropoides jeunes et adultes," Archives de Zoologie expérimentale, Sr. 2, Vol. III, 1885, pp. 125, 131.

2 F. Champneys. "On the Muscles and Nerves of the Chimpanzee (Troglodytes niger) and a Cynocephalus anubis," Journ. of Anat. and Phys., Vol. VI, 1872.

3 Loc. cit., Vol. I, pp. 428, 456.

4 Loc. cit., Vol. I, Part 2, p. 697.

5 Loc. cit., Vol. II, Part 2, p. 208.

6 Loc. cit., I, p. 15.

Bischoff[1] also remarks upon the fact that the intermediate tendon often fails to develop in the ape; in Bischoff's Orang, however, the whole muscle failed. This authority also refers to an Orang dissected by Alix in which the omo hyoid arose from the clavicle as well as from the scapula; this variation in the Orang is of interest, because a similar variation sometimes occurs in man. The total absence of the omo hyoid is not rare in man; of this Testut[2] has recorded nine cases. Again the absence of either the anterior or posterior belly may occur, and the bony attachment more particularly of its posterior belly is subject to great variation in man. Gegenbaur[3] after a critical study of the varieties of the omo hyoid as it occurs in man, and the conditions of its development met with in the lower animals, concludes that it belongs to a muscle group including in man the sterno hyoid and sterno thyroid muscles. These muscles in some animals (reptiles) form a continuous attachment from the sternum, along the clavicle to the scapula. Referring the omo hyoid to such a group of muscles we can readily explain the occurrence of the intermediate tendon and the variation in the bony attachments, sometimes to the clavicle, sometimes to the scapula, or it may be to both bones.

The *Sterno mastoid* had an extensive origin from the mastoid process and the occipital bone, and was inserted by two heads, one into the manubrium sterni on its anterior aspect, and the other into the inner fourth of the clavicle. Cuvier[4] figures the sterno mastoid in the Orang as two very distinct muscles, the clavicular portion arising from the skull below the sternal portion and proceeding to its insertion into the clavicle. In the Gorilla it is usually in two distinct portions, as indeed it is also in the other anthropoids. The two portions of the sterno mastoid in man are separated from one another by a varying interval at their insertion.

The *Pectoralis major*, consisted of three very distinct portions:—(1) *Pars costo-abdominalis* (plate IV, fig. 2, *p.m. 1*), which arose from the osseous part of the fifth rib near its sternal extremity, and by an origin 4 cm. wide from the aponeurosis of the external oblique muscle of the abdomen. The fibres passed very obliquely upwards and outwards and lay on a plane posterior to the other two portions of the muscle. The insertion was into the strong fascia over the Biceps tendon, and

1 Loc. cit., I, p. 205.

2 Loc. cit., Vol. I, Pt. 2, p. 677.

3 C. Gegenbaur, "Ueber den Musculus Omohyoïdeus und seine Schlüsselbeinverbindung." Morphologisches Jahrbuch, Vol. I, 1876, p. 264.

4 Loc. cit., plate 15.

extended up to the greater tuberosity of the humerus and the capsule of the joint—the insertion extended further up on the humerus than the other two portions of the muscle. (2) *Pars sterno-costalis* (plate IV, fig. 2, *p.m. 2*), arose from the cartilages of the third, fourth, fifth and sixth ribs, and from the adjacent portion of the anterior aspect of the sternum. It was inserted by means of the strong fascia over the Biceps tendon into the humerus. The fibres of this portion of the muscle passed almost horizontally from origin to insertion. It lay intermediate in position between the pars costo-abdominalis and the pars sternalis. (3) The *Parssternalis* (plate IV, fig. 2, *p.m. 3*), arose from the anterior surface of the manubrium sterni near its upper margin. There was no attachment to the clavicle. The fibres passed very obliquely from above downwards and outwards in front of the other portions of the muscle. The muscle was inserted into the humerus on the anterior aspect of the bone in front of the biceps by an insertion 2 cm. wide, extending further down on the bone than the other portions of the muscle. The three portions of the pectoralis major were very definitely separated from one another, the intervals being filled in by a large amount of fat.

The other three anthropoid apes, according to Bischoff, possess a fourth division of the pectoralis major, viz., a "pars clavicularis" arising from the sternal end of the clavicle, whilst in an Orang dissected by Bischoff[1] the clavicular portion was, as in my specimen, absent. On the other hand Fick[2] describes a clavicular portion in both Orangs dissected by him, and Bischoff[3] found in a second Orang examined by him, a portion of the pectoralis major arising from the ligaments of the sterno-clavicular joint. Chapman and Owen[5] both failed to find a clavicular portion in the Orang. Bischoff, it may be added, is authority for the statement that the pars clavicularis fails in the lower apes.

It would therefore appear that the pectoralis major muscle is composed of four portions; this fact is recognized by Testut[6] in describing the muscle in man as consisting of: 1st, portion claviculaire; 2nd, portion sternale; 3rd, portion abdominale; 4th, portion chondro-costale. The clavicular portion, which is, as a rule, well developed in man, is

1 Loc. cit., I. p. 208.

2 Loc. cit., I. p. 15 and 2 p. 298.

3 Bischoff. "Beiträge zur Anatomie des Gorilla." Abhand. der math.-physik. Classe der könig. bayer. Akad. der Wissenschaften. Vol. XIII. Abth. 3. München, 1880, p. 9.

4 Loc. cit., p. 161.

5 Loc. cit., p. 29.

6 Loc. cit., Vol. I. pt. 2, p. 722.

present only occasionally in the Orang, and is absent in the lower apes. On the other hand, the Gorilla, Chimpanzee, and Gibbon resemble man in the well-developed clavicular portion of this muscle; in the Gorilla, in fact it is more strikingly developed than in man. One notices in man considerable variation in the width of the interval separating the clavicular portion of the muscle from the remaining part: according to Testut this may be several centimetres. One is inclined to believe that the portion in the Orang which I have described as the "pars sternalis" in reality corresponds to the "pars clavicularis" of man (see plate IV, Fig 2, *p.m. 3*). My reason for coming to this conclusion is that we have in the anterior part of the "pars sterno-costalis" in my Orang a portion corresponding to the "pars sternalis" of man, whilst the wide interval existing in my Orang between the middle and upper portions of the muscle would correspond to the varying interval observed in man between the sternal and clavicular portions of the muscle. It would appear, therefore, that the upper portion of the great pectoral has gradually extended its width of attachment, and has also travelled outwards. At first purely sternal (as in the lower apes) then having a varying degree of clavicular attachment. In the case of Bischoff's Orang, quoted above, the attachment was intermediate in position, namely to the sterno-clavicular joint. One may note that in man the muscle may extend along the clavicle and become incorporated with the deltoid or, on the other hand, in rare cases, the clavicular portion may be absent (Quain). In my Orang a large triangular interval existed between the anterior border of the deltoid and the superior border of the pectoralis major and the clavicle; this space was crossed by the pectoralis minor.

In connection with the pectoralis major in man, various anomalous muscles have been described. In a female subject Bryce[1] has recently reported the following anomalous development of the pectoral sheet. The upper part of the pectoralis major muscle was ill-developed, being represented by a narrow band resembling in fact, very much, the pars sternalis which I have described in my Orang. He found present also a "sterno-clavicularis" which arose from the side of the manubrium sterni and the second costal cartilage, and was inserted into the clavicle along the inner two-thirds of the bone. A "sternalis" attached partly to the second cartilage and the tendon of the sterno-clavicularis above, and below to the aponeurosis of the external oblique opposite the seventh cartilage, and a "chondro-epitrochlearis" which arose from the outer end

[1] T. H. Bryce, "Note on a Group of Varieties of the Pectoral Sheet of Muscle." Journ. of Anat. and Ph[...]., Vol. XXXIV, 1899, p. 75.

of the sixth costal cartilage running under the lower border of the pectoralis major, it passed down the arm and was inserted into the intermuscular septum two inches above the internal condyle.

The *Pectoralis minor* (plate IV, fig. 2, *p. min*), arose from the bone of the fourth rib by an origin 2 cm. wide. immediately external to the cartilage, and from the bone and cartilage of the third rib by an origin of similar width. The muscle was inserted into the superior and inner part of the coracoid process of the scapula. Certain fibres of the tendon of insertion were carried on beyond the coracoid and were definitely traced as two ligamentous structures which diverged from one another, one of which was attached to the outer end of the clavicle, and the other into the acromion process of the scapula (see plate IV, fig. 2, and fig. 3, *lig. 1*, *lig. 2*), the insertion here described has not hitherto been demonstrated, and it would appear to be an observation of some interest. Duvernoy[1] states that in the Chimpanzee the pectoralis minor became attached to the coraco-clavicular ligament; again whilst I found no description of an acromial attachment among the anthropoid apes I find that in Cynocephalus, according to Bischoff[2] the pectoralis minor is inserted into the coracoid process and the coraco-clavicular ligament. In the Chimpanzee we find that Huxley, Fick, Bischoff, Hepburn and others have described an insertion into the capsule of the shoulder joint. It is not unusual to find this capsular attachment in man. This relation of the pectoralis minor to the capsule, in certain cases occurring in man and monkeys, induces Bland Sutton to believe that the coraco-humeral ligament of the shoulder joint is the tendon of the pectoralis minor muscle transformed into a fibrous band. But as the insertion varies so greatly in apes it would seem that Bland Sutton is not warranted in coming to the conclusion he does. Hepburn found that in the Gibbon in addition to a coracoid and a clavicular attachment, the muscle was inserted into the common tendon of the coraco-brachialis and biceps a short distance below the tip of the coracoid process. Whilst in the Chimpanzee both Huxley[5] and Hepburn describe the muscle as uniting with the supra-spinatus. Judging from the attachments described in my Orang, and from the relations found in some other apes and the variations in man, it may be that the trapezoid portion of the coraco-clavicular ligament and the coraco-acromial ligament are in part derived

1 Loc cit., p. 76.

2 Loc. cit., I, p. 209.

3 J. Bland Sutton. "Ligaments, their Nature and Morphology." London. 1887. p. 71.

4 Loc. cit., p. 154.

5 Loc. cit., Vol. I. p. 456.

from the tendon of the pectoralis minor. Wood[1] has described in man a case in which the muscle joined the coraco-acromial ligament and another in which it was inserted into the clavicle and the costo-coracoid membrane.

The *Serratus magnus* arose from the upper eleven ribs, interdigitating below with the external oblique muscle of the abdomen and was inserted into the whole length of the vertebral border of the scapula, blending above with the levator anguli scapulæ at its insertion. Fick describes an origin in the Orang from twelve ribs. In man the muscle rarely extends beyond an attachment to the upper nine ribs.

The *Deltoid* arose from the outer third of the anterior surface of the clavicle, from the acromion process and from the spine of the scapula also from the fascia over the infra spinatus muscle. It was inserted into the outer aspect of the humerus as in man: some additional slips pass to the humerus for about 2 cm. above the main point of insertion, and some superficial fibres pass to the fascia, which extends down to the external condyle. Fick speaks of this muscle as similarly well developed in his Orang.

The *Teres major* arose from the lower fourth of the axillary border of the scapula and from the dorsal surface of the inferior angle; its insertion 3cm. wide found attachment to the humerus behind the latissimus dorsi. The lower part of the muscle near its insertion was joined by the slip from the latissimus dorsi already described (p. 525).

The *Teres minor*, the *Supra spinatus* and the *Infra spinatus* muscles had similar attachments to those found in man; it was noted, however, that the aponeuroses of insertion of the last two muscles were directly continuous with one another and blended with the capsule of the shoulder joint.

The *Subscapularis* resembled that found in man. Fick described a slip of origin of this muscle from the teres major.

The *Subclavius* was not strongly developed, measuring only 0.3 cm. in width; it arose from the cartilage of the first rib, and had an insertion 2 cm. wide into the clavicle at the junction of the middle and the outer thirds of that bone on its under aspect; it here extended to the point of attachment of the coraco-clavicular ligament, but was in no manner continuous with that structure. The subclavius is poorly developed in

1 J. Wood, "Variations in Human Myology." Proceedings of the Royal Society of London, Vol. XV, 1867, p. 231.

the anthropoid apes; in Huxley's Gorilla[1] it was only represented by a ligament.

The *Triceps* muscle had the following origin:—1. The long head arose from the upper two-thirds of the axillary border of the scapula to the extent of 4 cm.. The upper part of its origin being in front of the teres minor and the lower part behind the teres major. 2. The inner head arose from the posterior aspect of the humerus a short distance above and behind the lowest point of attachment of the teres major. The musculo-spiral nerve crosses this head obliquely about 2.5 cm. below its upper limit; the nervé is thus separated from the bone by the muscle. 3. The external head arose from the posterior aspect of the humerus as high up as the insertion of the teres minor. The musculo-spiral nerve proceeds outwards between the lower part of this muscle and the bone. The triceps possesses a very wide fascial insertion in the region of the elbow, and is inserted also into the olecranon process. Fick remarks upon the striking weakness of the inner head in his Orang.

The *Coraco brachialis* arose from the anterior portion of the coracoid process, and from the fascia over the subscapularis muscle; two portions of the muscle were defined, one found insertion by an attachment 2.5 cm. wide into the middle of the inner portion of the humerus, whilst a more feebly developed upper portion found an attachment by an insertion 0.5 cm. wide immediately above the other portion. The two parts are separated by the passage of the musculo-cutaneous nerve, which sends a branch of nerve supply to each. Some fibres from the upper portion pass down in front of the tendinous insertion of the lower part, and there find independent insertion into the humerus. Wood by a comparative study of this muscle in the mammalia concludes that the coraco brachialis is made up of three component parts. 1. The *coraco brachialis brevis*, which passes from the outer side of the coracoid process near its root, to the capsule of the shoulder-joint near the anatomical neck of the humerus. 2. The *Coraco brachialis medius* obtaining its insertion into the inner border of the humerus near its middle. 3. The *Coraco brachialis longus*, which extends down the inner side of the arm to be attached to the internal condyle. The coraco brachialis medius is the portion of the muscle which is characteristically of human type; in man also, both brevis and longus occur as varieties, the latter being the

1 Loc. cit.. Vol. I, p. 558.

2 John Wood, "On Human Muscular Variations, and their Relation to Comparative Anatomy. Journ. of Anat. and Phys., Vol. I, 1867, p. 45.

more common. Vrolik[1] describes the medius and longus as existing in the Chimpanzee, a condition which also existed in Hepburn's Orang. The degree of development of this muscle is, however, by no means constant, but, according to Bischoff, numerous variations occur both among the anthropoid apes and among the lower apes. In certain of the mammalia, according to Wood, the brevis alone is developed as in the dog and cat, also in bats and moles. Bland Sutton[2] compares the arrangement of the coraco brachialis in its three parts in the arm to the arrangement of the three adductor muscles in the thigh.

The *Biceps* resembled, in its two heads of origin, the condition found in man; it was inserted into the radius by an aponeurosis of insertion 1.5 cm. wide, very thin and ribbon-like as it passed back into its insertion, which lay wrapped around the neck of the radius when the forearm was pronated. A well-developed bicipital fascia passed off to blend with the fascia on the inner border of the forearm. This fascia was absent in Fick's Orang. Bischoff[3] states that in all apes (anthropoids and others) the biceps arises as in man, with the exception of the Gibbon, where he found that the short head arose from the lesser tuberosity of the humerus instead of from the coracoid process; Huxley[4] found in his Gibbon, the short head arising from the tendon of the pectoralis major. The muscle is subject to great variation in man chiefly in the multiplication of additional heads of origin: the long head has occasionally been absent, as described by Lubosch[5] and others in man, but such a defect is extremely rare.

The *Brachialis anticus* arose from the anterior portion of the humerus as high up as the insertion of the deltoid, the origin of the muscle being wholly external to the insertion of the coraco brachialis. It was inserted into the coronoid process of the ulna. A narrow slip from the outer aspect of this muscle crossed in front of the musculo spiral nerve and joined the supinator longus. This connection with the supinator longus has been observed in man (Testut).

The *Pronator radii teres* arose by two heads, one from the internal condyle and the intermuscular septum, and the other from the coronoid process of the ulna on its inner aspect. The median nerve passed into

1 Loc. cit., p. 30.

2 Loc. cit., p. 13.

3 Loc. cit. 1, p. 210.

4 Loc. cit., Vol. I, p. 648.

5 W. Lubosch. "Ein M. Coraco—Antibrachialis beim Menschen Beiträge zur Morphologie des M. Biceps Brachii." Morphologisches Jahrbuch, Bd. XXVII, Heft 2, 1899, p. 309.

the forearm between its two heads, the deep head separating the nerve from the ulnar artery. It was inserted into the radial border of the radius by an insertion 2 cm. wide immediately below the upper third of the bone. The high insertion of the pronator radii teres corresponds to that found by Langer[1] in his Orang. This, he points out, differs from the condition found in man, where the muscle in question is inserted below the middle of the bone. It also implies a shorter extent of attachment of the supinator brevis, which is attached above the pronator. This circumstance led Langer to assert that it is only the lower part of the radius which is so enormously elongated in the Orang compared with the condition found in man. Langer's Orang was young, but in the adult animal dissected by Fick[2] he found the position of the insertion of the pronator similar to that occurring in man; he therefore concludes that either the high insertion is characteristic of the young Orang thus differing from the old animal, or that Langer's case was abnormal—my specimen would go to prove the truth of the former hypothesis. In Bischoff's Gorilla the coronoid head of the muscle was absent, but Macalister[3] found it in his specimen. Chapman[4] found both heads in the Orang. The coronoid head is frequently absent in man (Testut).

The *Flexor carpi radialis* arose from the common origin of the flexors from the internal condyle and the intermuscular septum, also from an oblique line on the outer border of the radius in common with the flexor sublimis digitorum; it was inserted into the base of the second metacarpal bone, after passing through the groove in the trapezium. Fick and Langer both describe a radial origin in the Orang. The radial head occurs as an occasional variation in man.

The *Palmaris longus* arose in common with the other flexors from the internal condyle and from the fascia over it. It lay immediately subjacent to the fascia of the forearm until it reached a point 3 cm. above the wrist joint, where it perforated the fascia and continued down upon its superficial aspect. Crossing the anterior annular ligament it proceeded to its insertion into the palmar fascia. There is a very definite slip to the base of the thumb, and from this the abductor pollicis arises in part. In both Orangs dissected by Fick there was a slip to the abductor pollicis and he describes, in addition, another slip to the flexor minimi digiti. Bischoff states that the palmaris longus was absent in the

1 Loc. cit., p. 179.
2 Loc. cit., 1, p. 22.
3 Loc. cit., p. 502.
4 Loc. cit., p. 162.

Gorilla, and the result of Hepburn's investigations was that he found this muscle present in the Chimpanzee, Orang and Gibbon, but absent in the Gorilla.

The palmaris longus, both in man and apes, would appear to be a rudimentary structure; in many animals it is a well developed muscle and sends tendons to all the digits. From a comparative study of this muscle Bland Sutton[1] and others have arrived at the conclusion that the palmar fascia of the human hand arises from the degeneration of the distal end of the palmaris longus muscle. According to Grapow[2] the palmar fascia was first described as an expansion of the palmaris longus by Dupuytren in 1832. The view which Grapow holds concerning it is, that the main part of the palmar fascia is derived as a prolongation of the anterior annular ligament of the wrist, whilst the superficial, longitudinally coursing fibres are derived from the palmaris longus muscle. The muscle in man is very variable in its development, it is entirely absent in ten per cent. of all cases, and it presents great variety, not only in its points of insertion but also in the development of its fleshy and tendinous fibres.

The *Flexor carpi ulnaris* arose in common with the flexors from the internal condyle, also from the inner side of the olecranon process of the ulna. The ulnar nerve passed into the forearm between the two heads. It was inserted into the pisiform bone. The muscle thus resembles that found in man.

The *Flexor sublimis digitorum* vel *Perforatus* arose from the common origin from the internal condyle and intermuscular septum, also from the coronoid process and the olecranon process and in common with the flexor carpi radialis from the oblique line of the radius. Passing beneath the annular ligament it there passed into the palm in four tendons. The tendon for the index finger and that for the little finger were derived mainly from fibres arising from the internal condyle. The tendon for the middle finger was derived mainly from fibres arising from the radius. The tendon for the ring finger was derived mainly from fibres having an origin from both the radius and the internal condyle. The fleshy mass from which the tendon for the index finger arose formed a very definite fasciculus which passed down on the deep aspect of the main part of the muscle along its ulnar border, and

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1 Loc. cit. p. 16.

2 Max-Grapow, "Die Anatomie und Physiologische Bedeutung der Palmaraponeurose." Archiv fur Anatomie und Entwickelungsgeschichte, 1887. p. 145.

then crossed obliquely behind the other tendons to reach the index finger. The fasciculus is joined at an acute angle by a few fibres from the radial origin; this radial fasciculus represented not more than one-twentieth part of the main fasciculus, being a very slender, though definite contribution. In Bischoff's Gorilla there were four almost completely separated muscles having an arrangement similar to that found in my Orang. This differs from the muscle dissected by Fick in his Orang, in which there was a superficial fasciculus passing to the fourth and fifth digits, and a deep fasciculus to the second and third digits. The muscle in man is developed in two layers, more or less separable from one another, the superficial passing to the third and fourth, and the deep to the second and fifth digits.

The *Flexor profundus digitorum* vel *Perforans* arose by three distinct fasciculi.

1. From the anterior and inner aspects of the ulna extending back to the posterior border and upwards as high as the posterior portion of the olecranon process, and downwards on the ulna to about its middle. (The nerve supply was from the ulnar.)

2. From the anterior aspect of the ulna up to and including the lower part of the coronoid process; from the anterior and inner border of the ulna below the fasciculus I. and from the interosseous membrane. (The nerve supply was the median.)

3. From the anterior aspect of the radius, and from the interosseous membrane; this radial attachment extends two-thirds of the way down the bone. In the middle third, well over to the radial border, its attachment is limited by the origin of the flexor sublimis digitorum. (The nerve supply was from the median.)

The tendons passed under the annular ligament, and fasciculus No. 1 supplied tendons to the minimus and the ring fingers; fasciculus No. 2 to the middle finger, and fasciculus No. 3 to the index finger. A *lumbrical* muscle was developed on the radial side of each tendon in the palm. Rudolf traced the nerve supply of the lumbricals, and found the outer two were supplied by the median and the inner two by the ulnar nerve.

There was no trace of a long flexor for the thumb. In this particular man differs very markedly from the Orang. In man the *flexor longus pollicis* is a separate well developed muscle, and nothing approaching it is found in the ape. Langer,[1] Fick,[2] Bischoff,[3] Huxley,[4] Chapman,[5] and others have failed to find a trace of the flexor longus pollicis in the Orang. Duvernoy, in the Gorilla, describes the flexor as going to the index finger and from this a slender tendon is detached for the thumb, which takes the place of the flexor longus pollicis.[6] Brooks[7] in dissecting an Orang found that the two heads of the flexor brevis pollicis were separated at their insertion by a slender tendon which, he considered, represented the flexor longus pollicis; this tendon was inserted into the ungual phalanx, and it could be followed up the forearm, but about two inches above the wrist it expanded into areolar tissue. Among the anthropoids one finds a rudimentary tendon going to the thumb, this is derived from the flexor tendon which is distributed to the index finger. Thus in the Chimpanzee, Huxley and Macalister both describe a very slender tendon to the thumb from the flexor longus digitorum tendon for the index finger. A similar condition is found by Bischoff and others in the Gorilla and the Gibbon. Among the lower apes of the old world (Cynopithecini) Huxley found a rudimentary slender tendon to the pollex derived from the flexor tendon to the index, a condition similar to that in the anthropoids named. Among the Lemurs (Stenops tardigradus) the same authority states,[8] that a true and distinct flexor longus pollicis of separate origin and insertion exists. Similar observations have been made by Bischoff regarding the lower apes and the rudimentary condition in them of the flexor longus pollicis. The anthropoid apes and the lower apes therefore resemble one another in respect to this muscle, whilst they all differ from man where the flexor longus pollicis is developed as a strong muscle completely separated from the flexor profundus digitorum, a condition never yet found in the ape. It is not common to find much variation in the development of the flexor longus pollicis in man, but such does occur occasionally. Turner[9] placed on record several cases in which the flexor longus pollicis contributed a tendon of communication

1 Loc. cit., p. 180.

2 Loc. cit. I, p. 23.

3 Loc. cit. I, p. 214.

4 Loc. cit., Vol. I, p. 596.

5 Loc. cit., p. 162

6 Loc. cit., p. 106.

7 H. St. John Brooks, "On the Short Muscles of the Pollex and the Hallux of the Anthropoid Apes with Special Reference to the Opponens Hallucis." Journ. of Anat. and Phys., Vol. XXII, 1887-8, p. 82.

8 Loc. cit., Vol. II, p. 145.

9 W. Turner, "On Variability in Human Structure, with illustrations from the Flexor Muscles of the Fingers and Toes." Transactions of the Royal Society of Edinburgh, Vol. XXIV, 1867, p. 179.

with the flexor profundus digitorum. Schulze[1] has described a similar condition. Turner records one case in which the bond of union passed in the opposite direction from the flexor profundus to the flexor longus pollicis. Wagstaffe[2] has described a case in which a muscle arose like the flexor longus pollicis, but was inserted into the deep flexor tendon to the index finger and was connected also with the fibrous structures about the wrist; there was also a tendon on the palmar aspect of the first and second phalanges of the thumb, which, however, was attached above to the head of the metacarpal bone. Gegenbaur[3] has recorded a case in which the flexor longus pollicis was absent from the thumb of man—the muscle had evidently fused with the flexor for the index finger; the thumb itself was very rudimentary, and presented an appearance very similar to that found in the apes. The abnormality was found on the left side of the body, the right flexor longus pollicis being normally developed. The importance of these facts concerning the absence of the flexor longus pollicis in the ape and its existence as a strongly developed structure in man is emphasized by Testut[4] when he says, "De toutes les dispositions anatomiques qui différencient actuellement l'homme des autres Primates, l'une des plus importantes est, sans conteste, la présence chez l'homme, l'absence chez les Singes d'un long fléchisseur propre du pouce, complètement distinct des autre fléchisseurs." Testut holds that the flexor longus pollicis is present in the apes, arising as it does in man, but the peculiarity in apes is that it fuses with the flexor profundus and loses the characteristic individuality which is found in man where it passes as a distinct and separate muscle to the thumb. Testut himself, after examination of a large number of subjects, had never found the flexor longus completely absent from the thumb of man.

Gratiolet and Alix[5] describe a rudimentary muscle in the Chimpanzee arising from the ligaments over the anterior aspect of the carpus and inserted into the last phalanx of the thumb.

The *Pronator quadratus* consisted of a number of muscle fibres passing transversely from the radius to the ulna; in the upper part of

1 F. Eilhard Schulze, "Die Sehnenverbindung in der Planta des Menschen und der Säugethiere." Zeitschrift für Wissenschaftliche Zoologie, Bd. 17, 1867, p. 1.

2 W. W. Wagstaffe, "Partial Deficiency of the Tendon of the Long Flexor of the Thumb." Journ. of Anat. and Phys., Vol. VI, 1872, p. 212.

3 C. Gegenbaur, "Ein Fall von mehrfachen Muskelanomalien an der oberen Extremität." Virchow's Archiv für Pathol. Anat. und Phys., Vol. XXI, 1861, p. 382.

4 L. Testut, "Le Long Fléchisseur Propre du pouce chez l'homme et chez les Singes." Bulletin de la Soc. Zool. de France, Vol. VIII, 1883, p. 164.

5 Loc. cit., p. 172.

the muscle the fibres were very oblique, arising from the ulna as high up as the upper portion of the lower fourth, and passing obliquely downwards and outwards to the radius. The obliquity of the fibres was also noted by Fick.

The *Supinator longus* arose from the supracondyloid ridge of the humerus as high as the middle of the bone, and extended down to within 2.5 cm. of the external condyle. It was inserted into the outer aspect of the lower extremity of the radius, including the styloid process, the whole insertion being 2.5 cm. wide. In Fick's Orang the insertion began 7 cm. above the styloid process. In the Gibbon, Birchoff found it short, not reaching to the styloid process but inserted into the middle of the bone. A similar condition was found in the Gibbon by Huxley.[1] In man the muscle has been found inserted as high up as the middle third of the radius.

The *Supinator brevis* and *Anconeus* were well developed, and resembled in their connections and relations the condition found in man, in other anthropoids and in the lower apes.

The *Extensor carpi radialis longior* arose below the supinator longus from the supra condyloid ridge of the humerus as low as the external condyle. It passed under the annular ligament in company with the short radial extensor and was inserted into the dorso-radial aspect of the base of the second metacarpal bone.

The *Extensor carpi radialis brevior* arose from the common extensor origin from the external condyle, and was inserted into the dorsal aspect of the base of the third metacarpal bone. The two radial extensors were crossed obliquely by the short and long extensors of the thumb and the extensor ossis metacarpi pollicis; they resembled in their relations and connections the condition found in man and in the lower and the anthropoid apes.

The *Extensor communis digitorum* arose from the common extensor origin, and passed under the annular ligament in company with the extensor indicis; it divided into four tendons for insertion into the four inner digits as in man.

The *Extensor minimi digiti* was a very small fasciculus arising in common with the extensor communis; it was inserted into the extensor expansion over the proximal phalanx of the ring and the little fingers. One finds that the slip to the ring finger occurs as a variety in man,

[1] Loc. cit., Vol. I, p. 648.

whilst it would appear to be the usual condition in the Orang, as described by Fick, Bischoff, Huxley, Hepburn and Chapman. On the other hand, according to Bischoff,[1] in the Gorilla, Chimpanzee and Gibbon, and in the lower apes (excluding Cynocephalus, where it exists as in the Orang), the tendon is restricted to the little finger as it is in man.

The *Extensor carpi ulnaris* arose from the common extensor origin, from the olecranon process and the posterior portion of the ulna and from the intermuscular septum ; it was inserted into the ulnar border of the fifth metacarpal bone.

The *Extensor Indicis* arose from the middle of the ulna by an origin 1.5 cm. wide, and from the interosseous membrane, passing beneath the common extensor, it was inserted into the extensor expansion over the dorsal aspect of the proximal phalanx of the second and third digits. In man the extensor indicis is inserted into the index finger only, although, as a variation, it is not very uncommon to find a slip to the middle, or even the ring fingers, whilst occasionally there is a slip to the thumb. It is sometimes altogether absent in man, and Testut[2] states that he has seen it tendinous throughout its whole extent. According to Bischoff[3] in the Gorilla alone among anthropoids do we find the extensor indicis restricted to the index finger and thus resembling man. In the Orang and Chimpanzee it passes to the second and third digits, whilst in the Gibbon it passes to the second, third and fourth digits. In the lower apes also it would appear to be distributed, as a rule, to the second and third digits. Pithecia being an exception (Bischoff), where it is restricted to the index finger only. Huxley,[4] in discussing this muscle in the Orang along with the extensor minimi digiti, calls attention to the fact that the normal arrangement in many of the lower mammalia is to have a superficial and a deep extensor supplied to every digit. This arrangement is approached when as in my Orang the extensor minimi digiti is supplied to the fourth and fifth toes, and the extensor indicis to the second and third toes. These two muscles, as they occur in man, are therefore but fragments of a more extensive muscle group occurring in lower animals.

The *Extensor longus pollicis* arose from the dorsal aspect of the ulna above the origin of the extensor indicis, and passed to its insertion in a

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1 Loc. cit. I, p. 212.

2 Loc. cit. I, Vol. I, pt. 2, p. 813.

3 Loc. cit. I, p. 212.

4 Loc. cit., Vol. I, p. 596.

separate compartment of the annular ligament; it was inserted into the second phalanx of the thumb.

The *Extensor brevis pollicis* arose from the interosseous membrane and from the dorsal aspect of the radius and the ulna, it was inserted into the radial aspect of the base of the first metacarpal bone well to the anterior surface. This muscle is absent in most apes. Langer, Fick, Bischoff, Huxley and Chapman failed to find it in the Orang, whilst Hepburn[1] describes the muscle as being inserted, as in my example, into the metacarpal bone. Bischoff states that the muscle is absent in all apes, with the exception of the Gorilla. The muscle in my Orang was quite separate from the extensor ossis metacarpi pollicis, and had a distinct and separate insertion into the metacarpal bone. It represents a condition intermediate between that normal in man and that which Testut says is[2] constant in most apes where, according to this authority, the short extensor is blended with the extensor ossis metacarpi pollicis.

The *Extensor ossis metacarpi pollicis* arose from the radius and ulna, the more extensive attachment being to the radius, and was inserted by two tendons, one of which passed to the trapezium and the other to the fascia, from which the abductor pollicis and opponens arose. On the right side Rudolf found this tendon passing to the metacarpal bone of the thumb. On close examination of the slip to the trapezium one found, close to the point of insertion, a small irregularly oval sesamoid bone about 4 mm. in length. This bone was embedded in fibrous tissue which extended from the styloid process of the radius above to the base of the first metacarpal bone, and was there closely applied to the trapezium immediately below the tubercle of the scaphoid; the fibres of the tendon of the muscle appeared to be inserted into this bone. The sesamoid bone is described by Fick[3] and by Hepburn[4] in connection with the tendon of the extensor ossis metacarpi pollicis in the Orang. Fick describes the muscle as inserted into the trapezium and the first metacarpal on the left side, whilst it had an additional insertion into the scaphoid on the right side of his Orang. Bischoff[5] states that in the Orang, Cynocephalus, Pithecia and Hapale, the muscle is inserted as in man, into the metacarpal bone, whilst in the Gorilla,

1 Loc. cit., p. 167.

2 Loc. cit. 1. Vol. I. pt. 2. p. 811.

3 Loc. cit. 1. p. —.

4 Loc. cit., p. 167.

5 Loc. cit. 1. p. 213.

Chimpanzee, Hylobates, Circopithecus and Macacus it parts into two tendons—one for the trapezium, and the other for the middle phalanx of the thumb. Huxley describes the two divisions of the extensor ossis metacarpi pollicis in all four anthropoids, although he says the division is not so definite in the Orang as in the others.[1] Brooks[2] states that the sesamoid bone is apparently developed in all anthropoids in the tendon of the extensor ossis metacarpi pollicis. The double insertion of this muscle into the trapezium and the first metacarpal bone is frequently found as a variation in man, whilst the occurrence of the sesamoid bone in the tendon of the muscle in question in man has been reported by Zuckerkandl.[3]

The occurrence of the sesamoid bone in the tendon of the extensor ossis metacarpi pollicis has considerable interest attached to it, as Fick has suggested,[4] that it represents a præpollex rudiment. The probability is that the ossicle occurs very constantly in the Orang, although it may be of very small dimensions as Fick[5] found in a second Orang dissected by him, where it was scarcely the size of a grain of rice. Thus it may be very easily overlooked, and requires to be searched for with considerable care. The occurrence of this bone in the tendon of the muscle in question is no new discovery, as it is mentioned and figured by Vrolik[6] in the Orang, and the same writer states that it had been described by Camper in that animal. Camper looked upon it as a ninth carpal bone. Fick is inclined to believe that it does represent a supernumerary carpal bone. He has found it appearing as such in the skeleton of an old female Orang in the Leipzig Zoological Institute, where, on both sides it is attached to the carpus, on the one side being attached by some connective tissue, still unmacerated, to the trapezium, and on the other side lying between the trapezium and the scaphoid. There has been a great deal of discussion concerning the occurrence of marginal structures in connection with the hand, held by some to represent additional digits, and designated in the hand the præpollex and the postminimus. Similar observations are made concerning the foot. The question is, whether or not we have evidence that the pentadactyle type of hand was derived from the heptadactyle type. The difficulty in determining the significance

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1 Loc. cit., Vol. I, p. 596.

2 Loc. cit., p. 81.

3 Zuckerkandl. Discussion on Pfitzner's Paper, "Bemerkungen zum Aufbau des Menschlichen Carpus." Verhandlungen der Anatomischen Gesellschaft. Göttingen, 1893, p. 193.

4 Loc. cit. 1, p. 25.

5 Loc. cit. 2, p. 298.

6 Loc. cit., p. 13, (and Plate VI, Fig. 2).

of these marginal structures is increased, because we recognize a large number of supernumerary carpals occurring in different parts of the carpus. Thus the os centrale is a structure apparently always represented in the human embryo, but it soon blends with one of the neighbouring bones and loses thus its individuality. We find this bone in the Orang remaining separate throughout life. In my specimen it lay between the scaphoid, the trapezium and the os magnum. Vrolik[1] claims to have been the first to describe this bone in the carpus of the Orang. Later investigation has proved that in the human embryo a large number of carpal elements are often present. Thus Thilenius[2] in the human carpus in embryos, from the second to the fourth month, found such supernumerary bones, all appearing as hyaline cartilage, their structure differing in no manner from the normal eight carpals. Thilenius describes some thirteen of such. They unite with the neighbouring carpals or metacarpals, so that normally in man eight carpals finally result. The os centrale may join the scaphoid, the third metacarpal, the trapezoid, or the os magnum. Thilenius found the "prætrapezium" in four cases of 113 hands examined, whilst the os centrale was present in all cases without exception; the other supernumerary carpals were present only occasionally. Pfitzner,[3] in a paper upon the human carpus, attempts to group all these supernumerary carpals in the human hand, and reconstructs the carpus so as to shew in a diagrammatic fashion the position occupied by all these additional carpal bones, and their relation to one another. It is in connection with the marginal bones, however, that the greatest interest has been aroused, and some anatomists look upon the bone described as the prætrapezium (or the os radiale externum) as representing a præpollex rudiment. Born[4] has examined similar structures in the tarsus of amphibians. In rana esculenta he figures a tarsus in which a supernumerary digit is added on the tibial side of the foot. This consisted of three catilaginous elements separated by joints and united with a tarsal element which it shared with the first metatarsal; a somewhat similar condition was found in Bufo variabilis. Emery[5] traces various carpal elements in the larvæ of amphibia, and describes in the anura what he considers to represent the præpollex, and the præhallux; he also demonstrated similar structures in rodents.

1 Loc. cit., p. 13.

2 G. Thilenius. "Die 'Uberzähligen' Carpuselemente menschlicher Embryonen." Anatomischer Anzeiger. ix., 1894. p. 665.

3 Pfitzner. "Bermerkungen zum Aufbau des menschlichen Carpus." Verhandlungen der Anatomischen Gesellschaft. Göttingen, 1893. p. 186.

4 G. Born. "Die Sechste Zehe der Anuren." Morphologisches Jahrbuch. Vol. I. 1876, p. 436.

5 C. Emery. "Zur Morphologie des Hand und Fussskeletts." Anatomischer Anzeiger. 1890. p. 287.

Baur,[1] as the result of his investigations of the reptilian carpus, concluded that the præpollex element was one of the true carpals (radiale) displaced, being pressed out whilst the radiale centrale had taken its place and appeared as the representative of the true radiale. He considers that a similar view may be held regarding the amphibian carpus. Baur thus questions the validity of the præpollex theory. On the other hand, Bardeleben[2] is one of the strongest exponents of the theory. After studying the subject from the embryological standpoint and examining more than a thousand skeletons in the comparative anatomy collections of Berlin, Leyden, and London, he concludes that we must relinquish the old doctrine of five digits for the mammalia. The argument of Bardeleben is very interesting and ingenious. He finds in one of the Cape rodents (Pedetes capensis) in two skeletons a præpollex possessing a nail, and a postminimus in which were two bones. He also conducted his investigations among fossil forms and in the oldest fossil mammal in which the hand skeleton has been preserved he describes a præpollex rudiment. This fossil animal *Theriodesmus phylarchus,* comes also from South Africa (Nicholson[3]). The præpollex rudiment in the carpus of Theriodesmus has also been described by Thilenius.[4] The elements of the præpollex rudiment here, according to this authority, lie on the radial side of the hand, between the scaphoid, centrale and trapezium. Bardeleben, in his paper, attempts to trace the muscles of the præpollex and the post minimus, or rather their representatives, in the pentadactyle type. Thus the palmaris longus in the hand, and the plantaris in the foot, are looked upon as giving evidence of the existence of those supernumerary digits. Among lower animals (as has already been stated for the palmaris longus) these muscles give a varying number of tendons, numbering from three or four to seven, in some animals. Thus Bardeleben states that we have seven tendons representing the termination of the muscle in *Centetes* (one of the hedge-hog family of Madagascar). One of these tendons went to the præpollex and the other to the postminimus. Similar conditions were found in the plantaris. To the four groups of interossei present in the mammalian hand or foot Bardeleben would add the abductor muscles

1 G. Baur. "Der Carpus der Schildkröten." *Anatomischer Anzeiger,* 1892, *p.* 206.

2 K. Bardeleben. "Ueber die Hand-und Fuss-Muskeln der Säugetiere, besonders die des Præpollex (Præhallux) und Postminimus." Anatomischer Anzeiger, 1890, p. 435.

3 A. Nicholson. "A Manual of Palæontology." Edin. and Lond., 1880. Vol. II, p. 1269. Nicholson's description of this mammal is as follows:—"In the Karoo system of South Africa, in a hori[zon] which is probably of lower mesozoic age, has been obtained a slab showing the impression of a pectoral limb, apparently referable to a small mammal, which has been described under the name of *Theriodesmus*.

4 G. Thilenius, "Ueber Sesambeine fossiler Säugetiere." Anatomischer Anzeiger, 1894-5, p. 42.

of the first and last digits. The abductor pollicis, and the abductor hallucis, arising from what he considers to be the rudiments of the præpollex or præhallux, and the abductor minimi digiti in both hand and foot arising from the postminimus. These abductor muscles together with the so-called "interossei," Bardeleben would designate the "flexores breves profundi." In addition, Bardeleben claims certain of the marginal long muscles as contributing to the præpollex, etc.; among others, the extensor ossis metacarpi pollicis, and flexor carpi radialis acting on the præpollex, and the flexor carpi ulnaris acting on the post minimus rudiment. He traces similarly corresponding muscles in the foot. Fick[1] discovered in man what he believed to be a flexor præpollicis. It arose from the outer margin of the radius near the insertion of the pronator, and as a continuation of the flexor longus pollicis, a portion was inserted into the transverse carpal ligament, but the chief tendon of insertion was attached to the volar projections of the trapezium and the scaphoid, processes which were considered by Pfitzner to represent the prætrapezium, and therefore the præpollex rudiment. Fick places considerable importance upon the fact that this præpollex rudiment was still a "rudiment" in the oldest known mammal, and concludes that it is highly improbable, therefore, that the primitive mammal possessed a true præpollex. This fact would also go to disprove the other theory that the præpollex, etc., are secondary new formations. These digits, if they exist, do not appear to have made any progress in development in the mammal.

Gratiolet and Alix[2] found the extensor ossis metacarpi pollicis inserted in the Chimpanzee by two tendons—one into the trapezium and the other into the base of the first metacarpal. In a foot note these authors refer to the fact that no sesamoid bone was present in the slip to the trapezium, and its absence they attribute to the fact that the animal was young. The explanation is not valid, as the bone was present in my Orang, although it was a young specimen.

The *Abductor pollicis* (plate V, fig. *5 ab.p.*) muscle was well developed; it arose from the trapezium and the annular ligament, and was inserted into the radial border of the proximal phalanx of the thumb. The muscle would appear to present very few variations in the ape from the condition found in man. In Hepburn's Orang it arose from the annular ligament and had no direct attachment to the carpal bones.

The *Opponens pollicis* arose from the trapezium and the annular

1 Loc. cit. 1. p. 27.

2 Loc. cit., p. 163.

ligament, and from the tendon of the extensor ossis metacarpi pollicis, and was inserted into the radial border of the first metacarpal bone. Brooks[1] also described the origin from the extensor ossis metacarpi pollicis. The opponens is well developed in apes and resembles in attachment and development the same muscle in the human hand.

The *Adductor obliquus pollicis* arose from the bases of the second and third metacarpal bones and the ligaments over the anterior surface of the carpus. A portion of the adductor obliquus pollicis (indicated in plate V, fig. *5 a.ob.p.*) exists as a separate slip passing over the anterior surface of the metacarpal bone. This apparently corresponds to the muscle and tendon fasciculus which Langer[2] describes and figures, and which he believes to represent the flexor longus pollicis of man; it is in consequence of the existence of this muscular slip that the Orang is capable of bending the terminal phalanx of the thumb.

The *Adductor transversus pollicis* arose from the base of the third metacarpal bone and the distal extremity of the second metacarpal bone, and from the fascia over the interossei muscles between the two bony points named. The adductor muscles of the thumb in the Orang thus correspond very closely to the muscles of the same group in the human hand.

The *Flexor brevis pollicis*. The inner head of the muscle (the "interosseus primus volaris" of Henle, plate V, fig. *5 f.b.p.2*) arose from the base of the first metacarpal bone, and was inserted into the base of the first phalanx with the adductor obliquus pollicis. The outer head of the flexor brevis pollicis (plate V, fig. *5 f.b.p. 1*), arose from the anterior annular ligament and was inserted into the radial portion of the base of the proximal phalanx. Flemming[3] looked upon the flexor brevis pollicis as a single headed muscle. This view has been proved to be incorrect by Cunningham[4] who holds that in the foot as in the hand the flexor brevis of the first digit is always a double headed muscle, and man is no exception to the rule. In man the ulnar head has suffered diminution and has been suppressed by the great development of the adductor. The inner head is the muscle which Henle called the "interosseus primus volaris." It was Bischoff who first enunciated the view that such was the case in demonstrating the true significance of the interosseus

1 Loc. cit., p. 82.

2 Loc. cit., p. 183.

3 W. Flemming, "Ueber den Flexor brevis pollicis und hallucis des Menschen." Anatomischer Anzeiger, 1887, pp. 68, 269.

4 D. J. Cunningham, "The flexor brevis pollicis and the flexor brevis hallucis in man." Anatomischer Anzeiger, 1892, p. 206.

primus volaris of Henle, and Cunningham confirms him in every particular. In the case of the foot Flemming advanced an argument based upon the nerve supply, but his argument fails, because Cunningham has shown that Flemming followed Henle and Schwalbe in describing the nerve supply of the fibular head to be from the external plantar nerve, whilst throughout the entire class of the mammalia Cunningham has only once found this head thus supplied (*i.e.*, in the fox-bat), with this exception it is always supplied by the internal plantar, as is the tibial head. Even if Flemming were right regarding the nerve supply Cunningham holds that the point would not afford sufficient proof, as it has been shown that where two nerves approach one another, a tendency to variation in the supply to muscles occurs when they reach the confines of their distribution. Cunningham states that in only one instance was he able to trace the nerve supply of the interosseus primus volaris in the hand, and in that instance it appeared to come from the deep branch of the ulnar.

The *Abductor minimi digiti* (plate V, fig. *5 ab.m.d.*), arose from the pisiform bone and the annular ligament, and was inserted into the base of the first phalanx of the little finger on its ulnar side.

The *Flexor brevis minimi digiti* (plate V, fig. *5 fl.b.m.d.*) arose from the unciform bone and the annular ligament, and was inserted into the base of the first phalanx of the fifth digit on its ulnar side. In Fick's Orang a second head arose from the palmaris longus tendon.

The *Opponens minimi digiti* (plate V, fig. *5 op.m.d.*) arose from the unciform bone and the annular ligament, and was inserted into the whole length of the metacarpal bone of the little finger.

The short muscles of the thenar and hypothenar eminences have a greater or less extension of their fibres of insertion beyond the bony points already described, and blend with the extensor aponeurosis on the dorsal aspect of the digits. In this respect they resemble the interossei, and Langer[1] would, from this circumstance, argue in favour of the theory that these muscles are modified interossei.

The Orang would appear to have a greater development of thumb muscles than obtains in the hand of man as far as the development of those muscles which act upon the metacarpal bone is concerned, but the movements of the terminal phalanx are obviously very weak, the flexor longus pollicis being absent or extremely rudimentary. Further, it would appear that adduction to the index is the most powerful movement attainable, as judged from the development of the muscles. The

[1] Loc. cit., p. 184.

flexor brevis pollicis is also well developed, probably better than in man, and thus flexion of the first phalanx can be well accomplished. The inner head of the flexor brevis resembles that in man in being very feebly developed, and in being completely pressed into the deeper parts and covered over by the adductor obliquus, and according to Bischoff[1] a similar condition is found in the Gibbon. In the Gorilla, Bischoff[2] was unable to separate the outer head of the flexor brevis from the opponens, or the inner head from the adductor obliquus. It would appear from reference to the records of various authorities, that whilst great variations exist among apes in the degree of development of the short muscles of the thumb, they are nevertheless all represented in the different species. Even in the spider monkey (Ateles) according to Huxley, in which the thumb is functionless, being wholly rudimentary and buried under the skin, all the muscles, abductors, adductors, short flexors and opponens are present, the long flexor alone of the muscles usually found in this situation being absent. A variation sometimes occurs according to Fick[3] and others, in the insertion of certain fibres of the adductor into the shaft of the metacarpal bone of the thumb, thus constituting a second opponens.

The *Interossei* (plate V, figs. 6 and 7). The first dorsal interosseous muscle arose from the ulnar side of the base of the first metacarpal by one head, whilst the other head arose from the dorsal, radial and palmar surfaces of the second metacarpal bone. The second dorsal interosseous arose from the ulnar half of the dorsal surface of the second metacarpal bone, and from the dorsal, radial and palmar aspects of the third metacarpal. The third dorsal interosseous arose from the radial half of the dorsal surface of the fourth metacarpal, and from the dorsal, ulnar and palmar aspects of the third metacarpal. The fourth dorsal interosseous arose from the radial half of the dorsal surface of the fifth metacarpal, and from the dorsal ulnar, and palmar aspects of the fourth metacarpal bone.

The palmar origins of the dorsal interossei, above described, were in all instances particularly well developed, forming in fact larger fasciculi than those arising from the dorsal region. On the palmar aspect of the third metacarpal bone the palmar origins of the second and third interossei meet together over the proximal half of the bone. The muscles were inserted as in man.

1 Loc. cit. 1, p. 215.

2 Loc. cit. 2, p. 16.

3 Loc. cit. 2, p. 302.

The palmar interossei arose each by a single head from the metacarpal bone of the digit upon which it acts. The first palmar interosseous arose from the palmar and ulnar surfaces of the second metacarpal, whilst the second and third palmar interossei arose from the palmar and radial surfaces of the fourth and fifth metacarpal bones respectively. They were inserted as in man.

The drawings (plate V) are faithful representations of the relations which existed, and one has reproduced in a diagrammatic fashion in fig. 4, plate IV, the relations of the interossei to the metacarpal bones as they appear in transverse section. The second, third and fourth metacarpal bones were thus completely surrounded by the interossei in the proximal two-thirds of their length.

Bischoff described the interossei very fully in a large number of the lower apes and the anthropoid apes. He recognized the fact that there existed a palmar set of interossei as distinct and independent muscles. They vary in the number present in the different apes, but never exceed three, and were always developed in connection with the second, fourth and fifth digits. The double insertion of the various interossei, both palmar and dorsal, whereby they are on the one hand attached to the base of the proximal phalanx and on the other into the extensor aponeurotic expansion on the back of the phalanx, was first pointed out by Huxley[2] in anthropoid apes. The interossei and their attachments were fully described by Huxley in all four anthropoids. Bischoff found the interossei in the Gorilla developed as in man.[3]

The palmar portions of the dorsal interossei formed such very definite structures in my Orang that they attracted special attention. This segment of the dorsal interosseous muscle, in fact resembles a palmar interosseous muscle, but this ventral segment is blended very intimately with the dorsal in the tendon of insertion of the muscle. The palmar interossei on the other hand remain independent structures throughout. This condition is very similar to that found in man, and, obviously, the description in most text books of human anatomy regarding these muscles is faulty. Gegenbaur[4] however, describes and figures them in their correct relations. Hepburn[5] apparently found these ventral segments of the dorsal interossei, and, if I read his description aright, looked

1 Loc. cit. I, pp. 216, 224.

2 Loc. cit., Vol. I. p. 456.

3 Loc. cit. 2, p. 17.

4 C. Gegenbaur, "Lehrbuch der Anatomie des Menschen." Leipzig. Vol. I. p. 431. fig. 303.

5 Loc. cit., p. 174.

upon them as additional palmar interossei, and thus described six palmar interossei in the Chimpanzee instead of three. From one point of view Hepburn would appear to be justified in classing these ventral segments of the dorsal interossei with the palmar interossei, and this whole group of six muscles, as represented in my Orang, (plate V, figs 6 and 7) might be referred to the intermediate layer of Cunningham which that author describes as constituting the "flexores breves." We shall return to the discussion of the interossei after describing the muscles of the foot.

In the dissection of the muscles of the lower extremity one found the fascia lata poorly developed, as compared with the similar structure in man.

The *Gracilis* arose from the body of the pubis by an origin 3.5 cm. wide, immediately external to the symphysis and corresponding in width of attachment to the depth of the symphysis, it did not extend to the descending ramus of the pubis; it was inserted into the inner aspect of the tibia by an expanded aponeurosis of insertion 3 cm. wide. The upper limit of the insertion is 3 cm. below the articular surface of the tibia. It forms a flat ribbon-like muscle varying in width from 2 cm. near its origin to 1 cm. near its insertion, and was supplied by the obturator nerve. Fick remarks on the strong development of this muscle in the Orang, and also observed the absence of any origin from the pubic ramus.

The *Sartorius*, a very poorly developed muscle, arose from the ilium below the anterior superior spine, and was inserted into the inner surface of the tibia, above and anterior to the insertion of the gracilis. This muscle was only about one-fifth the size of the gracilis, and was supplied by the anterior crural nerve. On the right side Rudolf found that the muscle divided into two tendons of insertion, the anterior being inserted into the inner aspect of the tibia in the position indicated above for the left side, the posterior joined with the fascia around the knee joint, between these two portions passed an artery of considerable size, which was found to arise from the femoral one inch above the knee, and ran down the inner side of the leg to the cleft between the first and second toes, where it disappeared between the heads of the first dorsal interosseous muscle; a vein accompanied the artery and entered the femoral vein one inch above the knee. Fick[1] described an artery the *arteria genus suprema* in the Orang as a large vessel as thick as the profunda arising above the knee and extending with the saphenous nerve

[1] Loc. cit. 1, p. 35.

to the dorsum of the foot. The sartorius muscle is usually very feebly developed in the anthropoid apes as compared with man. Gegenbaur states[1] that the sartorius is as well developed in the anthrophoid apes as it is in man, but this is by no means invariably the case—in my Orang it was very rudimentary, and Fick found it so also in the same animal. Bischoff, too, and Duvernoy[2] state that the muscle is weak in the Gorilla, whilst Gratiolet and Alix[3] found it weakly developed in the Chimpanzee. The attachment of the sartorius to the inner side of the knee joint, similar to that found by Rudolf, has been described in man, (Testut).

The *Adductor longus* arose from the inner portion of Poupart's ligament and from Gimbernat's ligament and from the pubis extending 1 cm. along the bone on the superior part of the horizontal ramus immediately external to the pubic spine; it was inserted into the inner aspect of the femur, the line of insertion being 1.5 cm. long, the lower limit of this line being only 2 cm. above the internal condyle.

The *Pectineus*, lying in the same plane as the adductor longus at its origin, arose from the horizontal ramus of the pubis, the origin being 1 cm. wide, continuous there with the adductor longus as it passes backwards and downwards, wrapping itself around the shaft of the femur, and was inserted into the posterior aspect of the femur at the junction of the middle and upper thirds, the insertion being 2.5 cm. wide.

The *Adductor brevis* arose from the pubis immediately beneath the adductor longus, by an origin 1.5 cm. wide; it was inserted into the posterior aspect of the femur on a plane posterior to that of the pectineus. The muscle was supplied by the obturator nerve.

The *Adductor magnus*, a large bulky muscle, arose from the pubic bone opposite the whole extent of the symphysis immediately subjacent to the gracilis, and on the same plane as the adductor brevis at its origin. The attachment of origin extends back along the descending ramus of the pubis and the ascending ramus of the ischium to within 1 cm. of the tuberosity of the ischium. The lower, or inner border was thick and rounded, whilst the upper (or outer) was thin and attenuated. The lower part of the muscle was inserted by a rounded tendon into the internal condyle of the femur, the lowest fibres passing to the internal lateral ligament of the knee joint. The muscle above this point is inserted into the posterior aspect of the femur in a plane posterior to the

1 Loc. cit., (Lehrbuch) Vol. I, p. 430.

2 Loc. cit., p. 90.

3 Loc. cit., p. 186.

adductor brevis, longus and pectineus, extending as high up on the shaft as the lower limit of the upper fifth of the bone. The muscle is supplied by the obturator nerve. The femoral vessels crossed over the anterior surface of the adductor longus near its insertion, and passed through the adductor magnus.

The *Adductores femoris* are, according to Bischoff, particularly strongly developed in all apes. In the Orang he was only able to distinguish the adductors longus and magnus; in all other apes investigated by him, including the Gorilla, Chimpanzee and Gibbon he found the adductor group in five muscles, not only the pectineus, adductor magnus, longus and brevis, but an additional muscle arising from the crest of the pubis. This additional muscle from the crest Duvernoy[1] described in the Gorilla as a part of the pectineus.

The *floor of Scarpa's triangle.* From without inwards, the floor was formed by the iliacus, psoas, pectineus and adductor longus. The adductor brevis was entirely hidden from view, and there was a triangular interval between the psoas and pectineus (with the base uppermost), the floor of which was formed by the anterior ligaments of the hip joint covering the head of the femur. Passing down in the inner portion of the triangle was the femoral vein, lying in direct contact with the *ramus* of the pubis, and the anterior capsule of the hip joint and the femoral artery lying upon the inner edge of the psoas. The anterior crural nerve was separated from the femoral vessels by an interval of 2 cm. at the base of Scarpa's triangle, and lay upon the iliacus muscle.

The *Psoas* arose from the bodies of the lumbar vertebrae, and from the transverse processes. A well-developed *psoas parvus* lay on the anterior aspect of the psoas. It arose from the body of the first lumbar vertebra and was inserted into the pubis. Hepburn found a psoas parvus in each of the four anthropoids. Fick also found it in the Orang and Bischoff in the Gorilla. The *Iliacus* arose from the concavity of the ilium. These two muscles (constituting the Ilio-psoas) were inserted into the lesser trochanter of the femur. They lay in the same plane at the base of Scarpa's triangle, but afterwards the psoas came to lie in front of the iliacus and was inserted into the upper part of the lesser trochanter; the iliacus on the other hand, fully four times as wide as the psoas, was inserted into the lesser trochanter and into the shaft of the femur for 1 cm. below.

The *Rectus femoris* (Plate VI, fig. 8 rect.) arose by a single head from

1 Loc. cit., p. 85.

the anterior margin of the ilium at a point 3 cm. below the anterior superior spine, the width of origin being 2 cm., lying behind the Iliacus and in front of the gluteus minimus it passed into the thigh to join the quadriceps extensor muscle in the usual way. There was no reflected head of origin. Hepburn[1] found the double origin in the Orang, Chimpanzee and Gorilla, but not in the Gibbon. In establishing homologies between the muscles of the thigh and of the arm Humphrey[2] considered the rectus in the thigh to represent the scapular part of the triceps in the arm; and the shorter deeper portion, extending more laterally, formed by the vasti and crureus in the thigh, as representing the humeral head of the triceps in the arm.

The *Vastus externus* (Plate VI, fig. 8, v.i.) arose from the anterior inter-trochanteric line and from a line skirting the lower part of the great trochanter. Posteriorly a part arose from the trochanter itself. This part of the origin of the vastus externus embraces the insertion of the scansorius. Below this point the vastus externus arose from the postero-external aspect of the femur as low as the condyle, its origin here being immediately in front of the insertion of the gluteus maximus.

The *Vastus internus* arose from the antero-internal aspect of the femur as high as the root of the neck, its origin extending down to the internal condyle.

The *Crureus* arose from the anterior aspect of the femur as high as the neck and extending down between the lines of origin of the external and internal vasti as in man. These various muscles united as in man to form the *quadriceps extensor cruris.* This muscle is developed in apes as in man.

The *Gluteus maximus* (Plate VI., fig. 8, g. max.) arose from the posterior part of the iliac crest, the back of the sacrum, coccyx, and the sacrosciatic fascia by an origin 6 cm. wide, and was inserted, the lower (posterior) fibres, by a rounded cord which was traced down the external aspect of the femur to the external condyle, being intimately attached to the fascia lata throughout its whole extent. Most of the superficial fibres converged to this rounded tendon and have thus a fascial insertion, whilst the deep fibres were inserted into the femur by an attachment 1.5 cm. wide immediately external to the vastus externus, behind that muscle; the biceps lying posteriorly. The gluteus maximus was thus a very well developed muscle, and the proverbial

1 Loc. cit., p. 329.

2 Humphrey. "On the Disposition and Homologies of the Extensor and Flexor Muscles of the Leg and Forearm." Journ. of Anatomy and Physiology, Vol. III, 1869, p. 320.

diminutive size of the nates in apes, which is usually ascribed to the ill-developed glutei muscles, was not demonstrated in my specimen. Fick also[1] observed that the gluteus maximus, though relatively weak was still a strong muscle in his Orang, its weight being 432 grms. whilst the gluteus maximus in a lean man was found by Langer to be 366 grms.

The *Gluteus medius* (Plate VI., fig. 8) was a large well developed muscle, which arose from the dorsal surface of the ilium as far forwards as the anterior superior spine, and backwards over the whole extent of the iliac crest, and from the dorsal surface of the ilium below this, some fibres coming from the posterior sacro-iliac ligament. Along its posterior border it is joined by the pyriformis muscle.

The *Pyriformis* is a narrow ribbon-like muscle arising from the anterior surface of the sacrum. It joins the gluteus medius on its deep aspect and proceeds to its insertion into the upper part of the great trochanter, as in man. It was intimately connected with the gluteus medius, but it was possible to separate them entirely from one another. It is customary, according to Bischoff, to find these two muscles closely connected in apes. Hepburn found them blended in all four anthropoids. The muscle is present in all apes.

The *Gluteus minimus* (Plate VI., fig. 8, g.min.) arose from the margin of the great sacro-sciatic foramen, and slightly from the dorsal surface of the ilium below this by an origin 2.5 cm. wide, it passed outwards beneath the pyriformis and the gluteus medius and was inserted into the anterior margin of the great trochanter.

The *Scansorius* (Plate VI., fig. 8, scan.) arose from the anterior margin of the ilium below the anterior superior spine by a broad base of origin 3.5 cm. wide, the muscle being triangular in shape. It was inserted by its apex into the anterior border of the great trochanter by an insertion 1.5 cm. wide immediately in front of the gluteus medius and is embraced at its insertion by the vastus externus. This well-developed muscle lay at its origin between the gluteus medius behind and the iliacus in front. The narrow ill-developed sartorius separates the iliacus from the scansorius, whilst the rectus also separates these two muscles along the inner border of the scansorius. The muscle was very distinct and separate from both the gluteus medius and the gluteus minimus.

The scansorius is described by Fick as a typical Orang muscle. It is certainly best developed as a separate muscle in the Orang, whilst in the other apes (both anthropoid and lower apes) it is more or less

1 Loc. cit. 1, p. 36.

blended with other muscles. Fick[1] described it as a muscle wholly separate and distinct in his first Orang, whilst in the second Orang dissected by him[2] the muscle was superficially united with the gluteus medius. Bischoff[3] also describes the scansorius in the Orang as a separate muscle, and so too do Huxley,[4] Owen,[5] Hepburn,[6] and Langer,[7] whilst Chapman[8] figures the muscle, but looks upon it as a portion of the gluteus minimus. Gratiolet and Alix[9] in their description of the Chimpanzee describe the gluteus medius and the gluteus minimus together as forming a single muscular mass, and the anterior portion of the muscle sheet thus described would correspond to the scansorius, although not so designated by them, and certainly not existing as a muscle completely separate in their specimen. Hepburn[6] however describes it as a separate muscle in the Chimpanzee, as do also Huxley[10] and Owen,[5] whilst Bischoff[3] and Champneys[11] describe it in the Chimpanzee as closely connected with the gluteus minimus. Macalister[12] found it attached to the gluteus medius in one Chimpanzee and to the minimus in another. In the other anthropoids, namely the Gibbon and the Gorilla, it has not been described as a separate muscle save in the fœtal Gibbon where Deniker[13] found it well marked, whilst in the fœtal Gorilla it was not completely separated from the gluteus minimus. Bischoff[14] and Hepburn[15] both found it united with the gluteus minimus in the Gibbon, whilst Huxley[16] states that it is not very distinctly represented in that animal. In the Gorilla it has not been described as a separate muscle. Duvernoy in his description of this region in the Gorilla[17] makes no mention of the scansorius, Bischoff[18] says it fails in the Gorilla, but the gluteus minimus arises

1 Loc. cit., p. 36.
2 Loc. cit. 2, p. 303.
3 Loc. cit. 1, p. 224.
4 Loc. cit., Vol. I, p. 506.
5 Loc. cit., p. 68.
6 Loc. cit., p. 325.
7 Loc. cit., p. 186.
8 Loc. cit., p. 163.
9 Loc. cit., p. 179.
10 Loc. cit., Vol. I, p. 428.
11 Loc. cit., p. 193.
12 Loc. cit., p. 504.
13 Loc. cit., p. 168.
14 Loc. cit. 1, p. 224.
15 Loc. cit., p. 325.
16 Loc. cit., Vol. I, p. 647.
17 Loc. cit., pp. 84, 85.
18 Loc. cit. 2, p. 19.

from the anterior iliac margin, and similarly Hepburn[1] describes it as blended with the gluteus minimus. On the other hand Macalister describes it as uniting with the gluteus medius (not minimus) in the Gorilla. Concerning the occurrence of the muscle among the lower apes, Huxley[2] tells us that in Cynopithecini the scansorius is found, but it is sometimes blended with the gluteus minimus. Bischoff whilst he states that it fails in the lower apes generally, mentions that it is represented by a weak bundle in Cynocephalus, Cercopithecus and Macacus.

Thus we find that the scansorius is best developed as a separate muscle in the Orang and the Chimpanzee among anthropoid apes, and in all other apes it varies very considerably in its development, and is usually blended with the gluteus minimus or the gluteus medius, commonly the former.

The scansorius would thus appear to have more or less intimate connection with the gluteus medius and minimus. Fick combats the suggestion of Henke that it is developed from the iliacus, on the ground that the sartorius muscle intervenes between these two muscles; in my specimen I not only found the sartorius intervening but also the rectus. Bischoff, too, refers to the rectus intervening between the ilio-psoas, and what he believes to be the representative of the scansorius in the Gibbon.

The function of the scansorius muscle was demonstrated by Owen, who called it the "Invertor femoris," holding that it was a powerful rotator of the thigh and could have very little effect in drawing the thigh up. He states regarding the muscle "that it appears rather to have reference to that structure in the hip joint which, in the Orang especially, from the absence of the ligamentum teres, and in the Chimpanzee, from the *yielding texture of that ligament, permits a greater extent of inward* rotation than can be accomplished in man." Fick[6] questions the appropriateness of calling this muscle the climbing muscle. Flexion of the femur which is carried out to a limited extent by the scansorius, is a movement performed in climbing, but there are many other more powerful flexors of the femur. Then the scansorius rotates the thigh inwards in a forcible manner, and this is apparently its chief action. The ape, however, does not appear to rotate the thigh inwards in

1 Loc. cit., p. 325.

2 Loc. cit., p. 504.

3 Loc. cit., Vol. II, p. 40.

4 Loc. cit. 1, p. 224.

5 Loc. cit., p. 68.

6 Loc. cit. 1, p. 36.

climbing, if it did so it would necessarily throw the leg and foot outwards at the same time, in consequence of the fact that the knee is flexed and never straight in the Orang; as a matter of fact, in climbing upwards the ape applies the sole of the foot to the tree, whilst the thigh is abducted and rotated out. The ape thus climbs in a different fashion from that in which a boy would climb a pole, with thighs adducted and rotated in and with the knees hard pressed inwards. Fick states, however, that man in climbing with naked feet, as for example, the child of a Malay negro, will climb as the ape does, with the soles of the feet applied to the trunk of the tree and with thighs rotated out. This action of flexion of the femur with rotation outwards is not the function of the scansorius but of the ilio-psoas. In this sense, therefore, the name scansorius is inapplicable. Fick admits that the scansorius may be brought into action when the ape is climbing from one branch to another, when, he observes, the animal very frequently performs this movement with flexed thigh rotated inwards.

The scansorius muscle was first described and named by Traill (quoted by Bischoff, from Memoirs of the Wernian, Nat. His. Soc., Vol. III, p. 29, 1821), in the Chimpanzee. According to Testut[1] there is frequently found in man a small fasciculus more or less differentiated from the gluteus minimus anteriorly, which passes to be inserted into the great trochanter; this Testut considers the representative of the scansorius in man. This fasciculus, he adds, exists normally in a large number of mammals.

The weak development of the glutei muscles in general in man is to be ascribed to the erect attitude, whilst again the comparatively strong development of that part of the gluteus maximus in the ape which proceeds down the thigh—in my Orang as far as the external condyle—is associated with climbing, the thigh being carried back with considerable force by that part of the muscle.

The *Tensor fasciæ femoris* was entirely absent in my Orang. Bischoff states regarding it that the fascia lata is more weakly developed than in man, and the muscle is scarcely present as an independent muscle in any instance, but may be represented by a few fibres derived from the anterior part of the gluteus maximus. This agrees with the freer and more isolated action of the thigh muscles in apes, as is necessary in climbing, whilst in man these muscles are required to be more firmly bound together in the erect position and in walking.

1 Loc. cit., Vol. I. pt. 2. p. 837.

The *Obturator internus* arose as in man, and passed over the lesser sciatic notch, where it is joined by a well-developed *Gemellus inferior* and a less strongly developed *Gemellus superior*. The muscle was inserted into the upper part of the great trochanter behind the insertion of the pyriformis and in contact with the capsule of the hip joint. Fick likewise describes the superior gemellus as weak in the Orang, whilst Hepburn found them both well developed. Bischoff in the Gorilla found the obturator internus completely blended with the quadratus femoris.

The *Obturator externus* arose as in man and, appearing between the obturator internus and quadratus femoris, it found insertion into the inner part of the great trochanter just behind the obturator internus.

The *Quadratus femoris* was a well-developed muscle. It arose from the outer part of the ischial tuberosity by an origin 1.5 cm. wide and was inserted into the posterior part of the great trochanter and the shaft of the femur below this process. Langer[1] found the muscle closely connected with, and hardly separable from, the adductor magnus, and he therefore looked upon it as one of the adductor group. The muscle is sometimes blended with the great adductor in man.

The *Semitendinosus* arose from the tuberosity of the ischium and the bone immediately in front of this by an origin 1 cm. wide, and was inserted into the tibia, the tendon expanding to have a wide attachment (2 cm.); into the antero-internal surface of the tibia behind the insertion of the gracilis. Rudolf on the right side found a second head of origin coming from the ischial ramus and joining the muscle 1½ inches from its insertion.

The *Biceps* arose from the outer part of the tuberosity of the ischium, immediately posterior to and slightly in front of the semitendinosus. The two were closely associated at their origin. The muscle was inserted along the whole length of the lower two-thirds of the shaft of the femur, immediately behind the origin of the vastus externus, also into the external lateral ligament of the knee joint, the external tuberosity of the tibia, the head of the fibula and into the fascia on the outer surface of the upper part of the leg. Associated with this muscle is another (the femoral head of the Biceps in man) which arose from the shaft of the femur immediately behind (*i.e.*, internal to) the line of the femoral insertion of the biceps as described above. The line of origin was 4.5 cm. wide. The muscle passed to be inserted into the fascia of

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1 Loc. cit., p. 187.

the leg extending downwards from the level of the knee joint; the fascia over the muscles of the leg being here very strongly developed. Fick[1] describes the ischio-femoral portion of the biceps as the direct antagonist of the scansorius, the action of the former muscle being to extend the hip and to rotate it outwards; both these muscles are absent in man. Langer[2] describes the long head of the biceps as in part going to be inserted into the patella, and he characterizes it as the great "sprungmuskel" which, in quadrupeds, is capable of extending all three joints, hip, knee and ankle. In Langer's Orang connection with the tendo Achillis alone was absent. The ischio-femoralis is sometimes joined with the gluteus maximus in the Orang, but more frequently is completely separate. In the Gorilla, Bischoff[3] describes the two heads of the biceps, b t states that the long head is not inserted into the linea aspera as in the Orang, but passes to the head of the fibula and the fascia cruris. In the Chimpanzee and the Gibbon, according to the same authority, the Biceps is most human-like but extends also into the fascia cruris. In the lower apes the biceps has only one head—the long head—which is inserted, not into the fibula, but into the tibia; this fact is noted by Bischoff and by Huxley.[4] Hepburn found both heads present in the Orang, and, whilst one was inserted into the fibula and the other into the tibia, there was no femoral attachment. The biceps has been found in rare cases inserted in part into the tendo Achillis in man (Testut).

The *Semimembranosus* arose external to the point of attachment of the semitendinosus from the posterior part of the tuberosity of the ischium and the bone immediately in front of this (0.75 cm. wide); i was inserted into the inner aspect of the head of the tibia.

The absence of a ligamentum teres in the hip joint was noted. No vestige of this structure could be found; the head of the femur presenting an unbroken surface smooth throughout. One could not determine any definite ilio-femoral ligament, although the capsule of the hip-joint was thickened anteriorly in the line of its usual development.

The shortness of the hamstring muscles in the Orang and their low attachment, removed some distance below the knee, prevent complete extension of the leg at that joint, and this inability to extend at the knee is necessarily still further increased when the hip-joint is flexed.

1 Loc. cit. 1, p. 39.

2 Loc. cit., p. 187.

3 Loc. cit. 2, p. 21.

4 Loc. cit. Vol. II, p. 40.

A strong fascia covered the muscles of the calf. The anterior annular ligament of the ankle-joint was a well-developed structure consisting of two distinct bands, the upper passing from the internal malleolus outwards to be attached to the lower part of the fibula; the lower having a broad attachmeut to the external malleolus, becomes somewhat narrowed as it is attached to the fascia on the inner side of the foot below the internal malleolus. The external annular ligament too was well developed as it passed over the peronei muscles, as was also the internal annular ligament over the structures at the inner ankle.

The *Tibialis anticus* arose from the anterior aspect of the upper half of the tibia, from the external tuberosity and the interosseous membrane, and from the fascia over the muscle. The muscle became tendinous immediately above the ankle, where two tendons are readily distinguishable. The smaller one, which arose from the fleshy fasciculi of the anterior and outer part of the muscle, was inserted into the base of the first metatarsal bone at the junction of the inner and plantar surfaces. The larger tendon (three times the size of the former) was inserted into the internal cuneiform bone. The slip inserted into the first metatarsal bone acts as a strong abductor of the great toe, as does also the extensor longus hallucis.

The tibialis anticus in certain of the anthropoid apes is more or less completely divided into two muscles. In man we have a single muscle and a single tendon which, however, divides at its extremity to be inserted into the internal cuneiform and the first metatarsal bone. This double insertion in man is an indication of the complete separation into two portions occurring in some apes. In the Orang and Chimpanzee Bischoff[1] found this division complete, and, in fact, in the Chimpanzee he found a third tibialis anticus arising in common with the extensor longus digitorum, but completely separated from it, and dividing into two tendons at the ankle to be inserted into the inner margin of the foot. In the Gibbon, Bischoff, found a single muscle with a single tendon passing to the internal cuneiform bone. Huxley,[2] however, found a double insertion of the muscle in that animal. In the Gorilla Bischoff,[3] and Duvernoy[4] describe the muscle as in man, its tendon dividing for insertion into the first metatarsal and the internal cuneiform. In all other apes, Bischoff asserts, the tibialis anticus is double. It would appear, therefore, that in all apes the double insertion is almost

1 Loc. cit. 1, p. 227.
2 Loc. cit., Vol. I, p. 648.
3 Loc. cit. 2, p. 21.
4 Loc. cit., p. 94.

invariable; in this respect it may be compared to the extensor ossis metacarpi pollicis in the hand.

The *Extensor longus hallucis* arose from the upper fifth of the fibula and from the interosseous membrane, the line of origin being very short, and was inserted into the great toe, with similar relations to those in man. Fick[1] observed in an Orang a tendon given by this muscle to the second toe. Bischoff states that in all apes this muscle resembles that of man, but, except in the Gibbon, it does not extend along the dorsum of the foot as in man, but goes with the tibialis anticus to the inner side (the latter muscle being attached to the internal cuneiform), and runs along the inner margin of the foot to the first phalanx. The muscle must, in its direction act on the great toe as an abductor as well as an extensor. In the Gibbon alone the tendon runs a course similar to man.

The *Extensor longus digitorum* arose from the internal tuberosity of the tibia and the intermuscular septum, also from the head of the fibula and the interosseous membrane, the origin being only 1.5 cm. wide. It was inserted into the four outer toes.

Extensor brevis digitorum arose from the outer and superior surfaces of the os calcis. It was closely associated at its origin on the outer side of the foot with the insertion of the peroneus brevis. It was inserted into the four inner toes, having a similar relationship to the extensor longus digitorum as in man; that for the great toe formed a separate and distinct muscle, running almost at right angles to the main part of the muscle, and passed to the great toe with the extensor longus hallucis. Duvernoy[2] describes this slip in the Gorilla as a separate muscle of the great toe. Langer[3] describes in the foot a similar interdigital membrane to that found in the hand, the toes being thus even more sunken in the foot than are the fingers in the hand.

The *Peroneus tertius* was absent, as is the case apparently with all apes, both in anthropoids and the lower apes. This muscle is peculiar to man among mammals, and there is some evidence that its development has to do with the erect attitude assumed by man. Ramsay Smith[4] believes that it serves an important function in preventing spasmodic extension of the ankle joint in ordinary walking. This, according to Smith, occurred in cases where the muscle was paralysed.

1 Loc. cit. 2. p. 303.

2 Loc. cit., p. 103.

3 Loc. cit., p. 190.

4 W. Ramsay Smith. "The Functions of the Peroneus Tertius Muscle." Edinburgh Medical Journal, 1882, p. 632.

The *Peroneus longus* arose from the head of the fibula on its outer aspect, and from the intermuscular septum, the line of origin being 2 cm. long. The musculo-cutaneous nerve passed between the upper part of the muscle and the fibula; the muscle became tendinous at the junction of the lower and middle thirds of the leg; the tendon grooved the cuboid bone, and passing inwards across the sole of the foot, it was inserted into the base of the first metatarsal bone at the junction of the plantar and outer margins. The peroneus longus had also a very definite slip of insertion into the fifth metatarsal bone. Fick[1] also describes this double insertion in the Orang.

The *Peroneus brevis* arose over 4.5 cm. of the outer side of the fibula, along an oblique line extending from above and in front, downwards and backwards to the posterior aspect of the bone immediately above the external malleolus. The upper limit of its origin was as high as the junction of the upper and the middle thirds of the bone. It was inserted into the base of the fifth metatarsal bone, and into a tendinous arch extending from the os calcis to the base of the fifth metatarsal bone ("abductor ossis metatarsi quinti" of Huxley). This extensive and strong insertion band of the muscle gives rise to certain fibres of the abductor minimi digiti. Some of the tendon fibres of the peroneus brevis were directly continuous with the peroneus longus tendon in the sole.

Bischoff,[2] in comparing the peroneus longus in man and apes, refers to the fact that on account of the saddle shape of the joint between the cuneiform and the first metatarsal, and of the more isolated position of the great toe in the ape as compared with man, the peroneus longus in the ape acts in bringing the great toe into opposition with the other toes, whilst in man it acts on the anterior part of the foot as a whole.

Bischoff describes another muscle in the ape, the *Peroneus parvus*.[3] This muscle, he says, in lower apes, exists as a fourth peroneus. It lies between the longus and brevis arising from the fibula. It becomes tendinous in the leg and extending to the outer margin of the foot, passes to the first phalanx of the little toe, where it unites with the tendon of the flexor digitorum communis longus. This muscle Bischoff states evidently corresponds with the well-known tendon which almost always in man goes from the tendon of the peroneus brevis and

1 Loc. cit. 1. p. 42.

2 Loc. cit. 1. p. 229.

3 Loc. cit. 1. p. 230.

joins the extensor tendon of the little toe, derived from the extensor digitorum communis longus. Huxley[1] describes this muscle in the lower apes ; he calls it the *Peroneus quinti digiti.* The muscle appears to be very uncommon in the anthropoid apes, although Bischoff thought that possibly a tendon coursing along the outer margin of the foot, which proceeds from the tendon of the peroneus brevis and is inserted with the extensor tendon of the little toe, might be looked upon as a rudiment of the peroneus parvus in the Gorilla. He found this tendon also in the Chimpanzee, as also did Gratiolet and Alix.[2] This tendon has apparently not been found in the Orang, but Huxley[3] describes in the Chimpanzee a muscular slip arising from the calcaneum apparently detached from the abductor minimi digiti, and ending in a tendon inserted into the base of the fifth metatarsal bone. This, Huxley suggests, might be called the "*abductor ossis metatarsi quinti.*" This corresponds precisely to the tendinous arch which I describe in the Orang in connection with the insertion of the peroneus brevis, and possibly represents a rudiment of the peroneus parvus.

Fick[4] has described a peroneous parvus in the Orang. Hitherto it was held that it did not exist in anthropoids, and apparently it is of rare occurrence among those apes, as this is the only instance in which I find its presence noted, although carefully sought for by various observers.

Ruge[5] makes some interesting observations on the peroneal group of muscles. He considers that the peroneus longus tendon in the mammalia wanders from the anterior to the lateral part of the limb. Thus in carnivora it originally lies on the anterior surface of the fibula, in rodents the tendon at one time lies upon the lateral aspect of the external malleolus and at another time behind it. In the ape the tendon lies in a special synovial sheath separated from the brevis, whilst in man they lie both together in the same synovial sheath. Ruge evidently considers the extensor brevis digitorum to be derived from the peroneal group, and represents it as wandering toward the dorsum of the foot, as would appear by studying its relation in different mammals. In marsupials only two bellies pass over for the first and second toes. In rodents and insectivora for the first, second and third toes. In carnivora, apes, and man for four toes (first, second, third and fourth)

1 Loc. cit., Vol. II, pp. 40, 93, 124.

2 Loc. cit., p. 198.

3 Loc. cit., Vol. I, p. 429.

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5 Dr. George Ruge, "Untersuchung über die Extensorengruppe am Unterschenkel und Fusse der Säugethiere." Morphologisches Jahrbuch, Vol. IV, 1878, p. 592.

whilst that for the fifth toe still retains its original position among the peronei.

The *Gastrocnemius.* The outer head arose from the posterior aspect of the external condyle, and by a few fibres from the posterior ligament of the knee joint. The fibres of origin were closely associated with the flexor digitorum fibularis, the latter having a femoral origin behind the external condyle immediately internal to and above the place of attachment of the gastrocnemius. The inner head arose from the femur immediately above the internal condyle and from the posterior ligament of the knee joint. Langer and Fick both observed the connection of the outer head with the flexor digitorum fibularis. The muscle is not nearly so well developed as in man.

The *Soleus* arose by a narrow attachment (1 cm. wide) from the posterior part of the head of fibula; this was joined by a delicate, thread-like, distinctly tendinous structure which descends from the outer and posterior surface of the tibia. Macalister[1] found a trace of a tibial head in the Chimpanzee, but all other observers (Huxley, Fick, Langer, Bischoff, etc.,) state that the tibial head of the soleus is absent in all apes. The soleus and gastrocnemius unite in a tendo Achillis which is wholly tendinous at a point 3 cm. above the heel. In Fick's[2] Orang the fleshy fibres of the muscle extended down to its insertion into the os calcis, and this condition is held by him to be characteristic of anthropoids as compared with that found in the lower apes and in man. Bischoff[3] agrees with this statement excepting in the case of the Gibbon, in which the tendo Achillis, according to him, is developed as in man.

The *Popliteus* arose from the outer condyle of the femur within the knee joint passing through the posterior ligament of the knee. The muscle was overlaid at its origin by the outer head of the gastrocnemius and the femoral head of the flexor longus hallucis. It was crossed about its middle by the inner head of the gastrocnemius. Rudolf found on the right side that its nerve entered the superficial surface. It was inserted into the posterior surface of the tibia in its upper fifth and along the inner border of that bone extending down from the internal tibial condyle for one-fourth of the length of the bone. Langer and Fick both describe sesamoid bones in connection with the tendons of origin of the popliteus in the Orang. Humphrey[4] looks upon the popliteus

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1 Loc. cit., p. 205.

2 Loc. cit. 1, p. 40.

3 Loc. cit. 1, p. 228.

4 Loc. cit., p. 328.

in the leg as the homologue of the pronator radii teres in the forearm. The occasional second head of origin of the muscle from the fibula in man may correspond to the ulnar origin of the pronator. Bischoff[1] admits that pronation is possible to some degree in the knee of the ape, whilst in man of course the popliteus acts only as a flexor. Melzer[2] considers the homologies to be as follows:

Supinator longus..............	........Gastrocnemius	inner head.
Pronator teres (humeral head)		outer head.
Pronator teres (ulnar head)...........	.Popliteus.	

Macalister[3] looks upon the inner head of the gastrocnemius as the homologue of the pronator radii teres. It is superficial and not deep like the popliteus, and this fact he considers to be in favour of his hypothesis.

The *Plantaris* was absent and it would appear that the muscle is very rarely present in anthropoid apes. The only instance in which it was found in the Orang was in that dissected by Sandifort, who is stated by Fick[4] to have found it in that animal. It is frequently absent in man. Whilst the plantaris is almost invariably absent in anthropoid apes, it is well-developed, according to Bischoff,[5] in the lower apes (Cynocephalus, Cercopithecus, Macacus and Pithecia), forming a strong tendon passing under the posterior part of the os calcis, and it may be followed into the sole where it joins the plantar fascia. Bischoff,[6] however, found a slightly developed plantaris arise on both sides in the Chimpanzee. and in this animal, too, it has been described by Macalister[7] as present on the right side in one Chimpanzee and absent on both sides in another Chimpanzee. It is, however, frequently absent in this animal, and with the exception of the one instance recorded by Sandifort in the Orang, it has not been found in any of the other anthropoid apes, although carefully sought for, and its absence recorded by various authors. The plantaris in the leg doubtless corresponds to the palmaris longus in the forearm and has the same relation to the plantar fascia that the latter muscle has to the palmar fascia (see page 537). Thus Sutton[8] holds that the plantar fascia is derived from the degeneration of the distal end of

1 Loc. cit. 2, p. 23.

2 W. Melzer, "Zur Homologie der menschlichen Extremitäten." Internationale Monatsschrift für Anatomie und Physiologie, Vol. XI, 1894, p. 200.

3 A. Macalister, "On the Arrangement of the Pronator Muscles in the Limbs of Vertebrate Animals." Journ. of Anat. and Phys., Vol. III, 1869, p. 340.

4 Loc. cit. 1, p. 41.

5 Loc. cit. 1, p. 229.

6 Loc. cit. 2, p. 22.

7 Loc. cit., p. 505.

8 Loc. cit., p. 16.

the plantaris muscle. We find the muscle in a more fully developed condition in the lower mammalia. Cunningham[1] described it in the marsupials. In Thylacinus this muscle arises in common with the outer head of the gastrocnemius and remains fused with its under surface for a considerable distance. It ends in a strong tendon which proceeds downwards along the inner side of the tendo Achillis to the heel, where it expands and, passing superficially to the tendo Achillis, enters the sole. Here it spreads out in the form of a plantar fascia which divides into three slips for the index, medius and annularis. The plantar fascia is not attached to the subjacent muscles, and each of its terminal slips bifurcates to embrace the metatarso-phalangeal joint and is attached to the ligamentous structures around that articulation. Sutton describes a somewhat similar arrangement in the Armadillo. In higher mammalia it would appear that, owing to the backward growth of the os calcis the plantaris is shut off from its direct connection with the plantar fascia, and terminates by being inserted into the os calcis itself.

The *Flexor digitorum fibularis* (the flexor longus hallucis of human anatomy), was a very large bulky muscle of extensive origin from the posterior aspect of the external femoral condyle where it embraced the origin of the outer head of the gastrocnemius, also from the posterior and external lateral ligaments of the knee joint, the posterior aspect of the fibula as low as the junction between the middle and lower thirds, also from the fascia between it and the peronei muscles.

The *Flexor digitorum tibialis* (the flexor longus digitorum of human anatomy), was also a very bulky muscle and arose from the posterior aspect of the tibia immediately external to the attachment of the popliteus muscle as high up as the head of the tibia; it was attached along a line running downwards and inwards to the inner margin of the tibia at the junction of its upper and middle thirds. This portion of the muscle is joined by a well developed band of fibres descending from the fascia over the lower part of the popliteus muscle. These fibres may be traced upwards, and are found attached to the inner tuberosity of the tibia. Another very distinct head of origin of this muscle arose from the fascia over the tibialis posticus muscle, and extended as far as the inner margin of the fibula.

The two muscles just described, viz., the flexor digitorum fibularis

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1 D. J. Cunningham, "Report on the Marsupialia, with an Account of the Comparative Anatomy of the intrinsic Muscles and Nerves of the Mammalian Pes." Report of the Voyage of H. M. S. Challenger," Vol. V, 1882, Part XVI, p. 41.

and the flexor digitorum tibialis, both became tendinous immediately above the inner ankle, and proceeded towards the sole of the foot. They passed behind the inner ankle, where they lay in separate osteo-fibrous canals, separated from one another by a well-defined fibrous partition, the nerves and vessels which pass into the sole lying on a more superficial plane immediately over the fibrous septum between the muscles. The flexor digitorum fibularis was confined in a groove in the posterior part of the astragalus and passed immediately subjacent to and in contact with the sustentaculum tali of the os calcis, the flexor digitorum tibialis occupying a position anterior to this. In the sole of the foot the two muscles crossed one another, the tendon of the flexor longus tibialis occupying the more superficial position. From the flexor longus tibialis a considerable contribution was given to the flexor brevis digitorum to be presently described, and from the same source the deep flexor tendons were supplied for the second and fifth toes, whilst the deep flexor tendons for the third and fourth digits passed from the flexor digitorum fibularis. Four *lumbricales* existed in connection with these deep flexors. The first lumbrical was attached solely to the tibial side of the tendon of the flexor digitorum tibialis for the second toe. The second and third lumbricals were connected with the tibial side of the tendon of the flexor digitorum fibularis for the third and fourth toes. The fourth lumbrical arose by two heads, one from the tibial side of the flexor digitorum tibialis of the fifth toe, and the other head from the fibular side of the tendon of the flexor digitorum fibularis of the fourth toe.

The *Flexor brevis digitorum* was closely associated in the sole with the tibial and fibular flexors. It was a well-developed muscle, and arose from the inferior and inner aspects of the os calcis by an origin 2 cm. wide. It was inserted into the four outer toes. The tendon for the third toe was the strongest, and received the bulk of the fleshy fibres of the muscle. This tendon split into two portions, which passed to be inserted into the ventral aspect of the middle phalanx at its base, allowing the tendon of the flexor digitorum fibularis to perforate and pass beneath in the usual fashion. The division to the second toe was similar in its relations, but was not as strongly developed. The division for the fourth toe was very delicate, its tendon being very fine and thread-like. This delicate tendon was joined by a well-developed tendon, which was derived from a bundle of fleshy fibres in the sole, having their origin from the flexor digitorum tibialis opposite the inner ankle. The tendon for the fourth toe, being so constituted by fibres derived from the two muscles named, passed on and split to allow the perforating tendon (flexor digitorum fibularis) to pass beneath, and had similar attachments in the fourth toe to those described for the short flexor in the third toe. The tendinous slip for the fifth toe was extremely delicate, and was joined by a slip (which seemed to be wholly tendinous) from the flexor digitorum tibialis of similar character and connections as that described for the fourth toe. It will be observed that the flexor digitorum fibularis gave no tendon for the hallux.

It would appear that the distribution of the flexor digitorum fibularis to the third and fourth toes is very constant, occurring, according to Bischoff, in all apes,[1] and further in all apes save the Orang, according to the same authority, a tendon is given by this muscle to the great toe, but this tendon is extremely weak, excepting in the Gorilla, where Bischoff states that a very strong tendon to the hallux is found.[2] Duvernoy[3] describes and figures the flexor longus hallucis in the Gorilla as giving a very powerful tendon to the great toe, and also supplying the third and fourth toes. The tendon to the hallux fails utterly in the Orang. In Huxley's Gibbon,[4] the flexor digitorum fibularis was distributed to the first, second, third and fourth digits, and the flexor digitorum tibialis was supplied to the fifth digit only.

There can be no doubt that the flexor longus fibularis represents the flexor longus hallucis in man, and the flexor longus tibialis the flexor longus digitorum in man. Dobson[5] has traced the homologies of the long flexor muscles of the foot throughout the mammalia. In the human subject Turner[6] has shown that there is frequent communication in man of the flexor longus hallucis with the flexor tendons of the four outer toes. Thus, in fifty specimens dissected, he found that in eleven cases such a communication existed with the second toe only, in twenty cases, with the second and third toes, and in eighteen, with the second, third and fourth toes, whilst, in one specimen, there was a communication with the four outer toes. Schulze[7] gives somewhat similar results, but has not observed a communication with the fifth toe.

Huxley[8] observed a contribution to the flexor brevis digitorum from the flexor digitorum tibialis in the Gorilla, and in the Orang he also

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1 Loc. cit. 1. p. 232.

2 Loc. cit. 2. p. 50.

3 Loc. cit. p. 112.

4 Loc. cit., Vol. I. p. 648.

5 G. E. Dobson, "On the Homologies of the Long Flexor Muscles of the Feet of Mammalia, with Remarks on the Value of their Leading Modifications in Classification." Journ. of Anat. and Phys., Vol. XVII, 1883, p. 142.

6 Loc. cit., p. 181.

7 Loc. cit., p. 1.

8 Loc. cit., Vol. I, pp. 538, 596.

noted a contribution similar to that I have described above in my Orang. He observed a remarkable deviation from the human type in Cynopithecinæ where the flexor brevis pedis arose partly from the tendon of the plantaris (where this passes over the pulley-like hinder extremity of the calcaneum, to end in the plantar fascia) and partly from the long flexor tendons, so that it completely lost its connection with the os calcis.[1] Again, Turner[2] observed in man that the tendon of the short flexor for the little toe in one case arose from the common flexor tendon previous to the sub-division of that structure. Similar communications between the short and long flexors have been recorded in the apes by Bischoff.[3] Regarding variations in origin in man it may be noted that the flexor brevis sometimes arises from the cuboid bone, the cuneiform bones, or the bases of the metatarsal bones (Testut).

The *Flexor accessorius* (The "*Caro quadrata*" of Sylvius). On the left side of my Orang there was not a vestige of this muscle, whilst on the right side Rudolf found a very thin muscle possessing two heads of origin from the os calcis, and inserted into the tendon of the flexor digitorum tibialis.

Bischoff[4] states that he has never found the accessorius in any anthropoid ape. But Langer,[5] Fick,[6] and Chapman[7] have found it weakly developed in the Orang. Hepburn[8] and Gratiolet and Alix[9] have found it in the Chimpanzee. Huxley[10] found it well developed in the Gorilla; it was also found in that animal by Hepburn and Macalister. As far as I am aware it has not been reported in the Gibbon. It would appear to be absent in most cases in the Gorilla. On the other hand according to Bischoff and Huxley it is present in the lower apes.

It has been suggested that the accessorius is present in young anthropoids but disappears in the old; this view is however not tenable as it has been described as absent in many young animals. Fick points out that in the foot of the Orang an accessorius muscle is not necessary, as the foot is always strongly supinated and the flexor tendons pull in a straight direction and not, as in the foot of man, obliquely. The

1 Loc. cit., Vol. II, p. 40.

2 Loc. cit., p. 186.

3 Loc. cit. 1, 231, and 2, p. 30.

4 Loc. cit. 2, p. 31.

5 Loc. cit., p. 140.

6 Loc. cit. 2, p. 304.

7 Loc. cit., p. 164.

8 Loc. cit., p. 341.

9 Loc. cit., p. 203.

10 Loc. cit., Vol. I, p. 538.

muscle undergoes considerable variation in man. Turner[1] found in two instances that the flexor accessorius had an accessory muscle attached to it which arose from the deep fascia of the back of the leg in its lower third and joined below the inner margin of the flexor accessorius. In some instances this takes the place of the deep flexor tendon in one or other of the digits, the latter tendon for that toe being absent. The number of digits to which it is distributed in man is subject to considerable variation. According to Testut the muscle may be entirely absent in man, but this one would think a rare occurrence.

The *Tibialis posticus* arose from the fibula and the tibia and the interosseous membrane in the upper third of the leg; it was a very definite but ill-developed muscle. The muscle became tendinous at the level of the junction of the middle and lower thirds of the tibia. It then passed over the posterior aspect of the lower extremity of the tibia, lying there in a well-marked groove near the inner margin of the bone and held in place by a strong band of fibrous tissue. It was completely separated from the other tendons at the inner ankle by this band and passed under it into the sole of the foot. The muscle was inserted into the under aspect of the scaphoid bone, a slip passing to the internal, the middle, and the external cuneiform bones, and to the sheath of the peroneus longus tendon. It thus resembles the condition found in man.

The *Plantar fascia* was poorly developed, in fact hardly to be recognized as a definite structure, excepting in the posterior part of the foot. Fick also remarks on the weakness of its development. There was a very dense pad of fat and connective tissue over the heel.

The *Abductor hallucis* arose from the inner and under part of the os calcis, and was inserted into the tibial side of the base of the proximal phalanx. This muscle is well developed in anthropoids and apparently in all apes. In connection with it Langer[2] describes in the Orang a tendon which passes on to be inserted into the terminal phalanx of the great toe. This he compares to the condition found in the hand (see page 548) and considers it the representative of the flexor longus hallucis of man; in the Gorilla he finds this tendon derived from the flexor digitorum fibularis. The muscle as described in our Orang resembles that found in man. On the right side Rudolf found underneath the abductor hallucis a small but very distinct muscle which

1 Loc. cit., p. 184.

2 Loc. cit., p. 192.

arose from the annular ligament and was inserted into the under surface of the internal cuneiform.

The *Flexor brevis hallucis*. The inner head arose from the portion of the tendon of the tibialis posticus which was inserted into the external cuneiform bone and from the sheath of the peroneus longus. It formed a well developed muscle 1.5 cm. wide, and was inserted into the base of the proximal phalanx of the great toe on its under and fibular side.

The outer head (Interosseus primus volaris of Henle) was definitely demonstrated as a structure composed wholly of fleshy fibres .5 cm. wide arising from the base of the fibular portion of the first metatarsal bone and inserted into the outer aspect of the base of the proximal phalanx of the great toe, immediately under the insertion of the adductor obliquus. The outer head of the flexor brevis in anthropoids is weak and tends to unite with the adductor hallucis more or less intimately—thus Bischoff found it in the Gorilla.

The *Opponens hallucis* was well developed. It arose in common with the flexor brevis hallucis, but proceeded separately to its insertion into the whole length of the tibial border of the first metatarsal bone. Rudolf observed on the right foot that the opponens could naturally be split up into three more or less separate and distinct fasciculi or bundles. The opponens hallucis is very variable in its development in apes. Bischoff states[1] that he only found it as a separate muscle in the Orang among anthropoids and in Macacus among lower apes. Huxley[2] discovered it in the Orang, and speaks of it as "a most remarkable muscle." At the time he writes (1864), he remarks that "this has not been described by other authors nor indeed is there any trustworthy evidence of the existence of such a muscle in any of the mammalia." Macalister, however,[3] subsequently found an opponens hallucis in the Gorilla although others have failed to find it in any of the anthropoid apes save the Orang. Brooks[4] records that whilst it is absent in all anthropoids (with the exception of the Orang) some of the fibres of the adductor transversus (and sometimes also of the adductor obliquus) in anthropoids are inserted into the metatarsal bone of the hallux and constitute a "second opponens" corresponding to the "adductor opponens" described by Bischoff and Langer in the hand of the Orang. (See page 550.)

1 Loc. cit. 2, p. 235.
2 Loc. cit., Vol. I, p. 596.
3 Loc. cit., p. 506.
4 Loc. cit., p. 90.

The opponens hallucis is not always present in the Orang, and often times it is extremely weak. *Testut states that an opponens is sometimes found in man.* "On trouve quelquefois, au-dessous de lui (*i.e.*, brevis hallucis), quelques fibres profondes, insérées sur le metatarsien et constituant un veritable *opposant du gros orteil*, homologue de l'opposant du pouce ; mais ce muscle est rarement bien différencié."[1]

The *Adductor obliquus hallucis* and the *Adductor transversus hallucis* had a continuous origin from the bases of the third, fourth and fifth metatarsal bones, from the fascia over the interossei muscles, from the sheath of the peroneus longus and from a fibrous arch extending from the base of the fifth metatarsal to the middle of the second metatarsal bone. These muscles are inserted into the whole of the fibular and the greater part of the plantar aspect of the base of the proximal phalanx. The transverse and oblique muscles could be readily separated from one another, and a third portion was defined which had an insertion into the lower border of the first metatarsal bone. This, no doubt, represented the "second opponens" described by Brooks as derived from the adductor obliquus.

Fick[2] holds that the main function of the adductor hallucis in the Orang is opposition and not adduction. Brooks[3] describes in the Orang a portion of the adductor obliquus (inseparable at its origin from the rest of that muscle), which ended in a rounded tendon and which passed between the two heads of the flexor brevis, and running along in a well marked sheath in the middle line of the digit, was inserted into the base of the ungual phalanx. It took the place of the absent long flexor tendon. This may be compared with the description of similar conditions found in the hand of anthropoids and already noted (p. 548). A somewhat similar tendon is described by Gratiolet and Alix[4] in the Chimpanzee and the Orang ; the muscle arose along with the adductor transversus, and, passing over the proximal phalanx, was inserted into the base of the last phalanx. It was looked upon by these authors as representing the long flexor. Bischoff found in the Frankfort Orang on the left side a small tendon which in course and insertion corresponded to the flexor longus hallucis, but it arose from the fascia over the ball of the great toe.[5]

The tendency for intimate connection of the adductor hallucis with

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1 Loc. cit., Vol. I., Pt. 2, p. 882.

2 Loc. cit. 1, p. 47

3 Loc. cit., p. 87.

4 Loc. cit., p. 102.

5 Loc. cit. 1, p. 234.

the outer head of the flexor brevis has already been alluded to. Regarding the development of the transverse and the oblique adductor. Bischoff states that in the Gorilla, the Orang, Cynocephalus and Cercopithecia, both muscles are strongly developed and are separate from one another, whilst in the Chimpanzee, Gibbon, Pithecia and Hapale they are both present but united. In Macacus they are both present but weak.

The *Abductor minimi digiti* arose from the under aspect of the os calcis by two heads, one from the inner and one from the outer aspect of the bone, the inner head passing on the deep aspect of the flexor brevis digitorum. The muscle is also intimately united to the tendon of the peroneus brevis in the sole, from which it may be said to have an additional origin. This muscle terminated in a long tendinous structure which was inserted with the dorsal extensor expansion over the base of the proximal phalanx, and was attached also to the outer aspect of the proximal phalanx.

The *Abductor ossis metacarpi quinti* referred to on page 514, is closely associated with the abductor minimi digiti. It arose from the under aspect of the os calcis in common with the outer part of the flexor brevis digitorum and immediately overlying the inner head of the abductor minimi digiti. This structure is almost wholly tendinous in character. It was inserted into the outer and under aspect of the base of the fifth metatarsal bone.

The *Flexor brevis minimi digiti* arose from the base of the fifth metatarsal bone, and was inserted into the outer aspect of the base of the proximal phalanx. Rudolf on the right side found a slip of origin from the cuboid.

The *Opponens minimi digiti* arose from the sheath of the peroneus longus, and was inserted into the whole length of the fifth metatarsal bone along its outer aspect. The muscle was not found by Fick in the Orang. Bischoff[1] found it in the Gorilla.

The *Interossei* correspond in their detailed description to those of the hand. The third digit possessed two dorsal interossei lying in the interosseous spaces between the second and third and the third and fourth metatarsal bones. They arose from the dorsal surface and lateral margins of the two adjacent metatarsals; but, in addition, each is joined by a fleshy belly arising from the plantar and lateral aspects of the third metatarsal bone, the fleshy bellies of the two muscles meeting in the plantar aspect of the bone. Thus the third metatarsal bone is com-

1 Loc. cit. 2, p. 32.

pletely surrounded by the second and third dorsal interossei, with the exception of a narrow strip in the middle line on the dorsal aspect of the bone which is free from muscular fibres.

The fourth dorsal interosseous muscle arose in a similar fashion from the fourth and fifth metatarsal bones, but the third plantar interosseous takes the place of the plantar part of the fourth dorsal interosseous on the inner and plantar surfaces of the fifth metatarsal bone. The plantar portion of the second dorsal interosseous muscle is, in like manner, replaced by the first plantar interosseous on the second digit. The plantar portion of the third dorsal interosseous muscle is in like manner replaced by the second plantar interosseous muscle in relation to the fourth digit.

The first dorsal interosseous muscle is very powerfully developed. Its origin from the first metatarsal bone, however, is confined to the base of the bone. Some slips of origin from the internal cuneiform also join this head. The outer head of this muscle has an extensive origin from the second metatarsal bone, completely covering that bone, in fact, on its inner surface, and extending to the middle line on its plantar and dorsal surfaces, meeting on the plantar surface with the first plantar interosseous. Between the two heads of this muscle the dorsal vessels pass to the dorsum of the foot.

Fick[1] describes the interossei in the Orang as like those found in man. In both man and apes one finds that one digit in both hand and foot possesses an insertion of two dorsal interossei, whilst the remaining digits possess only one dorsal interosseous muscle. In man it is the third digit in the hand, and the second digit in the foot; whilst, in my Orang, it was the third digit in both hand and foot. In this respect, the foot of my Orang corresponded to the hand of either ape or man, and differed from the foot of man. Abduction or adduction in the foot of my Orang was from or to the third digit. Bischoff, in his first paper, asserts[2] that in all apes the arrangement of the interossei of the foot corresponds to the hand of man and apes; but, subsequently,[3] he found in the Gorilla an arrangement corresponding to the foot of man. Hepburn[4] found that abduction of the digits of the foot was from a line drawn through the second digit in the Gorilla and Chimpanzee, whilst in the Orang and Gibbon it was from a line through the third digit, as in my Orang.

1 Loc. cit. 1, p. 47.
2 Loc. cit. 1, p. 235.
3 Loc. cit. 2. p. 32.
4 Loc. cit., p. 347.

Gratiolet and Alix[1] differed from Hepburn regarding the Chimpanzee, as they found abduction was from a line drawn through the third digit. Thus, there is apparently some variation among the anthropoid apes, but the most common arrangement is abduction from a line through the third digit, and this, as far as my observation has extended, has always been found to be the case in the Orang, excepting in Fick's example mentioned above.

Attention has already been directed to the fact that the foot of the Orang resembles, in outward appearance, the human hand rather than the human foot. This observation led naturalists to apply the term "quadrumanous" to those apes possessing such characteristics. The external characters of the foot of the Orang certainly suggest a hand rather than a foot. Further, the foot of the Orang differs very materially in its external characters from that of man (compare the photographs of the hand and foot of man with those of the Orang). In considering the question as to whether the posterior extremity of the Orang possesses a hand or a foot, we must constantly have in mind the characteristic features of the human hand and the human foot with which to institute comparisons. It is not necessary to discuss at length the correspondences which are found in comparing the hand with the foot, but certain of the more obvious of these may be alluded to, and one is greatly aided in thus establishing homologies in man by reference to the lower animals. In the hand we have five digits as in the foot, and we find that the bones of the fingers and toes, *i.e.*, the metatarsals and metacarpals, with the phalanges, correspond in number, and have sufficient individual resemblances to make it an easy task to recognize those bones of the hand which correspond to similar ones in the foot. The carpal and tarsal bones are not so readily distinguished, but by referring both series of bones to a less specialized type of carpus and tarsus, one is able to establish very readily a series of probable homologies. The carpus or tarsus of the water tortoise has been suggested by Gegenbaur and Oscar Schmidt[2] for this purpose, and by referring the bones of the foot and hand to this simple form, we can determine the corresponding structures. In the following table, taken from Quain's Anatomy,[3] an attempt is made to establish these homologies. The "typical names" here employed refer to the bones in the carpus or tarsus of such a generalized form as the water tortoise:—

1 Loc. cit., p. 190.

2 Oscar Schmidt. "The Mammalia in their Relation to Primeval Times." London, 1895. p. 56.

3 Vol. II. Part I. p. 144.

TABLE OF THE HOMOLOGOUS BONES OF THE CARPUS AND TARSUS

Carpus.	*Typical Names.*		*Tarsus.*
Pyramidal	Ulnare	Fibulare	Os calcis
Pisiform	Ulnare sesamoideum(?)	Fibulare sesamoideum(?)	Os calcis
Lunar	Intermedium	Intermedium	Astragulus
Scaphoid	Radiale	Tibiale	Astragulus
Scaphoid	Radiale sesamoideum (?)	Tibiale sesamoideum (?)	*Navicular*
Scaphoid	Centrale	Centrale	*Navicular*
Trapezium	Carpale 1	Tarsale 1	Internal cuneiform
Trapezoid	Carpale 2	Tarsale 2	*Middle cuneiform*
Magnum	Carpale 3	Tarsale 3	External cuneiform
Unciform	Carpale 4	Tarsale 4	Cuboid
Unciform	Carpale 5	Tarsale 5	Cuboid

Thus it would appear that in the skeleton we have corresponding elements to deal with when we compare the hand with the foot. Again in connection with the soft parts it is quite obvious that many muscles in the foot are represented by corresponding structures in the hand. There is, however, room for considerable difference of opinion regarding homologies here, and whilst we are unable to go into this subject at length in this paper, we may consider it briefly.

Broadly speaking, the flexor group of muscles in the leg may be regarded as homologues of the flexor group in the forearm, and the extensors of the leg as homologues of the extensors of the forearm. Huxley[1] suggested, with apparently good reason, that the popliteus of the leg arising from the external condyle of the femur corresponded to the pronator radii teres arising from the internal humeral condyle; the fact that the external femoral condyle is the homologue of the internal humeral condyle being readily established by tracing the difference in direction of the rotation of the limbs in development. We find that pronation and supination are movements not possible in the leg, although Bischoff[2] considers the peroneus longus and brevis to be pronators of the foot by raising its outer margin. He is therefore inclined to regard these muscles as performing similar functions to the pronators of the forearm in their action upon the hand; similarly he would regard the tibialis anticus as a supinator in the foot. These muscles, however, (*peronei* and tibialis anticus), have as homologues in the forearm, according to Bischoff, the extensor carpi ulnaris and the two radial extensors, but these fail to raise the inner or outer margin of the hand as this movement is accomplished by pronation and supination of the hand as a whole. Bischoff would have us believe that whilst it is possible to establish

1 Loc. cit., Vol. I, p. 203.

2 Loc. cit. 1, p. 236-7.

analogues and homologues for other muscles, the movements of pronation and supination in the forearm must be regarded as being performed by muscles which have no homologues in the leg. The suggestion of Melzer (see p. 567 of this paper), deserves mention in this connection. He regards the humeral head of the pronator radii teres as being represented by the external head of the gastrocnemius, whilst the ulnar head, he claims, is represented by the popliteus. I, however, accept Huxley's view as the correct one and look upon the pronator radii teres of the forearm as the homologue of the popliteus in the leg. Melzer's view is not tenable; there is good reason to look upon the gastrocnemius muscle as representing the flexor carpi radialis and the flexor carpi ulnaris of the forearm.

Huxley[1] asserts that the foot of man is distinguished from his hand by the following absolute anatomical differences:

1. By the arrangement of the tarsal bones.
2. By having a short flexor and a short extensor muscle of the digits.
3. By possessing the muscle termed peroneus longus.

Bischoff[2] questions the correctness of Huxley's assertion. He considers that both peronei muscles together form a muscle which has become doubled in the foot and represents, as we have stated, the single extensor carpi ulnaris in the hand. In similar fashion he considers that the single muscle which we describe as the tibialis anticus in the foot is doubled in the hand, being there represented by the extensores carpi radialis longior et brevior. Huxley, however, has shown conclusively that the tibialis anticus corresponds to the extensor ossis metacarpi pollicis (abductor longus pollicis). There can be no doubt of this; the former is inserted into the first metatarsal bone and the internal cuneiform, whilst the latter is inserted into the first metacarpal bone and the trapezium.

The distinctive difference which Huxley claims for the foot in possessing the short extensor and the short flexor is denied by Bischoff, who concludes that if we contrast these muscles with the tendons which we describe under the terms "perforans" and "perforatus" in the hand, we shall find homologous structures, but we may go further, and we find it easy to produce evidence to lead us to the

1 Huxley, "Evidences as to Man's Place in Nature," New York. 1890, p. 107.

2 Loc. cit. 1, p. 256-7.

conclusion that the flexor sublimis digitorum of the hand has as its homologue in the foot the flexor brevis digitorum and the soleus, the latter muscle having been separated from the former by the growth backwards of the os calcis. Again in the case of the extensor brevis digitorum pedis we have in the hand as homologous structures the extensor minimi digiti and the extensor indicis. Huxley himself[1] in discussing these two muscles in the Orang, called attention to the fact that in many of the lower mammalia the normal arrangement is to have a superficial and a deep extensor supplied to every digit. This arrangement is approached when we find, as in my Orang, the extensor minimi digiti passing to the fourth and fifth digits, and the extensor indicis passing to the second and third digits. In the dissecting room of the University of Toronto, I found, in the human subject, an extensor indicis for the second digit, and an extensor minimi digiti for the fifth digit, whilst a very well developed muscular slip (1 cm. wide), arose from the ligaments over the back of the carpus, and proceeding over the dorsum of the middle finger beneath the tendon of the common extensor, it split at the head of the metacarpal bone and blended with the extensor expansion on the dorsum of the proximal phalanx. This was a true extensor brevis occurring in the hand of man.

The supinators (longus and brevis) do not appear to have any representatives in the lower limbs, nor do the two radial extensors. So, too we have structures in the foot not represented in the hand, of which the flexor accessorius is an example. One has observed the fact that the foot of the ape frequently differs from the foot of man in that the accessorius is often absent in the former. It is usually absent in anthropoids (although present on the right side of my Orang): it is present however in the lower apes. Bischoff[2] points out that in man it corrects the direction of the action of the flexor digitorum longus communis, otherwise the direction of the pull of the long flexor would be at an angle. In the foot of the ape this is of no importance, on the contrary the action of the flexor tendons in adducting the other toes to the great toe is of great service in seizing or grasping. The toes of the apes in their flexor arrangements would thus resemble fingers much more than toes.

Although difficulties arise in the attempt to establish homologies yet on the whole it would appear that a remarkable correspondence is obvious when we compare the musculature of the forearm with that of the leg. This is further evidenced in a most remarkable manner if we

1 Loc. cit., Vol. I, p. 596.

2 Loc. cit. 1, p. 257.

direct our attention to the muscles which Cunningham has called the "intrinsic muscles of the foot" when compared with a similar group of muscles in the hand. We find that homologies are best established here by referring the muscles of the hand or foot in man to a more generalized type and through the arrangement there found we may institute comparisons and establish homologies. Cunningham has done this for us in his work upon the marsupials.

One is aided greatly in appreciating the morphological significance of these muscles by reference to the conditions obtaining in the foot and hand of apes and mammals lower in the scale. Reviewing briefly Cunningham's observations on the subject we may first of all state that Cunningham[1] excludes from the intrinsic group those muscles which in man, or as homologous structures in other animals, take origin beyond the limits of the foot, and in the human foot he gives the following list of intrinsic muscles :

a. The four short muscles of the Great Toe.	1. Flexor brevis hallucis. 2. Abductor hallucis. 3. Adductor hallucis (adductor obliquus.) 4. Transversalis pedis (adductor transversus.)
b. The short muscles of the little toe......	1. Flexor brevis minimi digiti. 2. Abductor minimi digiti. 3. The occasional opponens minimi digiti. 4. The occasional abductor ossis metatarsi minimi digiti.
c. The Interossei..	1. Four dorsal. 2. Three plantar.

In establishing homologies here, we must not place too much importance upon nerve supply as an aid to correct conclusions. Thus Cunningham joins issue with Ruge of Heidelberg, who regarded a muscle as the end organ of a nerve, and that, therefore, when a muscle altered its position and connections, its origin and typical relations can always be identified by its nerve supply. Cunningham admits that nerve supply is a most valuable aid to one's endeavours to discover the history of a muscle, but that it is an infallible guide is contrary to fact. In this connection Cunningham observes[2] that wherever two nerves approach one another and reach the confines of their distribution there is a tendency to variation in nerve supply. He quotes Brooks' results as to his investigation regarding the variation in nerve supply of the flexor brevis pollicis in man, thus—

1 Loc. cit., (Marsupial Report), p. 48.

2 Cunningham, "The Flexor Brevis Pollicis and the Flexor Brevis Hallucis in Man." Anatomischer Anzeiger VII, 1892, p. 206.

Outer head supplied by the deep branch of ulnar alone	5 cases.
" " " twigs from ulnar and median	19 "
" " " median, inner by the ulnar	5 "
Median nerve, giving twigs to both heads, inner head also receiving an ulnar supply	2 "

In a careful study of the muscles of the feet of certain of the marsupials, Cunningham demonstrates three layers, and concludes that this trilaminar arrangement is the typical one for the intrinsic muscles of the foot and the hand.

1. A layer of adductores.

2. An intermediate layer of flexores breves.

3. A dorsal layer of abductores.

Young[1] has also investigated the intrinsic muscles in the foot and hand of marsupials and agrees with Cunningham in his observations on the trilaminar arrangement; he extended his observations to other members of the group than those dissected by Cunningham.

Cunningham explains that deviation from this trilaminar arrangement may occur by subdivision, fusion or suppression of members of one or other of the layers. The suppression may be complete or partial and the muscle may be represented by ligaments.

In transferring our attention to the conditions obtaining in the ape we can readily determine the trilaminar arrangement and we observe that either the muscle group in the hand or that in the foot corresponds to this typical arrangement. Thus by reference to Plate 3 one can readily distinguish the three layers in the hand of my Orang.

1. Fig. 5 shows the muscles of the palmar layer composed of the adductor muscles of the thumb.

2. Fig. 6 demonstrates certain of the flexores breves of the intermediate layer.

3. Fig. 7 shows the dorsal layer of the abductores.

As I have already stated, so far as the so-called "interossei" are concerned, the condition found in the foot of my Orang corresponded to that found in the hand in every particular, and in plate V is illustrated the arrangement of these muscles in either foot or hand.

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1 A. H. Young. "The Intrinsic Muscles of the Marsupial Hand." Journ. of Anat. and Phys. Vol. XIV, 1879, p. 149.

The dorsal layer of muscles is represented by a full series; the four dorsal interossei and with them the abductor pollicis and the abductor minimi digiti. It is interesting here to note the suggestion that the abductor of the thumb and the little finger each arise from marginal structures which have been looked upon as possibly præpollex and postminimus rudiments, viz., the ridge (or margin) of the trapezium and the pisiform bone. From this standpoint they have been regarded as interossei muscles which have persisted after the suppression of the osseous elements of the additional digits. I have already noted the relation of the extensor ossis metacarpi pollicis to the præpollex, and in this connection one may note an interesting variation of that muscle which I found in the dissecting room of the University of Toronto. The extensor ossis metacarpi pollicis split into two distinct tendons at a point 5 cm. above the wrist joint; one tendon was inserted into the base of the metacarpal bone in its palmar aspect, and the other passed on to join the abductor pollicis and could be traced as a distinct tendon extending 2 cm. along the deep aspect of that muscle, where it blended with its muscular fibres.

We have thus in the hand the following muscles in the *dorsal layer*.

1. Abductor pollicis.
2. Abductor minimi digiti.
3. The Dorsal interossei.

In the foot Cunningham adds a fourth muscle occasionally present, a rudiment of which I have described in my Orang, viz.:

4. The occasional Abductor ossis metatarsi minimi digiti.

The second layer of muscles, the intermediate layer, is made up of those muscles which Cunningham has termed the Flexores breves in the marsupials. These in man, as in the Orang, include the plantar interossei and the short flexors of the thumb and of the little finger. Cunningham[1] at first was inclined to place the plantar interossei in the plantar group of adductors, but he subsequently placed them in the intermediate layer for the following reasons:

1. In quadrumana he has traced the gradual disappearance of the adductor muscles except those belonging to the great toe.

2. We find plantar interossei not only in those apes which have

1 D. J. Cunningham. "The Intrinsic Muscles of Thylacine, Cuscus and Phascogale." Journ. Anat. and Phys., Vol. XII, 1878, p. 434.

complete adducting apparatus (*e.g.*, Cynocephalus) but also in those in which it is only represented by the adductors of the hallux and by fibrous bands (*e.g.* Orang) and in those in which it is reduced to the adductors of the great toe only (*e.g.* Gorilla.)

3. Ruge has pointed out that the deep division of the external plantar nerve, as it runs inwards across the sole is placed between the adductor muscles and the other muscles of the intrinsic group. This is a most useful, and, as a general rule, a most reliable guide in determining the muscles which belong to the plantar layer. Ruge[1] points out that in mammals the deep division of the external plantar passes inwards between the interossei and the contrahentes (adductors). In man this nerve passes between the plantar interossei beneath and the adductor obliquus hallucis above, and this Cunningham looks upon as most suggestive.

4. In a foot dissected by Cunningham he found a distinct fleshy slip proceeding from the outer edge of the adductor obliquus hallucis to be inserted into the outer side of the base of the first phalanx of the index This clearly represented the adductor indicis.

Cunningham would therefore place in the intermediate layer the following muscles:

1. Flexor brevis pollicis, deep and superficial heads.
2. Flexor brevis minimi digiti.
3. Plantar interossei.

In studying the interossei group (palmar and dorsal), as found in my Orang, and figured in Plate V, it appears to be a question worth considering as to the relation of the palmar portion of the dorsal interossei to the intermediate layer. On reference to the dissection (as figured in plate V), one cannot but be struck by the symmetrical arrangement of the palmar interossei and the palmar portion of the dorsal interossei as forming one group of flexores breves, and the origin of the palmar interossei may yet be accounted for by subdivision of originally single muscles, or we may suppose that fusion has occurred to produce the connection of the palmar portion with the remaining part of the dorsal interossei. In other words one would venture to suggest that the intermediate layer is represented in the Orang by the palmar interossei

1 G. Ruge. "Zur vergleichenden Anatomie der tiefen Muskeln in der Fussole." Morphologisches Jahrbuch. Vol. IV, 1878, p. 644.

plus the palmar portion of the dorsal interossei, and the short flexors of the thumb and little finger.

The flexor brevis of the first digit is represented by two heads, of which the deep head might otherwise be described as one of the palmar or plantar interossei, the interosseus primus volaris of Henle. This muscle resembling in its attachments and relations the other muscles of the plantar interosseous group, belongs to the intermediate layer.

The common origin of all these muscles of the interosseous group is indicated by Huxley[1] who states that amongst the Platyrrhini the interossei are no longer visible from the dorsum of the foot, but, as in the lower mammals, are altogether flexores breves inserted by sesamoid bones into the bases of the first phalanges. This resembles the condition described by Ruge in the human foetus (vide infra).

We have still left for consideration a series of muscles representing the adductor group. In the Orang, as in man, these are reduced to the adductors for the first digit. Thus we have in the hand the adductor obliquus pollicis and the adductor transversus pollicis. These represent a more extensive series found in marsupials in the plantar layer as adductors of the second, fourth and fifth digits. In the Chimpanzee and Gibbon there are two adductors, viz., for the first and fifth digits, whilst in the Orang and Gorilla the adductor for the first digit alone remains.

Thus in man and in the orang we have, in the palmar layer, the adductors of the thumb (obliquus and transversus),

Adductor obliquus pollicis.

Adductor transversus pollicis.

The only short muscles of the first and fifth digits, which we have not accounted for, are of the opponens group. In my Orang we found an opponens for the first and fifth digits in both hand and foot. These Cunningham considers as developed most commonly from the flexores breves group.

Our complete classification would therefore be:

Dorsal layer.

1. Abductor pollicis.

2. Abductor minimi digiti.

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1 Loc. cit., Vol. II, p. 94.

3. Dorsal interossei.

and in the foot occasionally

4. Abductor ossis metatarsi minimi digiti.

Intermediate layer.

1. Flexor brevis pollicis { deep head. / superficial head.

2. Flexor brevis minimi digiti.

3. Plantar interossei.

4. Opponens.

Palmar layer.

Adductor Pollicis { obliquus. / transversus.

We can now readily establish homologies for the hand and foot, and we may construct a table thus :

Flexor brevis pollicis	Flexor brevis hallucis
(*a*) Radial head	(*a*) Tibial head
(*b*) Ulnar head	(*b*) Fibular head
Flexor brevis minimi digiti...........	Flexor brevis minimi digiti
Abductor pollicis	Abductor hallucis
Abductor minimi digiti.....	Abductor minimi digiti
Opponens pollicis	*Opponens hallucis*
Opponens minimi digiti	Opponens minimi digiti
Adductor obliquus pollicis...........	Adductor obliquus hallucis
Adductor transversus pollicis.........	Adductor transversus hallucis
Interossei (Palmar and Dorsal).......	Interossei (Plantar and Dorsal).

Homologies are thus established for the limb muscles, as has been done also for the skeletal parts; one may add that an attempt is also made to establish homologies for the nerves (*vide* Quain, Vol. III., Pt 3, p. 384). We shall not, however, attempt to discuss the homologies of the nerves in this paper. Whilst we can thus establish homologies between the structural elements of the hand and foot, we yet observe certain anatomical differences due, we consider, to modification from a common type of origin. The foot of man is modified as an organ for support, whilst the hand of man, in the erect attitude of the individual, is left free to minister to his varied needs. There can be little doubt concerning the correctness of the view that these two extremities are derived from a common type and that the differences observable between the hand and the foot are due to modification resulting in departure from the original typical form, these modifications being due to a specialization of function—one holds this view despite the fact that Bischoff comes to the conclusion that both anatomically and physiologically the so-called posterior hand of the ape possesses more agreement with the human hand than with the human foot.

No doubt certain conditions in the ape's foot resemble the conditions present in the hand, and differ from those of the human foot. The adductor transversus hallucis in the ape's foot tends to blend with the adductor obliquus and is much more strongly developed than in the human foot. In this particular the muscle in the ape's foot approaches that found in the hand of man and differs from the human foot. In my Orang I found an opponens hallucis; this muscle is not always found in anthropoids, but appears to be peculiar to the Orang, and among lower apes it is found in Macacus. This is a characteristic muscle of the hand and is not found in the human foot. Among apes there is a frequent approach to the hand (as in my Orang), in the arrangement of the interossei, whereby abduction is secured from the third digit and not from the second. Huxley[1] admits that the foot of the Orang deviates very greatly from that of man. The great length of the phalangeal portion of the foot is very noticeable, and the narrow os calcis with an absence of the two tubercles which are present in man. There is great mobility between the carpal bones; the phalanges are greatly curved. The hallux is remarkably short, and is capable of extreme abduction from the other digits, whilst opposition is also possible to a complete degree. In connection with the movableness of the great toe in apes one is struck by the peculiarity of the shape of the articulation between the first metatarsal bone and the internal cuneiform. The articular surfaces are saddle-shaped, and thus provide for greater freedom of movement. This differs from the foot of man where the surfaces are flat and is in agreement with the hand of man where the characteristic saddle-shaped joint is found between the trapezium and the first metacarpal. This condition in the ape was described by Huxley in the Chimpanzee's foot, and it was also noted by Huxley that, in the hand, the trapezium in that animal presented a simple, oval, convex facet, and was no longer saddle-shaped.[2] In the lower apes, however, Huxley found the characteristic saddle shape of the trapezium.[3] Fick describes this joint of the first digit as being saddle-shaped in both foot and hand in the Orang;[4] Bis-

1 Loc. cit., Vol. I, p. 564.

2 Loc. cit., Vol. I, p. 428.

3 Loc. cit., Vol. I, p. 671.

4 Loc. cit. 1, p. 50.

choff in the Gibbon, however, describes a hollowed out socket in the trapezium for the head of the metacarpal bone, but says the joint was not a true saddle-shaped articulation.

The flexor accessorius is a characteristic feature in the human foot. We have already noted the fact that it is very frequently absent, and always ill-developed in the anthropoid apes. When we consider that its development is almost universal among the lower apes, it is not to be looked upon as an essential difference between man and apes; when absent, however, the inferior extremity of the anthropoid ape rather resembles the hand of man than his foot.

The strong well developed flexor longus hallucis is a characteristic feature of the human foot not found in apes. The Gorilla is an exception to this statement, as Bischoff and Duvernoy found a well developed strong tendon for the great toe in that animal. In the Orang the flexor longus hallucis gives no tendon to the great toe, whilst in other apes its distribution is mainly to the third and fourth toes, with usually a very weak slip for the hallux.

Whilst the ape's foot thus differs from the foot of man, it is also quite obvious that the hand also differs in a marked degree from the human hand. Compare (see photograph) the long thin hand of the ape with that of man, and note particularly the rudimentary thumb. The thumb is extremely rudimentary and ill-developed. It becomes still more so in the new world monkeys, according to Huxley[1]; in Ateles it is apparently functionless, although all its muscles (abductor, adductor, flexor brevis and opponens) are present, except the long flexor. In the *Arctopithecini* (marmosets) Huxley[2] says it can no longer be called a thumb; the digit lies on the same plane as the other digits and is not in the least degree opposable—this might be called a paw rather than a hand—whilst such is the case, the hallux, which is very small, is still slightly opposable in this animal.

The absence of a flexor longus pollicis, so strongly developed in man, is obviously a very marked and essential difference observable in comparing the hand of the ape. Again we have noted the absence of the characteristic saddle-shaped articular surface in the joint between the first metacarpal and the trapezium.

A fact of some interest regarding the comparisons which may be

1 Huxley, "Manual of Anatomy of Vertebrated Animals," New York, 1872, p. 396.

2 Loc. cit., Vol. II, p. 124.

established between the ape and man is one to which we have already called attention, namely, that in the human fœtus we find correspondences more marked than they are when the adult man is compared with the ape. Cunningham mentions Ruge's work in the following reference.[1] "Ruge in his memoir upon the development of the muscles of the human foot shows that the interossei muscles in the foot of the early embryo are plantar in position, and that the upward growth of the dorsal interossei and the formation of the interosseous spaces takes place as a subsequent and gradual step. In three of the diagrams which illustrate the text he gives representations by sections through the metatarsus at three different periods of development. In the first the metatarsal bones, with the exception of the first two, are in close apposition, and in consequence, all the interosseous muscles, excepting the first dorsal, are plantar in position. The second diagram is from a foot somewhat more advanced. It shows that as development progresses the metatarsal bones separate from each other, and that simultaneously with this the dorsal interossei begin to shoot up between them like wedges. The third illustration gives a view of the relative position of the muscles and metatarsal bones, as they are to be seen in the adult. The bones are widely apart from each other, and the muscles have reached the dorsum of the foot."

The transverse section (Plate IV, fig. 4), illustrates the fact that the interossei muscles are more plantar (palmar) than dorsal in my Orang; this condition is exaggerated in the lower apes where, as we have already stated, Huxley found among the Platyrrhini the interossei of the foot were no longer visible from the dorsum but existed as flexores breves towards the plantar surface. In the dog the metatarsals are closely compressed, and the interossei wholly plantar.

In the human fœtus the great toe is separated from the other toes and the position of the foot is that of "varus," resembling somewhat that found persistent in the ape. We find that this fact is alluded to by Flower,[2] who, in referring to the principal difference between the foot of the ape and the foot of man, emphasises the fact that in the ape the foot is converted into a more or less modified grasping organ. He directs attention to the effect produced upon the ape's foot in consequence of the fact that the articular surface of the internal cuneiform for the hallux is saddle-shaped, and is directed obliquely towards the inner or tibial side

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1 Quotation from Cunningham's Challenger Report, p. 138-9.

2 Loc. cit., p. 341.

of the foot. The consequence is that the hallux is not only separated from the other digits, but it is also set in a different plane, so that when it is flexed it turns towards the sole of the foot and becomes opposed to the others much as the thumb does in the hand. Flower (and others, *e.g.*, Fick) remarks that the terminal phalanx of the hallux is often wanting. Fick attributes this to ill-usage. Flower points out that the proportions of the three segments of the foot in the anthropoid ape are the exact reverse of those in man. In the ape the tarsal segment is the shortest and the phalangeal the longest; the reverse is true of man.

The result of our study is to bring us to the conclusion that whether we study the extremities of man or of the Orang we find corresponding structures in the upper extremity as compared with the lower. A common type of origin is clearly indicated. This is the more readily observed in the ape than in man where the highest degree of specialization of function has been reached. As a result of this we find greater differences exist between the human hand and the human foot, than between the hand and the foot of the ape. Moreover, in man there is a greater departure from the common type of origin in both hand and foot. Bischoff has investigated the subject of homologies, and although his conclusions differ in some details from the views expressed in this paper, he agrees in the main and establishes homologies for the hand and foot of man as in the hand and foot of apes. He further admits that certain correspondences exist between the foot of the ape and the foot of man. Following Bischoff's argument to a logical conclusion (as Fick observed[1]) we would be forced to conclude that man, like the ape, had four arms and four hands. Bischoff, however, views the matter not wholly from the morphological side, but from the physiological, and, looking upon the ape's foot as a grasping organ, he considers this strong evidence for the assertion that it is a hand. He admits that this alone is not sufficient evidence; on similar ground he says one might call the trunk of an elephant a hand, but there are obviously other similarities in the ape's foot to a hand, chiefly the short, movable, opposable hallux, differing from the first digit of the human foot, possessing the saddle joint with the internal cuneiform and thus resembling the human thumb. Whilst one cannot longer uphold in its entirety Huxley's assertion regarding the absolute anatomical differences in distinguishing the foot of man from his hand (see page 579), yet in the skeletal parts his argument regarding the arrangement of the tarsal bones is unanswerable and we are forced to conclude with him that the so-called hind hand of the ape is essentially a foot. The method of articulation of the foot with

1 Loc. cit. 1, p. 53.

the leg at the ankle joint is characteristic of the foot and not of the hand. There is also an absence of pronation and supination in the ape's foot. Langer[1] admits the resemblance of the ape's foot to a hand, but also points out the obvious fact that the anterior extremity of the Orang is as far removed from the human hand as the posterior extremity is from the human foot. Both extremities are wholly organized for holding and grasping in the ape, and Langer would have us look upon the posterior extremity as a holding or grasping foot. Huxley, it is true, argues the matter wholly from the morphological standpoint, and Fick[2] agrees with Huxley that the feet of man and apes are essentially alike in all variety of anatomical detail. But certain differences (non-essential) undoubtedly exist. The absence of a true arch and the fact that the Orang walks upon the outer margin of the foot with the digits flexed like a closed fist. In man the toes are, comparatively, very short, and as Turner points out, the great toe is fastened to the second digit by a strong ligament. The fixation of the great toe, however, may be greatly decreased in man as is evidenced in those individuals who have congenital absence of the arm; they are capable of doing many things with the toes, impossible on the part of an ordinary individual. By training, an armless painter, according to Fick, was able to copy Rubens' pictures, and one knows of the possibility of individuals writing, playing the violin, and doing a variety of things. Thus, when necessary, man is capable of using his foot for a number of purposes and to accomplish work ordinarily relegated to the hands. In the struggle for existence, similarly, the ape has developed great dexterity in the use of his foot, but it still remains a foot. Fick tells us that in the living ape there is an obvious difference in the manner in which he uses the upper and lower extremities. In walking, running and springing forwards from the hind legs the arms are scarcely burdened, but the hands are always ready to grasp an object such as fruit, and to do all finer work, such as the breaking open of fruit, seeking vermin, etc., the legs and feet being used for support and in running.

It was Tyson,[3] two centuries ago, who, struck by the great external resemblance of its hinder limb with its opposable thumb to a hand, remarked that the animals might be called "quadru-manus." Referring to the foot of the Chimpanzee which he dissected, he remarks as follows: —"But this part, in the formation and its function too, being liker a hand, than a foot, for the distinguishing this sort of animals from others,

[1] Loc. cit., p. 193.
[2] Loc. cit. 1, p. 53.
[3] Loc. cit., p. 13.

I have thought, whether it might not be reckoned and called rather quadru-manus than quadrupes, *i.e.*, a four-handed, than a four-footed animal." Huxley remarks that if we are to settle the question on the grasping power of the organ we must consider the terminal division of the hind limb of a bird or an oppossum to be equally a hand with that of the monkey. Huxley, however, holds that morphological analogies cannot be decided by physiological function, but only by exact comparison of the essential anatomical characters. An attempt has been made in this paper to show, with due regard to both structure and function, that the ape must be considered as possessing two feet and two hands; that the posterior extremities of the creature terminate in structures resembling both anatomically and physiologically the human foot rather than the human hand.

The comparative study of the muscles of the Orang is full of interest, and the interest increases when we institute comparisons with the arrangement of the musculature in the human body. Fick[1] holds that in the Orang we have more muscle variation (when we consider the literature), than we have in man, and it is interesting to note that in the sense of the modern view, we have in the present day Orang, evidence of a more active phylogenetic variation than in man.

By studying muscle variation in man relating to normal conditions in lower animals, we may throw light on the position of man in the animal kingdom. This conviction was long ago expressed by Professor Wood,[2] who remarked, concerning the comparative study of the musculature of man and the lower animals, that:—" If in addition to the general resemblance of the muscular mechanism, there are to be found in the former [*i.e.*, in man] fragmentary records of special apparatus which have, in the latter [*i.e.*, in lower animals] the fuller development of a definite purpose, then these may be taken as at least of equal importance with other evidence of traces, some may think, of a general unity of plan with varied teleological intentions, and others, of an ancient morphological relationship of a much closer character. But if, on the other hand, muscles are found which have no place in the various animal types, we may fairly take them as indications, valuable as far as they go, of progress still advancing towards a higher development of the human frame, —of an increase in the distance, already great, which separates physically man from animals."

1 Loc. cit. 2, p. 306.

2 Loc. cit., p. 44.

EXPLANATION OF PLATES.

The following plates are drawings from dissections made by the author:—

PLATE III.

FIG. 1.—Dissection of the posterior aspect of the neck and shoulder of the Orang Outang.

acrom., acromion process; *clav.*, clavicle; *e.a.m.*, external auditory meatus; *i.spin.*, infra spinatus; *l.a.s.*, levator anguli scapulae; *m.o.*, omo cervicalis: *rhom.*, rhomboid; *s. spin.*, supra spinatus; *s. mag.*, serratus magnus; *trap.*, trapezius; *t. min.*, teres minor.

PLATE IV.

FIG. 2.—Dissection of the anterior aspect of the chest wall and shoulder of the Orang Outang.

acrom., acromion process; *clav.*, clavicle; *cor.*, coracoid process; *Delt.*, deltoid; *H.*, humerus; *p. min.*, pectoralis minor; *p. m.* 1, the pars costo-abdominalis of the pectoralis major; *p.m.* 2, the pars sterno-costalis of the pectoralis major; *p.m.* 3, the pars sternalis of the pectoralis major. *S. m.*, sterno mastoid.

FIG. 3.—Representation of the mode of insertion of the pectoralis minor muscle.

acrom., acromion process; *clav.*, clavicle; *cor.*, coracoïd process; *lig.* 1 and *lig.* 2, continuation of the fibres of insertion of the pectoralis minor muscle into the clavicle and the acromion process; *p. min.*, the tèndon of insertion of the pectoralis minor muscle passing to the coracoid process.

FIG. 4.—The arrangement of the interossei muscles in the Orang Outang, as they appear in their relation to the metacarpal bones, on transverse section through the metacarpus.

d. i., dorsal interossei; *v. i.*, palmar interossei.

PLATE V.

FIG. 5.—Dissection of the short muscles of the thumb and the little finger in the Orang Outang.

ab.m.d., abductor minimi digiti; *ab.P.*, abductor pollicis; *ad.o.p.*, adductor obliquus pollicis; *a.t.p.*, adductor transversus pollicis; *F.*, palmar fascia, *f.b.p.* 1, *f.b.p.* 2, outer and inner heads of the flexor brevis pollicis; *fl.b.m.d.*, flexor brevis minimi digiti; *op.m.d.*, opponens minimi digiti; *o.p.*, opponens pollicis.

FIG. 6.—Dissection of the interossei muscles of the hand in the Orang Outang, viewed from the palmar aspect.

v.i. 1, *v.i.* 2, *v.i.* 3, palmar interossei, *d.i.* 1, *d.i.* 2, *d.i.* 3, *d.i.* 4, dorsal interossei.

FIG. 7.—Dissection of the interossei muscles of the hand in the Orang Outang, viewed from the dorsal aspect.

v.i. 1, *v.i.* 2, *v.i.* 3, palmar interossei, *d.i.* 1, *d.i.* 2, *d.i.* 3, *d.i.* 4, dorsal interossei.

PLATE VI.

FIG 8.—Dissection of the gluteal region, and the back and outer side of thigh in the Orang Outang.

g.max., gluteus maximus; *g.med.*, gluteus medius; *g.min.*, gluteus minimus; *g.s.n.*, great sciatic nerve; *g.troch.*, great trochanter of the femur; *h.m.*, hamstring muscles; *ib.*, iliac bone; *il.*, iliacus; *is.*, ischial spine; *ob.e.*, obturator externus; *ob.i.*, obturator internus; *py.r.*, pyriformis; *q.f.*, quadratus femoris; *rect.*, rectus femoris; *scan.*, scansorius; *v.i.*, vastus externus.

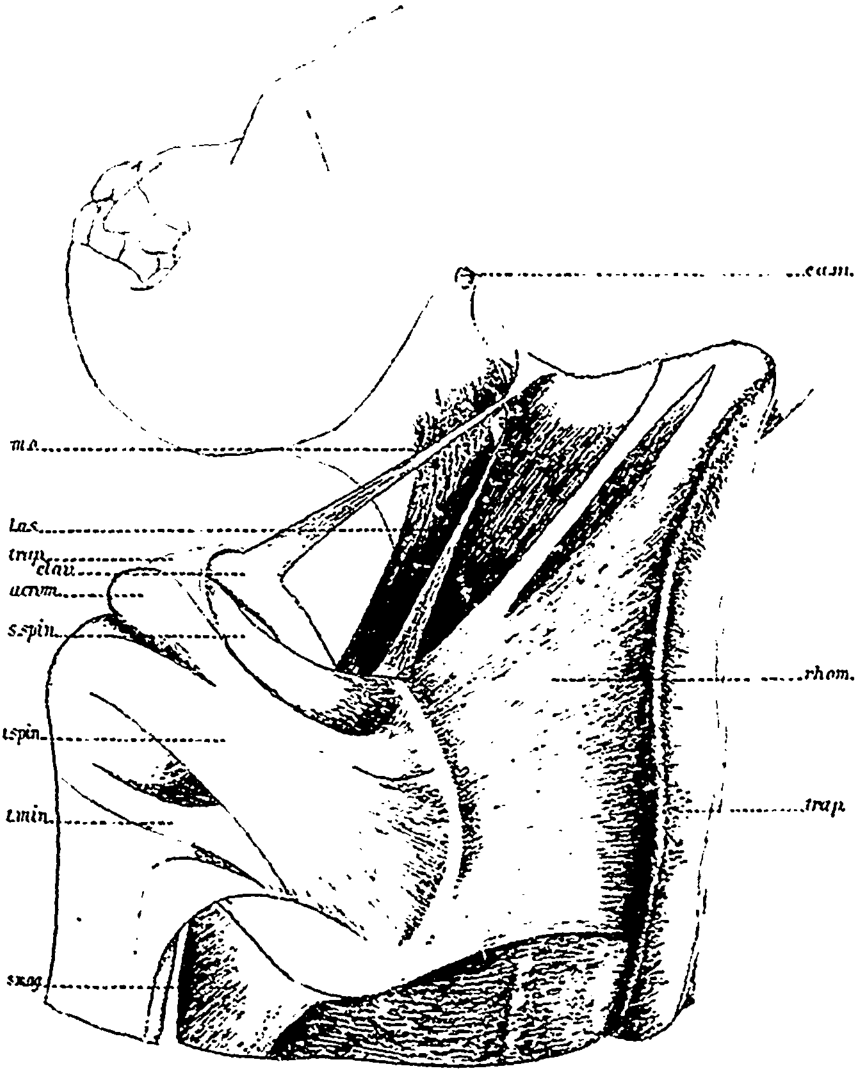


Fig.1.

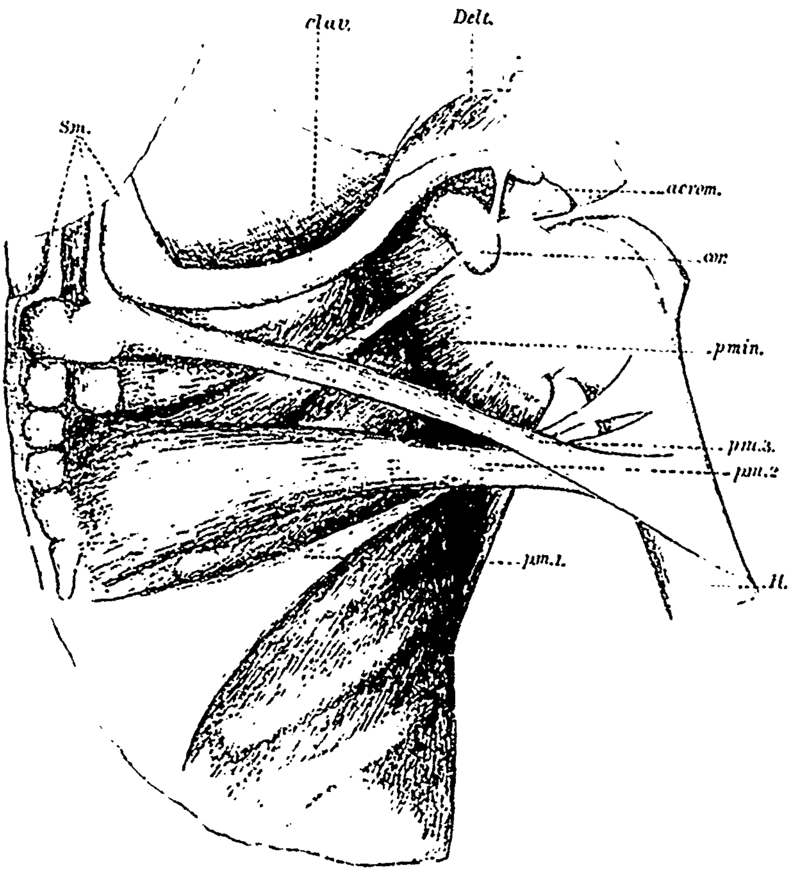


Fig.2.

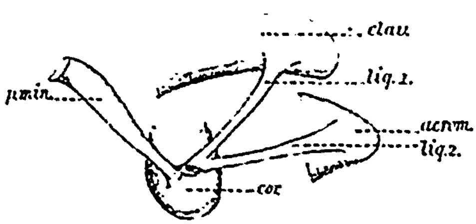


Fig.3

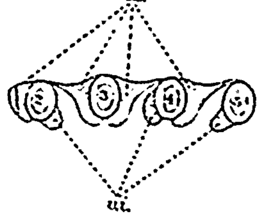


Fig.4.

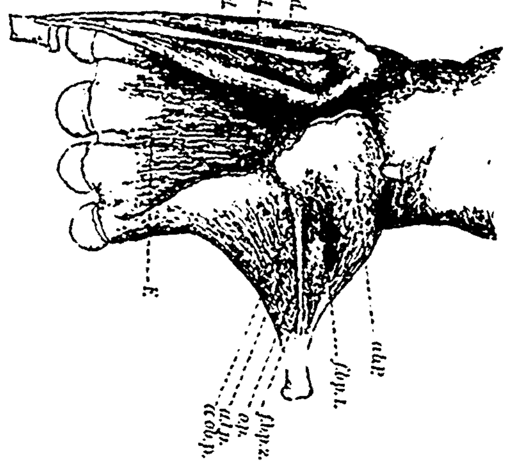


Fig. 5.

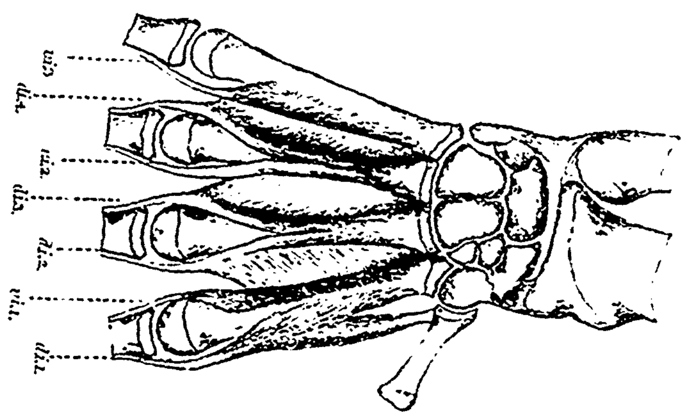


Fig. 6.

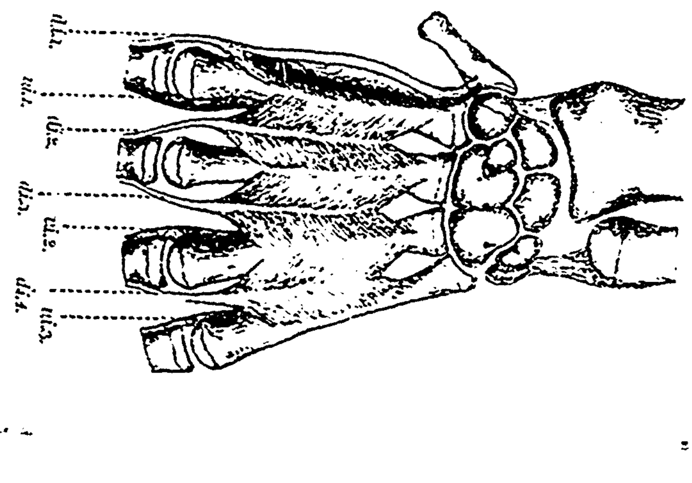
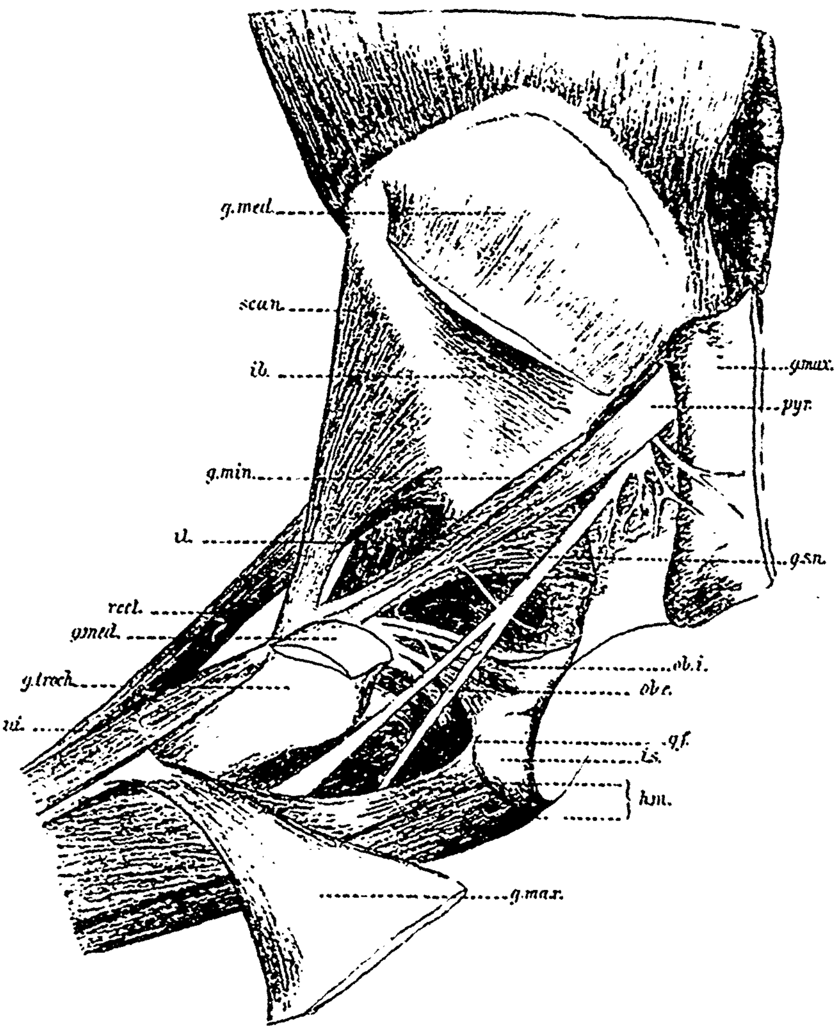


Fig. 7.


g.med.
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g.max.
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g.sn.
ob.i.
ob.e.
q.f.
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g.max.

Fig. 8.

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ERRATA.

Note 4, p. 565. Loc. cit. 1, p. 42.

Line 34, p. 565, should read: "In marsupials, only two bellies pass over for insertion into the first and second toes. In rodents and insectivora, three bellies exist for the first, second and third toes; and in carnivora, apes and man, there are muscle bellies for four toes, viz: the first, second, third and fourth."

THE MORPHOLOGY OF THE CENTRAL CYLINDER IN THE ANGIOSPERMS.

BY EDWARD C. JEFFREY, B.A. (TOR.), Ph.D. (HARV.)

(Read May 6th, 1899.)

The prevailing views in regard to the morphology of the vascular apparatus of the higher Cryptogams and the Phænogams are due to the studies of Van Tieghem and Strasburger. Both these writers have abandoned the conception of fibro-vascular strands, which is embodied in the classic comparative anatomy of De Bary. In this treatise, the axial organs, primary and secondary, of the higher plants are regarded as composed of more or less modified fundamental tissue of a parenchymatous nature, bounded externally by the integumentary tissues of the epidermis and traversed by conductive strands typically composed of vessels and sieve-tubes. These fibro-vascular strands may consist of clusters of xylem and phloëm placed side by side, and in this case the strands are called collateral fibro-vascular bundles. In another type the phloëm surrounds the xylem, and the bundle is then described as concentric. The latter type, by the localization of the phloëm at intervals on the outside of the xylem, becomes the radial bundle.

As a result of his study of the anatomy of the stem of the phænogamous order, Primulaceæ, Van Tieghem[1] published in 1886 an important memoir on the morphology of fibro-vascular strands, which has formed the basis of most of the subsequent anatomical work in this direction. Although the general conclusions reached are founded on the study of the Primulaceæ alone, Van Tieghem extends them to all vascular plants, including the vascular Cryptogams. The primitive type of axis, according to Van Tieghem, contains but a single concentric fibro-vascular strand, which is limited externally by a specialized layer, the pericycle. The innermost stratum of the fundamental tissue, immediately adjoining the pericycle, is also differentiated from the outer cortical tissue and is named the endodermis. The fibro-vascular axis so delimited is called the central cylinder or stele. This sort of fibro-vascular axis is found in the stem of many Cryptogams and in the root of nearly all vascular

1. Sur la Polystélie. Ann. de Sci. Nat. Bot., 7 sér., tom. 3.

plants, both cryptogamous and phænogamous. On account of the fact that the stele or central cylinder in such axes is obviously single and undivided, they are designated monostelic.

According to Van Tieghem the monostelic central cylinder is sometimes modified by becoming expanded. The stele grows larger, and a certain amount of the stelar parenchyma becomes aggregated in the centre to form the medulla or pith. From the pith, strands of parenchyma radiate outwards towards the pericycle and constitute the medullary rays. These parenchymatous rays divide the xylem and phloëm into segments, designated meristeles or bundles, which, in his opinion, are morphologically very different from the concentric bundles of De Bary. The pith and the medullary rays are also of a different morphological origin from the extracylindral fundamental tissue of the cortex. The whole complex medullated central cylinder of this type is shut off from the cortex by the same two layers, *viz.*, the pericycle and the endodermis, as is the primitive non-medullated concentric fibro-vascular strand. This modification of the central cylinder is found in the stems of nearly all the Phanerogams, and, in isolated instances, among the Cryptogams, *e.g.*, the Osmundaceæ, the genus Botrychium, and certain species of Equisetum.

In the medullated monostelic axis, the endodermis and pericycle, according to Van Tieghem, sometimes bend inwards between the meristeles and break into pieces at the bottom of the sinuosities. The fragments of the thus interrupted pericycle and endodermis unite around the inner side of the individual bundles, which they in the first place merely subtended. The original medullated monostelic central cylinder is considered to become, as a consequence, astelic, since its pith and rays are imagined to become continuous with the fundamental tissue outside the stele. The astelic type of central cylinder is found in certain amphibious or limicolous phænogamous orders and among the Cryptogams in the genus Ophioglossum and certain species of Equisetum. In these cases the separate meristeles, each surrounded by its own pericycle and endodermis, may unite so that a more or less complete fibro-vascular ring is formed, bounded both externally and internally by a continuous pericycle and endodermis. The central cylinder is then said to be gamodesmic. For example, in the genus Equisetum, *E. limosum* and *E. litorale* have the individual meristeles completely surrounded by an endodermis and pericycle; in the rhizome of *E. silvaticum* and in the aerial shoots of *E. hiemale*, on the other hand, the meristeles are fused together and the ring of united meristeles is bounded both outwardly and inwardly by a circular endodermis.

Instead of expanding and becoming medullated monostelic, or passing from this modification into the astelic condition, the fibro-vascular axis, may, according to Van Tieghem, undergo successive bifurcations and thus become polystelic. This type of central cylinder is very prevalent among the vascular cryptogams, and occurs also in certain species of Primula and Gunnera among the Phanerogams. In a cross section of an older stem of this type, numerous concentric fibro-vascular strands are to be seen imbedded in a matrix of fundamental tissue. The originally separate steles of the polystelic axis, may unite, according to Van Tieghem, to form a concentric annular stele, which is described as gamostelic.

More recently, Van Tieghem[2] has returned to the subject of the central cylinder of the Equisetaceæ. In his essay on Polystely, he describes the central cylinder of *E. arvense*, *E. pratense*, etc., as medullated monostelic; *E. limosum* and *E. litorale* as astelic, and the aerial shoot of *E. hiemale* as gamodesmic. Confirming an earlier research of Pfitzer,[3] he recognizes that in the species originally described by him as medullated monostelic, viz., *E. arvense* and *E. pratense*, etc., there are, in the region of the nodes, and at the basis of the smaller branches, well marked indications of an internal endodermis, which disappears in the internodes, only to recur in the successive nodes. He concludes that it was primitively present throughout the entire length of the stem, and has become in these species vestigial, persisting only at the nodes. He expresses the opinion that the astelic type of central cylinder, as found in *E. limosum*, is the primitive one, and that by fusion there resulted the gamodesmic type found in the aerial shoots of *E. hiemale*, and the subterranean stem of *E. silvaticum*. Forms like *E. arvense*, *E. pratense*, and *E. scirpoides*, are also gamodesmic, although the fact is obscured by the partial degeneracy of the internal endodermis. As a result of this investigation, it is apparent that the medullated monostelic type of central cylinder does not exist among the Equisetaceæ, and that those species which at first sight appear to possess a stelar system of this type are really degenerate astelic gamodesmic. The writer has recently studied the development of the young stem in the Equisetaceæ,[4] and has shown that the stelar system in the young axis of this group, is primitively gamodesmic, possessing a well-marked, continuous, internal endodermis. The modification, in which the bundles are surrounded by individual endodermal sheaths, appears quite late in the development of

2. Remarks sur la Struct. de la Tige des Prêles. Journ. de Bot., 4, 1890, p. 365.

3. U. d. Schutzscheide d. Deutsch. Equiset., Jahrb. f. wiss. Bot. 6.

4. Mem. Bost. Soc. Nat. Hist. Vol. 5, No. 5, p. 171.

the young sporophyte. If any dependence is to be placed on ontogenetic results, it would appear that the primitive type of cauline stelar arrangement in the Equisetaceæ, is not one in which the bundles are surrounded by individual endodermal sheaths, but is, on the contrary, that designated by Van Tieghem as gamodesmic. The appropriateness of this term, as describing the conditions present in the young stelar system of this group, will be discussed subsequently.

Van Tieghem[5] has recently re-examined the central cylinder of the Ophioglossaceæ, as a result of the discovery made by Poirault[6] of the occurrence of an internal endodermis in the *young* stelar system of several species of Botrychium and Ophioglossum. He confirms Poirault's results and describes the distribution of the endodermis in the young central cylinder of *Botrychium Lunaria*. The stelar system is tubular, and above the point of origin of the first leaf-trace has an internal, as well as an external, endodermis. The inner one rapidly disappears in the older region of the young stem. A similar state of affairs occurs in *Ophioglossum vulgatum*, although in this case, the stelar tube becomes quickly broken into separate strands on account of the overlapping of the foliar gaps. The endodermis in this species also disappears in the older region of the stem. Poirault[6a] has described a somewhat persistent *internal* endodermis in *O. Bergianum*, *O. capense*, and *O. ellipticum*. Quite recently an internal endodermal layer has been described by Farmer[7] as occurring in the interesting genus Helminthostachys. His own observations, together with those of Poirault, lead Van Tieghem to the conclusion that the cauline stelar system of the Ophioglossaceæ is, above the exit of the first leaf-trace, astelic in the sense already defined. It is apparent also, although Van Tieghem does not call attention to this fact, that the primitive condition of the fibro-vascular tissues in the stem of this group, is gamodesmic in his sense, and in this respect, corresponds with that described by the writer as existing in the young stem of the Equisetaceæ.

The recent investigations of Van Tieghem and Poirault apparently make it impossible to regard the central cylinder of the Equisetaceæ and Ophioglossaceæ as in any sense, monostelic. *Equisetum arvense*, the genus Botrychium and the genus Helminthostachys, which were described by Van Tieghem in his essay on Polystely as belonging to the latter type, are shown by a more complete study of their anatomy and development to possess a gamodesmic central cylinder (in the sense of

5. Journ. de Bot., 1890, p. 405.

6. Ann. d. Sci. Nat. Bot., 7 sér., tom. 18., p. 169.

6a. Op. Cit., p. 169.

7. Ann. Bot., vol. 13., p. 434.

Van Tieghem) in which the internal endodermis has become more or less obsolete. It has further been rendered probable by the interesting investigations of Poirault[8] that the apparently medullated monostelic central cylinder of the stem of the gleicheniaceous genus, Platyzoma, also possesses a pith derived from the extrastelar fundamental tissue.

The only remaining example cited by Van Tieghem in his classic essay on Polystely, of a Cryptogam possessing a medullated monostelic central cylinder is that offered by the Osmundaceæ. The writer hopes to show in a memoir on the anatomy of the Pteridophyta, which will appear shortly, that here too, the pith is in reality an included portion of the extrastelar fundamental tissue.

The medullated monostelic type of central cylinder may accordingly be regarded as of very doubtful occurrence among the Cryptogams, and in those cases where it is apparently present, it is derived from a modification of Van Tieghem's gamodesmic type. There would thus appear to be very slight evidence for regarding the medullated central cylinder, where it occurs among the Cryptogams, as derived from the dilatation of an originally pithless stele. It is a well-established principle with morphologists to attempt always the explanation of the structure of the higher plants by the more easily understood corresponding features of the lower groups. It seems to be in harmony with this method to elucidate the obscurities of the morphological interpretation of the central cylinder in the Angiosperms by the facts derived from the study of the anatomy and development of the Pteridophyta and Gymnosperms. The writer will shortly publish a memoir describing his studies on the latter groups. In the present essay, he proposes to examine in a general way, certain features of the structure and development of the Angiosperms, which in the light of the investigations mentioned above, seem to afford to some extent an elucidation of the morphology and phylogeny of the higher Phænogams.

PROBLEMS.

The questions to be treated in the present memoir are briefly as follows: Has Van Tieghem correctly described the mode of origin of his polystelic type of central cylinder? Is his astelic type essentially different from the polystelic? Does the medullated monostelic central cylinder ever arise by the dilatation of a primitively pithless stele? What are the salient anatomical features of the central cylinder of the Angiosperms?

8. Op. Cit., p. 182.

Do they throw any additional light on the difficult problems of the genetic relationships of the group? Anatomical studies have hitherto been almost entirely neglected by American botanists on account of the wealth of other matters, and that fact will serve as a sufficient justification for the present research. Were any other needed, it would be afforded by the extremely important phylogenetic results obtained in recent years by English, French, and German palæobotanists from the study of the fossilized remains of the chiefly vegetative organs of various groups of extinct Cryptogams. The advance of the science of Ecology has furthermore made it less difficult to distinguish between those cenogenetic features of structure which are the result of the adaptation of plants to their modern environment and those palingenetic traits which serve as an indispensable guide in the interpretation of phylogeny.

THE POLYSTELIC TYPE.

In his essay on Polystely to which reference has already been made, Van Tieghem[9] describes this modification of the central cylinder as originating from the pithless monostelic type, by the successive bifurcations of the primitively simple stele. He has referred to it more recently in practically identical terms.[10]

In studying morphological problems, it is an accepted method of procedure to pass from the lower forms to the higher. This course has been profitably pursued in the investigation of the morphology of sporangia, anthers, ovules, etc., and in the examination of the homologies of the gametophyte in the various groups of vascular plants. Curiously enough, Van Tieghem has given very little attention to the lower forms in his studies on the central cylinder, and still less to their development. In his essay on Polystely he does not describe the development of any cryptogamous stems of the polystelic type. It is only subsequently in his Traité de Botanique (p. 765), that he makes a slight reference to the development of the polystelic central cylinder of *Pteris aquilina*. Leclerc du Sablon[11] has given an admirable description of the earlier stages in the development of the stem of this species, but has apparently, not correctly observed the later phases.

The writer proposes to describe briefly his own observations on this form, as a preliminary to the examination of the phenomenon of

9. Op. Cit., p. 282.

10. Traité de Botanique, 1892, p. 1370; Élements de Botanique, 1898, p. 179.

11. Ann. Sci. Nat. Bot., 7 sér., 11 Tom., Récherches sur la Tige des Fougères.

Polystely in the Angiosperms. This species is chosen because the investigation of Leclerc du Sablon, and of the writer, show it to be quite typical of the polystelic Pteridophyta. The form selected presents, moreover, the phenomenon of Polystely in a high state of complexity, and its cosmopolitan occurrence will make it easy for other botanists to verify, if so minded, the accuracy of the description given here.

Leclerc du Sablon[12] has correctly described the transitional region of the young stem of *P. aquilina*. Higher up, and immediately above where the first leaf-trace is given off from the concentric central cylinder, the phloëm sends a process into the centre of the vascular axis of the strand. When the gap, caused in the axis by the exit of the foliar tracheids, is closed again, the central phloëm remains included, forming a sort of pith. The exit of the traces of several subsequent leaves causes similar gaps in the continuity of what is now the vascular tube, and through these gaps the internal phloëm communicates with that outside. Photograph 1, plate 7, shows the structure of the young stele, at a point where the second leaf-trace has just passed off. The central island of small-celled bast can be distinguished, surrounded by a ring of tracheids, which is interrupted opposite the leaf-trace, *t*. At the level of the fourth or fifth leaf, the fundamental tissue penetrates to the centre of the stele through the foliar gaps, forming, henceforth, a continuous core within the internal bast. At this stage the stelar system is a hollow cylinder, perforated by gaps above the points of origin of the leaf-traces. Leclere du Sablon[13] correctly describes it as being, in this phase, like the stelar tube, which is permanently present in the stem of Marsilea. The writer has not been able to distinguish any evidence of the repeated bifurcation of the young central cylinder, described by Van Tieghem as characteristic of his polystelic type. On the contrary, both the writer's observations and those of Leclerc du Sablon seem to show that the young stelar system of *P. aquilina* is of the type described by Van Tieghem as gamostelic. That term, however, can hardly be correctly used to describe the structure of the central cylinder of this species, because it implies the fusion of steles, originally separate, of which there is no indication whatever in this form. The writer[14-15], has previously suggested the term siphonostelic as more accurately describing the conformation of the young stelar system in the so-called polystelic Filicales; for his studies on the development of a number of

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12. Op. Cit., p. 4.

13. Op. Cit., p. 5.

14. Trans. Brit. Ass. Adv. Sci., 1897, p. 869.

15. Mem. Bos. Soc. Nat. Hist. V. 5, No. 5, p. 160.

representatives of this group have led to the conclusion that the young central cylinder of this type is always tubular, and that there is no indication of the bifurcation of the primitive fibro-vascular axis.

Photograph 2, plate 7, shows the older stelar tube of *P. aquilina*, where it is provided with an axial core of fundamental tissue. At *a* is to be seen the foliar gap corresponding to the leaf-trace l^2; *r* is a root, and l^1 an earlier leaf. When about a dozen leaves have been formed, the vertical young stem of *P. aquilina* bifurcates, or in some cases trifurcates, and the resulting divisions plunge into the soil and pursue a subterranean horizontal course. Leclerc du Sablon[16] has made a curious mistake in regard to the mode of origin of the horizontal rhizome of this form. He describes it as originating from a bud in the axil of one of the leaves of the vertically-growing young plant. The writer has seen the bifurcation of the stem regularly occurring in many hundreds of examples of plants grown from different lots of spores and in different years; so that there can be no doubt that it is a quite normal process The writer's account, moreover, agrees exactly with the older description of Hofmeister[17]. Photograph 3, plate 7, represents a section of the young stem just above the bifurcation of the stelar system; *a* and *b* are the tubular steles which are about to pass into the two horizontal rhizomes. The stele *a* has just given off a leaf-trace *l*; in *b* the foliar gap is also still open. Shortly after the young rhizomes make their appearance, the leaves, which at first originate at small intervals, become more widely separated, and their foliar lacunæ frequently overlap. For this reason, in a cross-section of the stem at this stage, one often sees an appearance of independent dorsal and ventral steles, as in photograph 4, plate 7. A series of sections, however, show that the stelar system is still tubular. At this stage, a strand of brown sclerenchyma becomes evident in the centre of the stelar tube, and, a few centimetres further on, the ventral wall of the latter becomes involuted. A fibro-vascular strand is subsequently detached dorsally from the involution, and forms one of the two large axial concentric bundles found in the mature rhizome. The single central strand is rapidly surrounded by a sclerenchymatous tube formed from the sclerenchymatous rod described above. This stage is represented in photograph 5, plate 7. Subsequently, a second central strand is detached dorsally from the ventral wall of the stelar tube. This strand is at first small, but ultimately becomes nearly as large as the first-formed strand (fig. 6, plate 7). The two axial concentric strands contribute to the formation of the leaf-traces, but have no connection with the vascular supply of the roots.

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16. Op. Cit., p. 5.

17. Higher Cryptogams, Ray. Soc., p. 224.

Possibly misled by Hofmeister's older account, already referred to, Van Tieghem[18] has described the large axial strands as primitive, and the strands outside as secondary cortical steles derived from these. A study of development shows that, in reality, the external strands are primitive, as may indeed be inferred from the fact that the traces of the roots and leaves are directly attached to them even in the mature rhizome. The axial concentric strands, on the other hand, are of later origin, and are to be regarded as medullary bundles.

It will probably be obvious to the reader who has followed the foregoing account and examined the accompanying photographs, that the development of *P. aquilina* offers little support to Van Tieghem's hypothesis of Polystely. The writer hopes to publish in the near future, an account of the stelar development of a number of cryptogamic forms of the so-called polystelic type, in which the arrangement of the nascent fibro-vascular apparatus is identical with that found in *P. aquilina.* The young stelar system of the so-called polystelic type among the Filicales would appear to be characteristically tubular, and the writer[19] has already suggested on that account, that it may be appropriately designated siphonostelic.

PRIMULACEÆ.

Having discussed in a general way the development of the so-called polystelic type in the Cryptogams, we may now profitably turn our attention to the development of the same type in the Angiosperms. It was the study of the anatomy of the stem of a large number of species of the genus Primula which led Van Tieghem to propose the doctrines in regard to the morphology of vascular strands, which are at present so generally accepted by anatomists. Although derived, in the first place, from an examination of certain Angiosperms, Van Tieghem's hypotheses have been extended by their author also to the Cryptogams.

Van Tieghem describes two main types of cauline anatomy as occurring in the Linnæan genus, Primula. In one type, the central cylinder becomes dilated above the cotyledons and forms a medulla[20] This medullated monostelic central cylinder does not subsequently undergo divisions. In a second type the central cylinder remains undilated and without a medulla for several internodes above the

18. Op. Cit., p. 765.

19. Trans. Brit. Ass. Adv. Sci., 1897, p. 869.

20. Sur. la Polystélie, p. 292.

cotyledons, and then bifurcates, repeatedly producing a varying number of eccentric steles.[21] The fibro-vascular system in this case is described as polystelic Van Tieghem retains, for species possessing a cauline central cylinder of the first type, the original Linnæan generic name Primula; for the polystelic species, he revives Tournefort's genus Auricula.

Van Tieghem does not seem to have followed closely the development of the polystelic type in his genus Auricula. The writer has given some attention to this subject, but it has not seemed necessary to make his studies exhaustive, because an admirable account[22] of the whole matter has recently appeared, with which the writer's own results are in close agreement. Gwynne-Vaughan has examined the development of the young stem and the relation of the leaf-traces to the cauline central cylinder. He calls attention to the fact that the young pithless stele of *P. japonica and P. involucrata* after the exit of from four to eight leaf-traces becomes gamodesmic (gamomeristelic) in the same manner as the central cylinder of the young stem of *Botrychium Lunaria*, described by Van Tieghem. In other words, there is present a collateral fibro-vascular cylinder with an internal endodermis as well as an external one. This cylinder is perforated at intervals by the gaps occurring at the points of exit of the leaf-traces, and around the margins of these gaps the external and internal endodermis become continuous. Higher up in the young stem, the gamodesmic cylinder becomes more or less completely gamostelic by the formation of internal xylem and phloëm. The leaf-traces show the same variability as the cauline strands. In the petioles of the younger leaves they are collateral strands, while in the stalks of the later-formed foliar organs some of them become concentric and would thus be considered, from Van Tieghem's standpoint, as steles.

As regards the nature of Polystely itself, this writer reaches conclusions which are so much in accord as far as they go with the investigations to be described in this memoir, that they may be quoted in full. For example (p. 320) he makes the following statement: "Van Tieghem seems to have entirely overlooked the all-important influence of the leaf-traces on the phenomena of transition, and, indeed, on the vascular system throughout the whole plant. On this account, he regards Polystely, when present, as having originated by the *continued bifurcation* of the central cylinder found in the lower part of the stem. He speaks of it as flattening itself out, and constricting itself in the middle

21. Op. Cit., p. 305.

22. Gwynne-Vaughan; Polystely and the Genus Primula, Ann. Bot., 1897.

until it becomes nipped into two. I have not seen anything that would lead to a similar conclusion. The transitional phenomena in the seedling and also the extreme variability in certain species of the most important characteristics of Polystely, give strong support to the opinion that Polystely is not a primitive feature of the group of Primulas, in which it is found, but a comparatively recent modification." On a later page (322) he writes: "One result appears clear: that in the Primulas the gamostelic condition is more primitive and nearer normal monostely than is the dialystelic (polystelic) type, and that probably a gamodesmic condition preceded either."

The writer's observations have been made entirely on *P. Auricula* and *P. farinosa.* The so-called monostelic species, *P. sinensis*, *P. obconica*, and *P. Forbesii*, have been studied for comparison. The writer's results in the case of *P. Auricula* correspond very closely to those reached in the same species by Gwynne-Vaughan[23]. As was long ago noticed by Kamienski[24] the epicotyledonary central cylinder remains an unmodified single strand until several leaf-traces have been given off from it. About the region of exit of the fourth or fifth leaf, it becomes a stelar tube with the usual foliar gaps. As soon as the central cylinder becomes tubular, the traces running to each leaf become three in number, the largest of which comes off from the bottom of the foliar gap, while the two smaller lateral traces are derived from the vascular tissues forming the sides of the gap. It is only by following a series of sections that the really cylindrical character of the stelar system can be made out, since the foliar lacunæ overlap and there is thus presented the appearance of completely isolated strands. It is only necessary in this connection to emphasize the statements of Gwynne-Vaughan quoted above, that Van Tieghem has overlooked the influence of the leaf-traces on the conformation of the central cylinder, and that there is no evidence of the repeated bifurcation of the primitive stelar strand, such as he describes for this and other so-called polystelic species.

The writer's study of the young stem of *P. farinosa* has resulted in very similar conclusions. In this case the problem is simplified by the fact that the individual leaves receive but a single strand from the cauline stelar system. In the quite young axis, the stele does not immediately become tubular. Above the point of origin of a leaf-trace, the pericycle sinks into the stele, forming a sort of medulla (photograph 7, plate 8), which may be compared with that composed of both phloëm and peri-

23. Op. Cit., p. 320.

24. Vergleich Anat. d. Prim., 1878, p. 28.

cycle in the young fibro-vascular axis of *Pteris aquilina* (photograph 1, plate 7). After six or more leaf-traces have been given off, the stelar tube encloses a core of fundamental tissue. The internal face of the young stelar tube is at first devoid of phloëm and it is only subsequently that it appears, thus recalling the state of affairs described by Gwynne-Vaughan in *P. japonica* and *P. involucrata*. At this stage the stelar tube would be described in accordance with Van Tieghem's terminology as gamodesmic (gamomeristelic): collateral strands occur even in the old stem; such a strand is figured by Kamienski.[25] Photograph 8, plate 8, shows a transverse section of the stelar system of this species at a region where the internal phloëm has already made its appearance. At r^1, a root is being given off; r^2 is a radical stele which has already made its exit from the central cylinder; l^1 and l^2 are foliar gaps; opposite l^1 may be seen its corresponding leaf-trace. Photograph 9, plate 8, is similarly lettered. In this case the leaf-traces corresponding to two foliar gaps are to be seen. The stelar system of *P. farinosa* is thus from the first, a tube, including primarily only a pericycle, and then fundamental tissue as well. The tube is, in the beginning, collateral, but becomes subsequently bicollateral through the appearance of internal phloëm. The stelar tube has gaps in its walls above the points of exit of leaf-traces. No such gaps occur opposite the outgoing radical strands.

The writer's examination of the development of *P. farinosa* leads to results similar to those obtained by Gwynne-Vaughan in the case of other so-called polystelic species of this genus, *viz.*, 1. That the stelar system in the young plant does not successively bifurcate, giving rise to a varying number of steles, as described by Van Tieghem, but from the first forms a stelar tube with foliar gaps. 2. That the stelar tube is primitively collateral and only subsequently becomes bicollateral; the development of the internal phloëm would seem to be a compensation for the disappearance of secondary growth in the vascular system of these peculiar species of Primula.

HALORHAGIDACEÆ.

The peculiar conformation of the fibro-vascular system of the genus Gunnera has been described by Reinke.[26] Subsequently the central cylinder of *G. macrophylla* has been somewhat exhaustively studied by

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25. Op. Cit., plate 6, fig. 3.

26. Morpholog., Abhand. v. Reinke, Leipzig, 1873.

Merker.[27] Van Tieghem[28] examined the anatomy of a number of species of this genus in connection with his essay on Polystely. Certain species, *G. cordifolia*, *G. monoica*, and *G. prorepens* possess monostelic central cylinders which are quite pithless. In these species this state of affairs is sometimes departed from in the leafy stems (as distinguished from the creeping rhizomes) where the stele may occasionally, according to Van Tieghem,[29] flatten out and bifurcate in the usual polystelic fashion. The strands however in these cases are never more than two. In *G. magellanica* and other species, the young stele bifurcates a certain number of times in the epicotyledonary region and becomes polystelic. In species with large stems, *e.g.*, *G. macrophylla*, etc., the bifurcations are described by Van Tieghem[30] as being exceedingly numerous.

Through the quite exceptional kindness of Dr. D. H. Scott, Director of the Jodrell Laboratory, Kew, the writer has had the opportunity of examining material of seedlings of *Gunnera scabra*. As Dr. Scott himself has an article on this species in preparation, it will be possible only to refer in a passing manner to the writer's own observations. All that need be said in this connection is, that the epicotyledonary system of *G. scabra* is primitively tubular, as are those of *Pteris aquilina* and *Primula farinosa*; and that it is further characterized by the same foliar gaps subtending the points of leaf-traces. It resembles, moreover, *Primula japonica* and *P. farinosa*, in the absence of internal phloem, on the inner side of the young stele. So far as may be judged from the development of these species, the polystelic Gunneras do not differ in the nature of their young stelar system from the other polystelic forms examined by Gwynne-Vaughan and the writer. They resemble the polystelic Primulas in showing developmental evidence that the so-called polystelic condition is derived from a primitively so-called astelic arrangement of the vascular tissues.

SAXIFRAGACEÆ.

The writer has found the so-called phenomenon of Polystely to be present in the Saxifragaceæ. As one of his students is working over the anatomy and development of the stem in this order, it will be necessary only to refer to certain features having an immediate bearing on the present research.

27. Merker, Gunnera Macrophylla. Inaug. Diss., 1888, Marburg.

28. Op. Cit., p. 307.

29. Op. Cit., p. 308.

30. Op. Cit., p. 300.

If a transverse section of the internodal region of *Parnassia palustris* be microscopically examined, it will be discovered that the stele is provided with a pith formed of thick-walled collenchymatoid cells. There is considerable secondary growth present in the woody zone traversed by slender medullary rays. The central cylinder is surrounded by a well-marked and lignified endodermis, which appears very clearly after the use of phloroglucin and hydrochloric acid. Most of these features may be seen in photograph 25, plate 11. In a section passing through the point of origin of a leaf-trace, the side of a central cylinder is seen to be hollowed opposite the outgoing trace; at the bottom of the concavity the phloëm and xylem are absent, so that the collenchymatoid tissue of the central cylinder of the stele is only separated from the external fundamental tissue by the pericycle and endodermis. Not unfrequently two leaf-traces come off from the stele, nearly opposite each other, as may be noted in photograph 26, plate 11. When this happens the central cylinder is split for a short distance into two strands. At their lowest point the two strands are devoid of internal phloëm and xylem, and have along their inner borders a layer of the pith-like tissues described above. The latter is separated from the fundamental tissue passing through the stele of this region, only by the pericycle and endodermis. These features may be seen in photograph 27, plate 11. Higher up, the fibro-vascular tissues cover over the internal faces of the two strands again, and they become, to employ Van Tieghem's terminology, two separate steles, each of which apparently possesses a medulla of its own. Photograph 26, plate 11, sufficiently illustrates the description given above. The photograph very closely resembles Fig. 33, plate 15 of *Gunnera magellanica* in Van Tieghem's memoir on Polystely.

The points of interest in the anatomy of this species seem to be that there is present an apparently medullated monostelic axis, which continues as such unless two leaf-traces from it come off close together; that under these circumstances the divided stelar axis becomes at first astelic, and then a little higher up, polystelic, in Van Tieghem's sense of these terms. It is further to be noticed that both astely and polystely are closely related to the exit of leaf-traces.

In *Parnassia parviflora* the central cylinder is astelic, or rather gamodesmic, since it consists of a collateral fibro-vascular tube with an internal endodermis, which communicates with that outside, through the gaps occurring in the cylinder opposite the points of exit of the leaf-traces. A section of the central cylinder of this species is shown in photograph 29, plate 11: *l* is an outgoing leaf-trace; g^2 is its corresponding gap, and g^1 is that of an earlier trace; *r* and r^2 are strands belonging to roots, which as is usual, cause no gaps in the fibro-vascular tissues, by their exit from the stelar tube.

The foliar vascular strands in both these species are generally throughout their cauline course collateral in structure, but early in their petiolar course, they become concentric. In these features, they resemble the leaf-traces of *Primula japonica* and *P. denticulata* described by Gwynne-Vaughan.[31]

It is undesirable, for reasons already mentioned, to describe further the anatomy of the Saxifragaceæ at the present time, and the subject of Polystely may be left with a brief summary of the writer's conclusions.

From the study of the development of the so-called polystelic central cylinder in the vascular Cryptogams and in the Angiosperms, the writer has reached the following conclusions: (1) Polystely (so-called) does not arise by the repeated bifurcation of the primitive epicotyledonary central cylinder. (2) The young central cylinder of this type is primitively tubular and is characterized by the occurrence of gaps in the wall of the stelar tube corresponding to the leaf-traces. These essential features may subsequently be obscured by the passage of numerous traces to the same leaf, by the overlapping of the foliar gaps of different nodes, and by the development of an internal or external system of strands (or both) derived from the original stelar tube. (3) If the above conclusions be accepted, the terms Polystely and Gamostely should apparently be abandoned, since they involve an erroneous conception of the mode of development of the central cylinder in the various forms described above. The writer proposes as more accurately describing the nature of the central cylinder in this type, the term siphonostelic.[32]

THE ASTELIC TYPE.

In his essay on Polystely, already often quoted, Van Tieghem describes a modification in the central cylinder of vascular plants, which he calls astelic. In this type, the epicotyledonary stele, having previously become expanded and medullated, is said to become further changed by the sinking in of the endodermis between the bundles. In this case, according to Van Tieghem, the endodermis is apt to break at the bottom of the undulations between the bundles, and the thus separated segments then envelope the several vascular strands with

31. Op. Cit., p. 312.

32. Originally suggested in Trans. Brit. Ass. Adv. Sci., 1897, p. 869.

individual endodermal sheaths. By this process the pith is supposed to become continuous with the extrastelar fundamental tissue, and the central cylinder disappears as such.

Van Tieghem states that of closely allied species some may have a medullated monostelic central cylinder, while others have the astelic type of central cylinder. For example, in the Equisetaceæ, *E. arvense* is monostelic, *E. limosum*, on the other hand, is astelic. Among the Phanerogams, *Ranunculus aquatilis* and *R. Lingua* are described as having an astelic central cylinder, while a number of other species, *e.g.*, *R. acris* and *R. abortivus*, are monostelic. In the genus Anemone, parallel cases are presented by *A. nemorosa*, which is astelic, and *A. pennsylvanica* which is monostelic. It has been pointed out in the introduction that Van Tieghem in more recent publications has abandoned the idea that any of the Ophioglossaceæ or Equisetaceæ are medullated monostelic, but, on the contrary, regards them as astelic throughout the epicotyledonary region of the stem. Although he has given up the view that the cauline central cylinder of these Cryptogams is in any case medullated monostelic, he is still of the opinion that certain ranunculaceous genera[33] present examples of both the above-mentioned types of central cylinder.

Before going on to submit Van Tieghem's views in regard to the morphology of vascular strands of certain Ranunculaceæ to the test of their agreement with the facts of anatomy and development, it is necessary to describe certain modifications of these views which have recently been proposed by Strasburger[34] and which have already been accepted by many botanists of eminence. Strasburger admits the great morphological value of Van Tieghem's definition of the central cylinder. He suggests, however, inasmuch as the innermost layer of the cortex which bounds the central cylinder is not always an endodermis, *i.e.*, a layer of cells provided with a cutinized undulating radial band, but is very often composed of sclerenchymatous elements or starch-bearing cells, that some general name is desirable for the internal layer of the fundamental tissue adjoining the central cylinder. He suggests the term phlœoterma as a suitable designation of the innermost layer of the cortex, no matter what its histological character may be. Strasburger questions the possibility of different species of the same genus having in some cases a medullated monostelic central cylinder, and in others presenting the astelic type of arrangement of their vascular tissues. In other words, he believes it impossible that the medullary

33. Éléments de bot., 1898, p. 179.

34. Histolog. Beiträge III, pp. 309-313, 442, 443, 484-486.

tissues should in some species of a given genus be intrastelar and in other species extrastelar. He accordingly regards the phlœoterma which surrounds the whole complex of bundles in the so-called monostelic type as morphologically different from the individual sheaths enclosing the bundles in Van Tieghem's astelic type. Strasburger has apparently overlooked the fact that Van Tieghem[35] had anticipated his objection to the different morphological interpretation of the pith in different species of the same genus, by announcing that in the case of the cryptogamous orders, the Equisetaceæ and Ophioglossaceæ, the medullary tissue is always extrastelar, thus, as has already been pointed out, departing from the view originally expressed in his essay on Polystely. Van Tieghem[36] still maintains, however, his earlier position in regard to the varying morphology of the central cylinder in different species of Ranunculus and Anemone.

We now come to the consideration of the development and structure of so-called astelic axis in the Ranunculaceæ and other groups.

RANUNCULACEÆ.

Our knowledge of the anatomy of this order is chiefly due to the studies of Marié.[37] Although he has described quite exhaustively the salient structural features of the root, stem, and leaves of this order, he has given little or no attention to the subject of the development of the stem, which, as the writer hopes to show, is of considerable importance from a morphological standpoint. Quite recently Jancezewski[38] has examined the anatomy of a number of species of Anemone. Strasburger[39] attributes to Marié the statement that *Ranunculus acris* possesses a common endodermis (phlœoterma), *i.e.*, in other words, that the central cylinder of this species is medullated monostelic. Marié's description[40] is extremely condensed, and, on that account, is somewhat ambiguous; but the writer is inclined to interpret it as meaning that the bundles of this species have individual endodermal sheaths, since he states that *R. acris* resembles *R. multifidus*, which has individual endodermal sheaths.

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35. Journ. de Bot., 1890.

36. Élements de Botanique, p. 179.

37. Récherches sur la Structure des Rénonculacées. Ann. de sci. Nat. Bot., 6 sér., tom. 20.

38. Révue Générale de Botanique., 1898. Études Morphol. sur le Genre Anemone.

39. Op. Cit., p. 311.

40. Op. Cit., p. 80.

The young stem of *R. acris* has a stelar system very much like that of *Botrychium Lunaria*, *i.e.*, it consists of a fibro-vascular tube pierced by foliar gaps. Through the latter, the internal phlœoterma, which is extremely well marked in the young stem of this species, communicates with the external phlœoterma. Photograph 13, plate 9, shows a leaf-trace passing off from the stelar tube, and subtending it is the foliar gap. The continuity of the internal and external phlœotermal layers through the foliar gap can be easily distinguished. The photograph in this case was made from a section treated with phloroglucin and hydrochloric acid, which causes the lignified phlœoterma to stand out sharply. The stelar tube, as in the case of the young so-called polystelic axes, only becomes fully established after several leaf-traces have been given off, including those of the cotyledons, and at first, as in the young stem of *Primula farinosa*, the tube contains only enclosed pericycle and no fundamental tissue. The leaf-traces to each leaf are originally single, but very soon become three in number: a central large one and two smaller lateral ones. The departure of the median trace causes a large gap in the stelar tube, through which, the internal and external phlœotermal layers communicate. The lateral strands cause smaller breaks in the continuity of the fibro-vascular cylinder and frequently the internal and external cortex do not become continuous through them. The gaps, as a result, are occupied merely by pericycle. The stelar cylinder in the more advanced young stem is characterized by the overlapping of the foliar gaps, so that in a cross section it appears as a circle of separate bundles. This state of affairs is shown in photograph 14, plate 9. Somewhat higher up in the young stem, the overlapping foliar gaps become more numerous, both on account of the increased number of leaf-traces given off to each leaf and the greater elongation of the individual foliar gaps. For this reason, the stelar tube, in transverse section presents the appearance of a number of separate vascular strands, the fibro-vascular bundles, each of which is surrounded by its own phlœotermal sheath. In older regions of the stem, the fibro-vascular strands of the leaf-traces dip inwards and pass outwards again, thus simulating the peculiar course of the leaf-traces which becomes the rule among the Monocotyledons.

From the thick parenchymatous hypogæous stem of *R. acris* the more slender aerial shoots originate. Since the latter must support, in spite of their comparative delicacy, a considerable weight of leaves, flowers, and fruit, the mechanical tissues which are scarcely present at all in the subterranean stem, are well developed in the epigæous shoots. As is well known, the mechanical tissues of *R. acris* appear as fibrous sheaths around the individual bundles. Already, in the older subterranean stem, the internal phlœoterma is less apparent, and at the base of the aerial shoots, both external and internal phlœotermal layers cease to be recognizable as such. This disappearance takes place *pari passu* with the appearance of the sclerified sheaths about the individual bundles. It is highly probable that the outer layer of sclerified cells on the external and internal faces of the bundle-sheath represents the phlœoterma, and that the rest of the fibrous tissue is to be regarded as sclerified pericycle. It is not easy to come to an opinion in regard to the position of the phlœoterma on the flanks of the bundles, but since the larger so-called bundles are completely surrounded by a phlœotermal sheath in the hypogæous stem, it may be safely assumed that the larger bundles of the aerial shoots are to be considered as morphologically bounded by a similar membrane. The smaller bundles in the hypogæous stem are often united with the larger ones by their pericycle; as a consequence, they are surrounded by the same phlœotermal sheath. It seems probable that they are to be regarded as similarly united with the larger bundles in the epigæous shoots.

The development of *R. sceleratus* has been studied by the writer, and does not differ essentially from that described in *R. acris*, in respect to the structure of the young central cylinder and the distribution of the phlœotermal sheath.

The young stem of *R. repens* also resembles closely that of *R. acris* in every respect, both as regards development and the distribution of phlœoterma. In the older stem of this species, the phlœotermal sheath disappears completely in the internodes of its characteristic runners; it becomes distinct again, however, in the rooting nodes, both internally and externally.

R. abortivus is described by Marié[41] as having an external phlœoterma. The development of this species is, accordingly, of special interest. The conformation of the young fibro-vascular tube does not differ in any important feature from that of *R. acris*, and consequently need not be described. The distribution of the phlœoterma in the young stem of this species is, however, of considerable morphological interest. In the lower region of the epicotyledonary central cylinder, an internal phlœoterma is present, which communicates with the phlœotermal layer outside the fibro-vascular tube, through the foliar gaps, in a manner quite similar to that obtaining in *R. acris*, as described above. The internal phlœoterma is somewhat persistent,

41. Op. Cit., p. 82.

and only in rather stout young hypogæous stems does it become quite obsolete.

Photograph 15, plate 9, represents a section through the upper region of the stem of a well-advanced seedling. Phloroglucin and hydrochloric acid have been used to bring out the lignified phlœoterma which can be clearly distinguished on the outer margin of the fibro-vascular segments, but less distinctly along their inner border. The occurrence of an internal phlœoterma in the young fibro-vascular cylinder of a species in which it is absent in the mature hypogæous stem, is of considerable morphological interest. In the aerial shoots, the phlœotermal boundaries are no longer distinguishable histologically, although on morphological grounds they should doubtless be regarded as nevertheless present.

Even in the quite young stem of *R. rhomboideus*, there is no trace of an internal phlœoterma. However, by examining the youngest region of the axis, a quite distinct internal phlœoterma may be demonstrated. Photograph 17, plate 9, represents a cross section of the young stem where the fibro-vascular cylinder appears as an unbroken ring. Photograph 18, plate 9, shows a tranverse section of the stelar tube where it is interrupted by a foliar gap; the junction of the internal and external phlœotermal layer around the sides of the foliar gap can be clearly discerned. Photograph 16, plate 9, represents a section through an older region of the subterranean stem; three foliar gaps are to be seen and the internal phlœoterma has now become quite obsolete. The aerial shoots of this species do not differ materially in the structure of their vascular strands from the other species already described. *R. rhomboideus* is distinguished from all the species examined by the complete disappearance of any histological evidence of the existence of an internal phlœoterma, even in quite young stems. Even here, the boundary of the cortical tissues on the inside of the stelar tube may readily be determined by examining the stem in a very early stage of development.

The writer has not been able to secure seedlings of other species of Ranunculus, but those described appear to be sufficiently varied in their affinities to afford reliable data for conclusions as to the correct morphological interpretation of the central cylinder of this genus. These deductions may, however, be advantageously deferred until the allied genus Anemone, has been considered.

As has been already mentioned, Van Tieghem states hat certain species of Anemone have a medullated monostelic central cylinder, while other species are astelic. *Anemone nemorosa* belongs to the latter class and is described by Marié[42] as having the individual bundles surrounded by phlœotermal sheaths. *A. pennsylvanica* has, according to the same author,[43] a continuous external phlœoterma surrounding the whole complex of bundles. The writer's discovery of an internal phlœoterma in the *young* stems of various so-called monostelic species of Ranunculus, has suggested the examination of the younger region of the subterranean axis of this species of Anemone. Photograph 19, plate 10, reproduces a section of the quite young hypogæous stem of *A. pennsylvanica.* The stelar system is interrupted by a foliar gap, around the margins of which the internal and external phlœotermal layers are in communication. Photograph 20, plate 10, represents an older region of the cylinder where it is interrupted by numerous foliar gaps, The segments of the stelar tube are, in this case, individually surrounded by phlœotermal sheaths. In the older region of the hypogæous stem, it becomes continually more difficult to distinguish the phlœoterma on account of the sclerification of the pericycle, and, ultimately, of the phlœoterma itself.

The young stem of *A. cylindrica* has also been studied in this connection, but in this species, even the outer phlœoterma is very poorly developed, and the internal one is obsolete throughout. The absence of a well-marked phlœoterma in the hypogæous stems of the genus Anemone has been especially noted by Janczewski,[44] and accordingly, it is not surprising that this feature should be exemplified by *A. cylindrica.*

The writer has also examined the stem of the closely allied genus Hepatica. In the seeding of *Hepatica triloba,* there is a well-marked external phlœoterma, but the internal phlœotermal sheath is not differentiated at all on account of the sclerification of both the pericycle and the external layer of the medulla. The latter features may be seen in photograph 30, plate 11.

In connection with the Ranunculaceæ may be described the structure of the young stelar system of *Sarracenia purpurea.* In this species, the young central cylinder is tubular with foliar lacunæ. The external phlœoterma is poorly developed and the corresponding internal layer cannot be distinguished even in the very young axis.

The reader who has followed the descriptions given in the foregoing

42. Op. Cit., p. 56.

43. Op. Cit., p. 62.

44. Op. Cit., p. 3.

paragraphs of the development of the stelar system of Ranunculus and Anemone, will doubtless be struck with the bearing of the facts there described, on the problem of the morphology of the central cylinder in the Angiosperms. For example, we find in this order that the astelic type of Van Teighem does not originate by the sinking in of the phlœoterma around the individual bundles, with a subsequent union of the individual phlœotermal sheaths to form a continuous external and internal phlœoterma, because the fibro-vascular system is, from the very first, tubular, and the central cylinder has primitively an internal phlœoterma. Further, the stelar system of so-called monostelic species of Ranunculus and Anemone appears from a study of the course of development to be really an astelic type, in which the internal phlœoterma has become obsolete. These two facts, *viz.*, the primitively tubular (gamodesmic) nature of the central cylinder in the Ranunculaceæ, and the derivation of the so-called monostelic medullated type by the degeneration of the internal phlœoterma, are, in the writer's opinion, of great importance in connection with the view to be taken of the morphology of the central cylinder in the Angiosperms generally. Before proceeding to consider that subject, however, it will be well to describe the development of representatives of other angiospermous groups, which present the phenomenon of astely, so-called.

NYMPHÆACEÆ.

In his essay on Polystely, Van Tieghem describes the Nymphæaceæ as an order illustrating his astelic type of central cylinder. The arrangement of the fibro-vascular strands in the mature stem of the various genera of this order is extremely complex, and, on that account, it is the more desirable to investigate the development of the stelar system in the young plant in order to discover, if possible, what is really the primitive condition of the fibro-vascular apparatus in this group.

The genus Brasenia is probably one of the most primitive of the order. In the internodes of the rhizome of the mature plant of *Brasenia purpurea*, there are present two concentric fibro-vascular strands, in which the elements of the xylem, as is commonly the case in aquatics, are represented merely by air-spaces. The epicotyledonary stele of the seedling of *Brasenia purpurea* is a pithless fibro-vascular strand, in which the vessels are not degenerate as in the mature rhizome. The stelar system retains the simple character until a considerable number of leaf-traces have been given off. The stem, however, sooner or later becomes relatively massive, and the fibro-vascular system becomes tubular, as in the young stems of the ranunculaceous species described above. The tube has, likewise, both an internal and external phlœoterma, and the stelar tube is characterized by the same foliar gaps, around the margins of which the internal and external phlœotermas communicate. When the young stem has reached a length of from four to eight centimetres, the foliar gaps begin to overlap, and the two concentric strands which are at present in the mature stem make their appearance. When the stem passes out of the mud into the water to form the well-known floating shoots, the xylem degenerates and is represented merely by a cavity in each of the two stelar strands. Photograph 22, plate 10, represents a section through the young tubular stelar system of *Brasenia purpurea*, at a point where a leaf-trace is being given off, and is subtended by its corresponding foliar gap. It will be obvious from the above description and the accompanying photograph that the young stelar system of *Brasenia purpurea* is primitively tubular.

Two species of Nuphar have also been examined in this connection. *Nuphar luteum*, var. *Kalmianum*, is very favorable for study on account of the relative simplicity of its stelar system. The young epicotyledonary central cylinder is here also, at first, a pithless strand, and only after the exit of several leaf-traces does it become tubular with a pith of fundamental tissue. The stelar tube is provided with an internal as well as an external phlœoterma. Photograph 22, plate 10, represents a section through the young rhizome at a point where a leaf-trace has just been given off and a second one is in the act of making its exit from the tubular central cylinder. In the older rhizome, the foliar gaps begin to overlap, so that in a transverse section the stelar tube seems to be broken up into two or more segments, each surrounded by its own phlœotermal sheath. The number of fibro-vascular segments become subsequently increased by the fact that several leaf-traces are given off to each leaf. Finally the stelar tube becomes entirely unrecognizable by reason of the increasing complexity in the arrangement of the vascular strands.

The stelar development of *Nuphar advena* is very similar to that of the species just described. In this case, the epicotyledonary fibro-vascular strand passes quite rapidly into the tubular condition. The fibro-vascular cylinder has likewise internal and external phlœotermas which communicate through the foliar gaps. Very soon the leaf-traces to the individual leaves become numerous, and the stelar tube is consequently interrupted by a large number of foliar gaps. The complexity is subsequently further increased by the appearance of an internal and external series of strands, and the stelar tube can no longer be recognized as such. Photograph 23, plate 10, represents a section of the young stem of *Nuphar advena* in a region where the leaves have numerous traces and the stelar tube, as a consequence, is broken into many segments.

The young stelar system of *Nymphæa zanzibarensis* is at first a pithless strand, but very rapidly becomes tubular with usual foliar gaps. Quite early all semblance of the original stelar tube vanishes on account of the appearance of complexly anastomosing internal and external systems of fibro-vascular strands.

The young stem of *Nymphæa tuberosa* has also been studied by the writer. The epicotyledonary central cylinder is originally pithless, as in the other nymphæaceous species already described, but rapidly expands and almost immediately breaks up into an extremely complex system of anastomosing bundles, so that it is extremely difficult to recognize the existence of a stelar tube. Towards the end of a season's growth, however, the stelar tube again becomes obvious in the more slender region of the stem which is formed during the autumn. The stelar tube in this case has an internal phloëm as well as an internal phlœoterma. The tubular condition is probably to be regarded as a reversion to the primitive type of stelar system, and may be compared with that noticed by Gwynne-Vaughan[45] in the autumnal region of the stem of *Primula obtusifolia* and *P. involucrata*. In another essay this writer[46] has described the occurrence of concentric fibro-vascular strands in slender pedicles of the tubers which are so characteristic a method of vegetative reproduction in this species. I have examined the structure of the pedicles in question and have confirmed the existence of the concentric strands described by Gwynne-Vaughan. The fibro-vascular tissues in this case form a tube with foliar gaps, a fact which seems to have escaped his notice. As the slender pedicle passes into the tuber, the tubular concentric stele vanishes in an extremely complex system of anastomosing strands, some of which are concentric while others are merely collateral. The reappearance of the tubular stelar system, in the autumnal region of the young rhizome and in the pedicles of the tubers is interesting as a probable case of reversion. The base of the lateral shoots of the rhizome of *Pteris aquilina* not unfrequently shows a reversion to the more primitive tubular stele with a single medullary strand. The writer has found a similar concentric tubular stelar system in the pedicles of *Nymphæa dentata*.

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45. Op. Cit., p. 305.

46. Ann. Bot., v. 10, p. 290.

Through the kindness of Mr. Jackson Dawson, of the Arnold Arboretum of Harvard University, the writer has had the opportunity of studying the anatomy of a number of seedlings of *Nelumbium luteum*. The first root in this species is abortive, so that in a series of sections through the base of the young plant, one passes almost immediately into the cotyledonary region. The very short, pithless central cylinder of the young axis becomes tubular immediately below the level of exit of the cotyledonary traces. The exit of the latter breaks the stelar tube into four segments. Photograph 10, plate 8, shows the disposition of the stelar system just above the point where the cotyledonary traces have passed off. One cotyledon, *cot.*, is present; the other has been broken off. The four cotyledonary traces anastomose outside the lacunar cortex and the resulting network gives off the cotyledonary strands proper, as well as a series of strands which run through the cortex of the first internode. Photograph 24, plate 10, represents a section through the first internode; *a* are the four primitive fibro-vascular strands; *f* are the cortical strands. At the second node, the four central strands again form a tube from which a number of functional roots are derived, as well as strands for the third leaf. The exit of the latter causes a breaking up of the stelar tube once more into segments, which are henceforth more numerous than four. The cortical strands likewise send off contributions to the third leaf; they have, however, no connection with the strands of the roots originating from the second node. The latter, as is the rule in both Cryptogams and Phanerogams, unlike the leaf-traces, do not subtend any gaps in the original central cylinder.

MONOCOTYLEDONS.

The orders hitherto discussed belong to the dicotyledonous Division of the Angiosperms. Astely so-called is of comparatively rare occurrence in the present group for reasons which will be subsequently suggested. In this division, as well as in the Dicotyledons, a study of the development of the stelar system seems to throw considerable light on its morphology. The writer does not propose in the present memoir to more than touch on the development of the central cylinder in the Monocotyledons, because that subject appears to him to be of great importance from the standpoint of the phylogeny of the group at present so much in dispute, and for that reason it seems advisable to devote a special memoir to the development of representatives of the various monocotyledonous orders.

Van Tieghem mentions *Pistia stratiotes* among the Aroids as possessing an astelic central cylinder. The writer has been able to confirm the existence of individual phlœotermal sheaths about the fibro-vascular strands in this species ; but, unfortunately, in the young plants available, the older region of the stem had already disappeared. Van Tieghem[47] does not give any account of the development of the cauline axis of Aroids in his well-known memoir on the anatomy of the order.

In *Calla palustris*, the young epicotyledonary stele is pithless until after the exit of the second leaf-trace (including that of the cotyledon); just below the point where the fibro-vascular supply of the third leaf is given off, the central cylinder becomes tubular. The traces of the cotyledon and the first leaf are single ; but three bundles pass out into the petiole of the third leaf. The three traces of the third leaf subtend three foliar gaps in the central cylinder, which usually close at the fourth node. A continuous fibro-vascular tube thus appears at the node of the seedling similar to that figured by Van Tieghem[48] as occurring at the nodes of the mature rhizome. Above this node the fibro-vascular cylinder is perforated again by gaps corresponding to traces of the fourth leaf, which are likewise three in number. The writer has had the opportunity of following the development of this species in specimens of not more than six nodes. The traces of the sixth leaf are three in number, as are those of the third, fourth and fifth. From the level of exit of the traces of the third leaf, the fibro-vascular cylinder is astelic in Van Tieghem's sense. The fundamental tissue forming the core of this cylinder is at this stage not traversed by any so-called medullary strands, so that the young central cylinder in this species closely resembles that of a Dicotyledon such as *Ranunculus acris*. The individual strands are likewise in the young plant collateral, and the so-called amphivasal concentric strands make their appearance subsequently, as the writer has been able to learn from somewhat older seedlings, which had already lost the primary region of their stems.

The base of the young shoot in *Symplocarpus fœtidus* is tuberous, as is often the case in the Aroids. Photograph 11, plate 8, represents part of the ring of fibro-vascular bundles as it appears about half a centimetre above the base of the tuber. The individual bundles are collateral at this stage, and by treating sections with strong sulphuric acid, the presence of a cutinized phlœoterma may be demonstrated. The phlœoterma appears in the form of sheaths surrounding the separate bundles and hence the fibro-vascular cylinder in this phase of development is astelic. If a section be made through the young axis in the region where the

47. Ann. Sci. Nat. Bot., 5 ser., 6 tom. Recherches sur la Structure des Aroidées.

48. Op. Cit., plate 4, fig. 5.

tuber passes over into the narrower cylindrical stem characteristic of the older plant, a single circular series of collateral bundles can still be observed. If the sections through this region be treated with sulphuric acid or with phloroglucin and hydrochloric acid, it may be demonstrated that the bundles are no longer surrounded by individual phlœotermal sheaths, but that a single lignified external phlœoterma surrounds the whole complex of bundles. There is present in this species a state of affairs comparable to that already described as occurring in the young stelar system of *Ranunculus rhomboideus*, *viz.*, a primitive so-called astelic condition followed by medullated monostely resulting from the degeneration of the internal phlœoterma. The gaps between the bundles in this stage may be compared with those subtending the subsidiary smaller leaf-traces of many Ranunculaceæ; for in the case of the latter, the fundamental tissues of the pith and of the cortex do not communicate through the foliar gaps because these are so exiguous that they are filled up by the pericycle flanking the adjacent fibro-vascular segments. In *Symplocarpus fœtidus*, the gaps are consequently patent in the thick tuberous base of the primary axis, but in its narrower subsequent cylindrical portion they are occluded by the encroachment of the pericycle on the reduced interval between the fibro-vascular strands. The foliar gaps are, nevertheless, morphologically indicated by the lacunæ in the fibro-vascular cylinder, filled with pericycle, which subtend each and all of the leaf-traces, no matter how small. Not far above the region of transition already described, the central cylinder becomes modified by the appearance of medullary strands and the fibro-vascular bundles become forthwith amphivasal. Photograph 12, plate 8, reproduces the appearance of the central cylinder in a section passing through the cylindrical axis about half a millimetre above its junction with the basal tuber; *c* is the external phlœoterma; *a* are the peripheral bundles, and *b* are leaf-traces which have begun to run in the medulla in the characteristic monocotyledonous fashion.

In *Zea mais* the epicotyledonary stele is a continuous cylinder of fibro-vascular tissue throughout the first internode, which is generally two or three centimetres in length. There is a single gap in the side of the cylinder throughout the internode corresponding to the trace of the cotyledon or scutellum. Above the second node, the fibro-vascular tube is perforated by a large number of foliar gaps, and the leaf-traces corresponding to these immediately pass into the medulla, and pursue henceforth the course so characteristic of the foliar strands in the monocotyledons. There is a well-marked external lignified phlœoterma and a less well-marked and somewhat interrupted internal phlœotermal sheath. The external and internal phlœotermas apparently do not unite through the foliar gap corresponding to the cotyledonary trace, probably for the reason that the latter is plugged with pericycle.

The writer believes it inadvisable at the present time to enter further into the subject of the development of the central cylinder of the monocotyledons, since it is somewhat complex and specialized, and, moreover, presents a number of interesting features which merit a separate consideration.

CONCLUSIONS.

As a preliminary to the description of his own observations on the anatomy and development of the vegetative axis in the Angiosperms, the writer has suggested certain questions to be answered by a renewed investigation of the facts. It is now in order to discuss how far the study of development and the re-examination of the anatomy of the central cylinder of the Angiosperms recorded in the preceding pages elucidate the problems suggested in the introduction.

I.—The first question concerns the accuracy of Van Tieghem's description of the mode of origin of his polystelic type of central cylinder. As has been already stated, he regards the polystelic arrangement of vascular strands as the result of the repeated bifurcation of the primary stele. If the writer's observations on the development of the central cylinder in the Filicales as exemplified by his description of the stelar development of *Pteris aquilina*, are correct, the vascular axis in Van Tieghem's polystelic type develops as a concentric fibro-vascular tube perforated by gaps corresponding to the points of exit of the leaf-traces. There is consequently no indication whatever of the repeated forking of the primary stele. In the case of the polystelic Angiosperms, the writer's observations on the Primulaceæ, Halorhagidaceæ and Saxifragaceæ, as well as those of Gwynne-Vaughan on the Primulaceæ, go to show that here also there is no indication of the repeated bifurcation of the epicotyledonary stele, but that the latter gives rise to a tubular central cylinder characterized by lacunæ subtending the points of exit of the foliar strands. It would appear that Van Tieghem has failed to notice the extremely important influence of the leaf-traces on the conformation of the central cylinder in the Filicales and Angiosperms. Had he devoted more attention to the subject of development, this important feature could hardly have escaped his observation.

The writer has already referred to the inadequacy of Van Tieghem's conception of the so-called polystelic type. It seems inappropriate to designate the young tubular central cylinder of *Pteris aquilina* and *Primula auricula* as gamostelic, since the use of this term implies Van Tieghem's conception of the repeated bifurcation of the primary stele and the subsequent union of the fractions to form a stelar tube. The study of development shows the tubular condition to be in reality primitive and the writer[49] has, previously, in view of that fact, suggested that this form of central cylinder be designated siphonostelic.

The studies of Gwynne-Vaughan and of the writer on the Primulaceæ, Halorhagidaceæ, and Saxifragaceæ seem to show that the siphonostelic type of central cylinder, with internal phloëm, is not to be regarded as primitive in the case of the Angiosperms, but that it is derived from a siphonostelic type in which there is primitively no internal phloëm. This conclusion is justified by the fact that the *young* stelar tube is sometimes actually without internal phloëm, *e.g.*, *Primula japonica*, *P. farinosa*, and *Gunnera scabra*, and by the fact that, even when the young stelar axis is concentric from the first, the leaf-traces retain the apparently ancestral collateral type, *e.g.*, *Primula Auricula*. Gwynne-Vaughan attributes the appearance of internal phloëm in the central cylinder of certain Dicotyledons to an effort to make up for the loss of a cambium, a feature correlated with so-called polystely.

II.—The writer's study of the development of the so-called astelic central cylinder of certain Ranunculaceæ and Nymphæaceæ shows that in this type, the course of events is practically the same as that in the so-called polystelic axis, *viz.*, that the epicotyledonary stele becomes in the young plant a tube interrupted by foliar gaps. The tubular character of the stelar system may be subsequently disguised by the increasing complexity of the arrangement of the fibro-vascular strands, but in all such cases the collateral stelar tube may be recognized in the young axis. The writer has not been able to find any evidence in the facts of stelar development in seedlings, supporting Van Tieghem's statement that his astelic type originates by the separation of the phlœoterma into segments, which unite around the individual bundles. Neither do his observations accord with the more recent description given by Van Tieghem[50] of the astelic type, in which he states that astely or schizostely as he now prefers to call it (adopting a suggestion of Strasburger's), originates by the stele breaking up into as many meristeles as it contains bundles. The young stele in these cases is

49. Trans. Brit. Ass. Adv. Sci., 1897, p. 869.

50. Éléments de Botanique, p. 179.

always a continuous hollow cylinder of fibro-vascular tissue, bounded internally and externally by phlœotermal sheaths, which communicate through the foliar lacunæ, and is in fact primitively of the conformation described by Van Tieghem as gamodesmic or gamomeristelic. The use of these terms, however, seems inappropriate, since they imply the union of bundles or meristeles originally separate. The writer has suggested the term siphonostelic as fitly describing the stelar type occurring in the stem of *Pteris aquilina* or *Primula farinosa.* The question may now be asked whether this term should not also be applied to the very similar stelar conformation found in the Ranunculaceæ and Nymphæaceæ. The most striking difference between the stelar systems of the two types is the absence of an internal phloëm in the case of the Nymphæaceæ and Ranunculaceæ. But Gwynne-Vaughan has called attention to the fact that the collateral fibro-vascular strands of the Nymphæaceæ often become concentric, an observation which the present writer has been able to confirm. On the other hand, the siphonostelic central cylinder of *Primula japonica* and *P. farinosa* starts as a collateral stelar tube, only subsequently becoming more or less completely concentric. In the floral axes of these species, moreover, both the internal phloëm and the internal phlœoterma disappear, giving rise to a central cylinder, which, if its mode of origin had not been followed, would be regarded as medullated monostelic. The flowering stems of all the described species of so-called polystelic Primulas have the same peculiarity, It has been shown in the earlier part of this essay that the stelar strands of *Parnassia palustris*, within an interval of a fraction of a millimetre, may be successively collateral and concentric, while in *P. parviflora* the cauline strands are collateral and the leaf-traces concentric. The two types of fibro-vascular strand pass imperceptibly into each other in the Angiosperms, and, as will be subsequently shown, also in the Gymnosperms and the Vascular Cryptogams. It would appear from the study of development that Van Tieghem's polystelic and astelic types are essentially the same, inasmuch as the stelar system in both cases is primitively a tube with foliar lacunæ. Further, the presence or absence of internal phloëm appears to be a matter of slight morphological importance.

III.—We may now pass to the question of the morphology of the medullated fibro-vascular axis, bounded by an external phlœoterma only. It has already been pointed out that Van Tieghem regards the central cylinder in this type as derived from the pithless stele of the hypocotyl, by dilatation and the formation of a parenchymatous medulla, differing morphologically from the fundamental parenchyma outside the stele. It has also been mentioned that Van Tieghem considers that his medullated monostelic type of central cylinder, and his astelic type, may co-exist in different species of the same genus. For example, *Ranunculus aquatilis* is, according to his view, astelic, and *R. abortivus* is, on the other hand, medullated monostelic. Strasburger has questioned the possibility that the pith in different species of Ranunculus should be sometimes extrastelar (in the astelic type), and intrastelar (in the monostelic type). He prefers to consider that the medulla is always intrastelar, and that, consequently, the individual endodermal sheaths in the species of Ranunculus, where they occur, are different morphologically from the phlœoterma, which he supposes surrounds the complex of bundles in the so-called medullated monostelic types.

The writer's examination of the development of a number of species of Ranunculus and Anemone has shown that in the young axis the stelar system possesses an internal phlœoterma which is continuous with the external phlœoterma through the foliar gaps, and is therefore of the same morphological value. In some species the internal phlœoterma disappears in the older region of the stem, *e.g.*, *R. abortivus* and *R. rhomboideus,* and the stelar axis then appears to be monostelic. A study of its development, however, shows that it is primitively astelic.

This view of the matter quite removes the difficulty of having to regard the pith in some species of Ranunculus and Anemone as intrastelar and in other species as extrastelar, because their ontogeny shows that the pith is in both cases extrastelar, *i.e.*, ordinary fundamental tissue which has been enclosed by the stelar tube. In the older stem of various species of Ranunculus and Anemone, both external and internal phlœotermas disappear when there is much sclerenchymatous tissue present in the vascular system. It is probably not going too far to state as a result of the study of development that in the genus Ranunculus the pith is throughout extrastelar. In consequence of his detailed anatomical study of the order Ranunculaceæ, Marié[51] has come to the conclusion that the genus Ranunculus is the stock from which all the other genera of Ranunculaceæ have taken their origin. It will probably not be an easy matter to demonstrate the existence of an internal phlœoterma even in the young stems of the various ranunculaceous genera, especially where there is much sclerification of the central cylinder or much secondary growth, since even the external phlœoterma under these circumstances is nearly always with difficulty distinguishable. It is not unlikely, however, that the internal phlœoterma will be found to persist in the more conservative vascular system of the floral axes. In any case, there appear to be

51. Op. Cit., p. 108.

better reasons for regarding the Ranunculaceæ throughout as astelic, in Van Tieghem's sense, than as entirely medullated monostelic, according to Strasburger, or in part medullated monostelic, and in part astelic, according to Van Tieghem.

If the central cylinder of the Ranunculaceæ be throughout collateral siphonostelic in the sense described by the writer, it would seem necessary to extend that conception of the morphology of the central cylinder to the rest of the dicotyledonous Angiosperms. It appears highly probable that an exhaustive study of seedlings and floral axes of representatives of the various orders will result in the discovery of a number of facts favorable to this view, and an investigation in this direction is in progress.

The writer's observations on Monocotyledons point to the same general conclusion, although here the reduction in size of the foliar lacunæ and the high development of the pericyclic mechanical tissues which has brought this division into special prominence in connection with Schwendener's mechanical theories, make the demonstration of an internal phlœoterma much more difficult. The Aroids have been chosen to illustrate preliminarily the fundamental astely of the Monocotyledons. *Calla palustris* is throughout astelic in Van Tieghem's sense; *Symplocarpus fœtidus* is obviously astelic in the young stem, while in the older axis it is apparently medullated monostelic, on account of the degeneration of the internal phlœoterma. We may preliminarily assume that the Aroids have throughout a pith derived from the fundamental tissues. This conclusion may be extended to the other Monocotyledons and it may be further stated that the primitive stelar condition in the Monocotyledons is tubular, and that the central cylinder is interrupted by foliar lacunæ corresponding to the leaf-traces. The peculiar cauline course of the bundles in the Monocotyledons is not primitive, since it does not appear in the young stem.

Taking into consideration all the facts derived from a study of the Angiosperms, the general statement may be made that the primitive type of stelar system in the group is a hollow fibro-vascular tube with gaps corresponding to the leaf-traces. This type of stele may appropriately be called siphonostelic. In siphonostelic axes the stelar tube may have both internal and external phloëm, and this case may conveniently be described as amphiphloic. Where the internal phloëm is absent, as is the case in the majority of the Angiosperms, the stelar tube is ectophloic. The pith is always to be regarded as merely an included portion of the fundamental tissues.

In the reduced central cylinder of certain angiospermous species of aquatic or amphibious habit, the stelar system has become contracted on account of the correlated degeneracy of the vascular elements. In these cases, the parenchymatous core in the centre of the stele, *e.g.*, that of *Parnassia palustris*, represented in photograph 25, plate 11, is to be regarded as included pericycle, morphologically similar, for example, to that found in the *young* fibro-vascular axis of *Primula farinosa*. The contracted central cylinder in such cases, is none the less to be regarded as essentially siphonostelic, although it has no true medulla.

IV.—We may now ask if the study of the development of the central cylinder in the Angiosperms supplies any morphological facts which are of phylogenetic value. Attention has already been directed to the primitively tubular character of the central cylinder throughout the Angiosperms. It has been furthermore noted that the stelar tube is characterized by foliar gaps corresponding to the traces of the leaves. It is of interest to discover whether the occurrence of foliar lacunæ is constant, or whether it is in any way influenced by environment. The Cactaceæ and the amentiferous genus Casuarina present perhaps the most extreme cases of foliar reduction among the Angiosperms, and it is of interest to discover whether the foliar gaps are obsolete in these examples. The writer has satisfied himself by examination of species of Opuntia and Cereus, of the accuracy of Ganong's[52] statement as to the occurrence of gaps in the fibro-vascular system of the Cactaceæ, corresponding to the extremely reduced leaves. The stelar system of seedlings of *Casuarina equisetifolia* grown from seeds obtained from Kew, is also characterized by the presence of well-marked foliar gaps. It may consequently be assumed that the occurrence of foliar gaps is a constant characteristic of the Angiosperms.

The possession of an essentially tubular stelar system interrupted invariably by foliar gaps appears to be a palingenetic feature of the Angiosperms. In this group there are so few anatomical characters which can rank as phylogenetic criteria that the demonstration of an additional one may be expected to contribute something to the solution of the extremely difficult problem of its origin.

In an earlier memoir,[53] the writer has called attention to the value of a study of the stelar system in connection with the phylogeny of vascular Plants. It would indeed be strange if an apparatus so characteristically separating them as a whole from the lower Cryptogams did not

52. Beiträg. Z. Kennt, d. Morph, u. Biol. d. Cacteen. Inaugural. Dissertation, p. 13, etc.

53. Mem. Boston Soc. Nat. Hist., Vol. 5, No. 5.

manifest some features of phylogenetic importance. The writer has pointed out that siphonostely exists under two modifications among the vascular Cryptograms, *viz.*, siphonostely, in which the gaps of the stele correspond to leaf-traces; and siphonostely, in which there are no foliar gaps, but in which the stelar lacunæ correspond to branches. He has designated the former type phyllosiphonic; the latter, cladosiphonic. The use of this distinction, together with all other available characteristics, results in the placing of the Lycopodiales and Equisetales near one another in the system as groups which are invariably cladosiphonic. The Filicales, Gymnospermæ, and Angiospermæ, on the other hand, are uniformly phyllosiphonic. The writer does not intend to go further into this matter in the present memoir, but it may nevertheless be suggested that there are two distinct primitive groups of vascular plants, *viz.*, the Lycopsida and the Pteropsida. To the former group belong the Lycopodiales and Equisetales; to the latter, the Filicales, the Gymnospermæ, and Angiospermæ. The validity of the classification indicated above, in the case of Lycopsida, has already been discussed by the writer,[54] in his memoir on the genus Equisetum. The considerations which favor the setting up of the other great alliance can be more advantageously examined subsequently.

V. If the writer has correctly interpreted the anatomical facts described and figured in the present memoir, the morphological ideas of Van Tieghem can no longer be accepted in full. It is the great merit of that distinguished botanist to have recognized in so large a measure the essential unity of the fibro-vascular system of plant axes. That he should have gone too far in the direction of unity in the case of the so-called medullated monostelic type, and not far enough in his polystelic type, is to be explained by the comparatively slight attention given by him to the subject of development. Strasburger, in respect to monostely, has gone even further than Van Tieghem, for he unites Van Tieghem's astelic type with the medullated monostelic, and regards the medulla in both cases as intrastelar parenchyma. *An examination of the anatomy of the young axis* apparently brings us back to the standpoint of De Bary in regard to the morphology of fibro-vascular strands. The older anatomist, however, on account of his intentional neglect of ontogeny, appears to have completely overlooked the morphological unity of the cauline fibro-vascular apparatus of the Angiosperms.

Since it is impossible to investigate experimentally any but the

54. Mem. Boston. Soc. Nat. Hist., Vol. 5, No. 5.

smallest morphological problems, all interpretations of the greater questions of morphology must ever remain more or less hypothetical. The persistent recurrence of a tubular stelar system throughout the various groups of vascular plants suggests that the tubular arrangement of the primitive skeletal tissues is often an advantage. The nature of the advantage is apparently not far to seek. One important function of plant axes is to afford support to their appendicular organs, and we may regard the tubulization of the stele as an adaptation for this purpose. Where the mechanical function is taken on by the extra-stelar tissues, siphonostely is often absent or degenerate. Further, those organs of plants which are normally supported by the soil, viz., the roots, are not primitively siphonostelic at all, and in the comparatively rare cases where their central cylinder is medullated, its parenchyma is derived from the pith of the stem. The truth of the latter statement will be more apparent when the development of the stem in certain Filicales has been described. It would consequently appear that the tubular fibro-vascular cylinder, which is so characteristic of the cauline axis of the Angiosperms, is the result of the operation of mechanical causes, and that the anatomical peculiarities which distinguish the primary central cylinder of the root from the stelar tube of the shoot are primitive features, retained undisturbed by the mechanical influences acting on the stem.

SUMMARY OF RESULTS AND CONCLUSIONS.

1. The polystelic type of Van Tieghem is not characterized by the repeated bifurcation of the epicotyledonary stele, but there is primitively in the young stem of this type a tubular concentric stele with foliar gaps subtending the points of exit of the leaf-traces.

2. The astelic type of Van Tieghem does not result from the separation of the epicotyledonary stele into its constituent bundles; for in the young so-called astelic axis, there are no bundles present at all, but a collateral stelar tube with foliar gaps subtending the leaf-traces, through which the internal and external phlœotermal sheaths communicate.

3. The medullated monostelic type of Van Tieghem does not originate, as he states, by the dilatation of the epicotyledonary stele and the formation of an *intrastelar* pith; for the writer's observations show that in favorable cases, both among the Dicotyledons and the Monocotyledons, the so-called medullated monostelic central cylinder of the older stem may be seen to be derived from the so-called astelic condition of the *young* axis, by the degeneration of the internal phlœoterma.

4. Van Tieghem's three types of central cylinder indicated above are all merely modifications of a single type, which has been designated by the writer, siphonostelic. In this type the central cylinder is primitively a fibro-vascular tube with foliar lacunæ opposite the points of exit of the leaf-traces. In the so-called polystelic modification, the central cylinder has internal, as well as external phloëm, and may be described consequently as amphiphloic. In the astelic type of axis so-called, the internal phloëm is absent and the central cylinder is accordingly to be designated ectophloic. The medullated monostelic type of Van Tieghem is derived from the last-named by the degeneration of the internal phlœoterma or endodermis.

5. The siphonostelic type of central cylinder as defined above is probably to be regarded as the result of the mechanical strengthening of the cauline axis to enable it to support the palingenetically large leaves which are characteristic of the Angiospermæ, Gymnospermæ, and Filicales. In these three groups, the siphonostelic, fibro-vascular cylinder is invariably distinguished by the presence of gaps corresponding to the points of exit of the leaf-traces, and, in this feature, offers a marked contrast to the tubular central cylinder of the Lycopodiales and Equisetales, in which there are no foliar lacunæ, but, on the contrary, gaps subtending the branches.

6. A study of the development and structure of the fibro-vascular apparatus of the various groups of vascular plants is likely to throw considerable light on their phylogeny and to elucidate the causes of the morphological differences in the structure of the central cylinder of root and shoot.

For many kindnesses in the matter of supplying material for this research, the writer wishes to express his obligations to the Director of the Royal Gardens, Kew; to the Director and Assistant Director of the Botanical Gardens of Harvard University; to Dr. D. H. Scott. Honorary Director of the Jodrell Laboratory, Kew, and to Mr. Jackson Dawson, of the Arnold Arboretum of Harvard University. He is specially indebted in this respect to Prof. G. L. Goodale, Director of the Botanical Gardens of Harvard University. Lastly, the writer owes not a little to his assistant, Mr. R. B. Thomson, B.A., for help in securing the seedlings necessary for the present investigation.

DESCRIPTION OF THE PLATES.

PLATE VII.

PHOTOGRAPH 1.—Transverse section of a young stem of *Pteris aquilina*, at the point of origin of the second leaf. (X 40.)

PHOTOGRAPH 2.—Transverse section of the older stem of *P. aquilina*: l^1 and l^2 are leaves; *r* is a root. (X 25.)

PHOTOGRAPH 3.—Transverse section of the stem of *P. aquilina* above the region of forking of the stelar system; *a* and *b* are the two cylindrical steles; *l* is a leaf-trace. (X 15.)

PHOTOGRAPH 4.—Transverse section of the young horizontal rhizome of *P. aquilina*. (X 25.)

PHOTOGRAPH 5.—Transverse section of the older horizontal rhizome of *P. aquilina*. (X 25.)

PHOTOGRAPH 6.—Transverse section of a still older region of the same. (X 25.)

PLATE VIII.

PHOTOGRAPH 7.—Transverse section of young stem of *Primula farinosa*. (X 40.)

PHOTOGRAPH 8.—Transverse section of the older stem of *P. farinosa*: l^1 and l^2 indicate the foliar gaps; r^1 and r^2 are roots. (X 25.)

PHOTOGRAPH 9.—Transverse section of the same stem with same lettering as photograph 8. (X 25).

PHOTOGRAPH 10.—Transverse section of the young stem of *Nelumbium luteum*, at the point of origin of the cotyledons. (X 25.)

PHOTOGRAPH 11.—Transverse section of part of the tuberous region of the stem of *Symplocarpus fœtidus*, showing the so-called "astelic" condition. (X 25.)

PHOTOGRAPH 12.—Transverse section of cylindrical portion of the stem of the same, showing the "medullated monostelic" condition; *c*, phlœoterma; *a*, peripheral strands; *b*, foliar traces. (X 20.)

PLATE IX.

PHOTOGRAPH 13.—Transverse section of the young stem of *Ranunculus acris*. (X 25.)

PHOTOGRAPH 14.—Transverse section of the older stem of *R. acris*. (X 25.)

PHOTOGRAPH 15.—Transverse section of the older young stem of *R. abortivus*. The internal phlœoterma is still perceptible. (X 25.)

PHOTOGRAPH 16.—Transverse section of the older young stem of *R. rhomboideus*. The internal phlœoterma cannot be distinguished. (X 25.)

PHOTOGRAPH 17.—Transverse section of the young stem of *R. rhomboideus.* The internal phlœoterma is still visible. (X. 25).

PHOTOGRAPH 18.—Transverse section of the young stem of *R. rhomboideus*, showing the communication of internal and external phlœotermal sheaths through the foliar lacuna. (X. 25.)

PLATE X.

PHOTOGRAPH 19.—Transverse section of the young stem of *Anemone pennsylvanica*, showing the presence of an internal phlœoterma. (X. 25.)

PHOTOGRAPH 20.—Transverse section of the older young stem of *A. pennsylvanica*, showing the overlapping of the foliar gap. (X 25.)

PHOTOGRAPH 21.—Transverse section of the young stem of *Brasenia purpurea*, showing the primitively tubular condition of the stelar system. (X. 20.)

PHOTOGRAPH 22.—Transverse section of the young stem of *Nuphar luteum*, var. *Kalmianum*, showing the tubular stele. (X 25.)

PHOTOGRAPH 23.—Transverse section of the older young stem of *Nuphar advena.* (X 25.)

PHOTOGRAPH 24.—Transverse section of the young epicotyledonary stelar system of *Nelumbium luteum; a*, primitive stelar strands; *f*, cortical bundles. (X 25.)

PLATE XI.

PHOTOGRAPH 25.—Central cylinder of *Parnassia palustris.* (X 45.)

PHOTOGRAPH 26.—"Polystelic" phase of central cylinder of *P. palustris*, l^1 and l^2 are leaf traces. (X 12.)

PHOTOGRAPH 27.—Inferior region of "astelic" portion of central cylinder of *P. palustris.* (X 45.)

PHOTOGRAPH 28.—Transverse section of the stele of *P. palustris*, at point of origin of a leaf-trace (X 12.)

PHOTOGRAPH 29.—Transverse section of "astelic" central cylinder of *P. parviflora*, g^1 and g^2 are foliar gaps; *l* is a leaf-trace. (X 25.)

PHOTOGRAPH 30.—Transverse section of central cylinder of the young stem of *Hepatica triloba.* (X 40.)

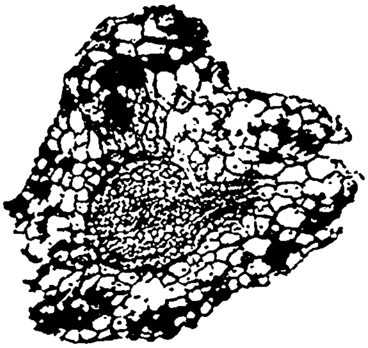


Fig. 1.

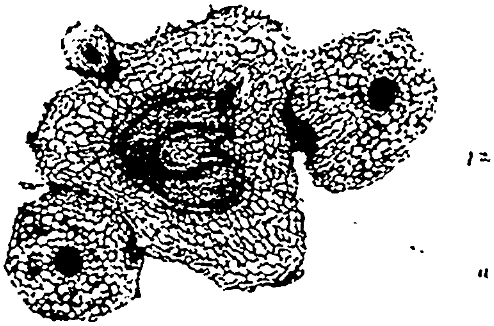
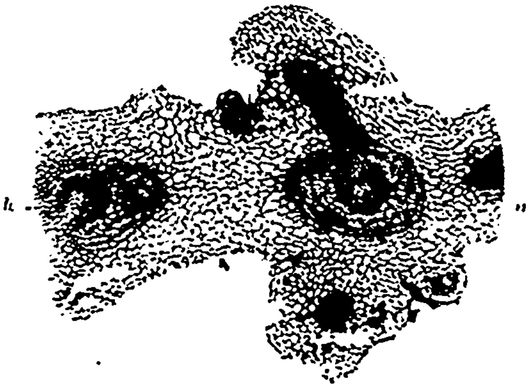


Fig. 2



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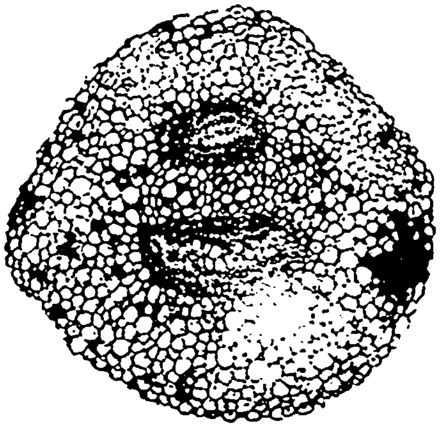

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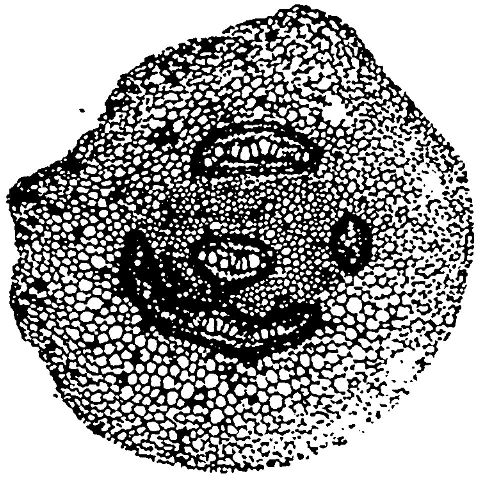
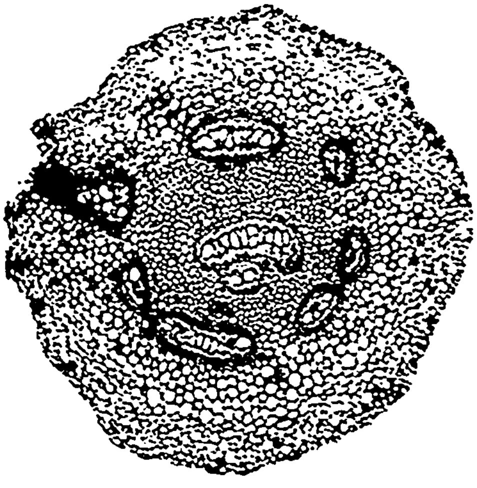


Fig. 5



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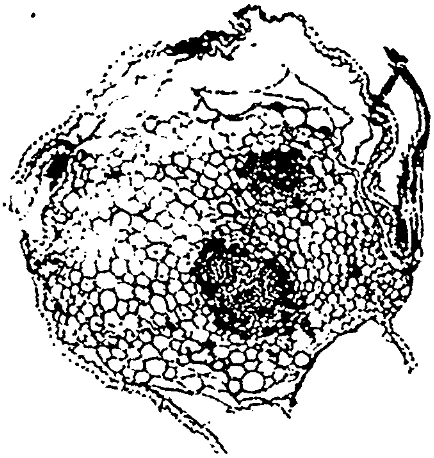

Fig.7.

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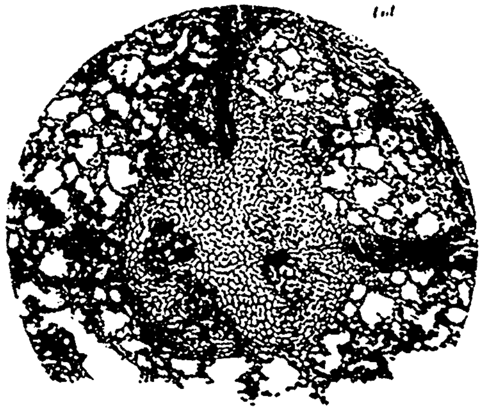

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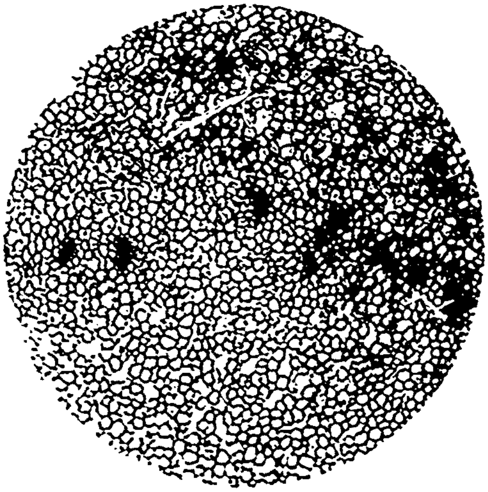

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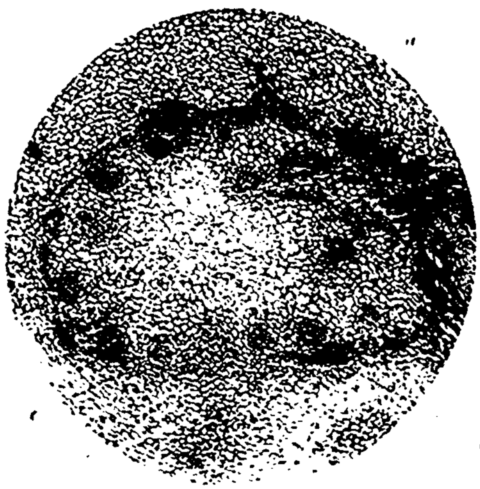

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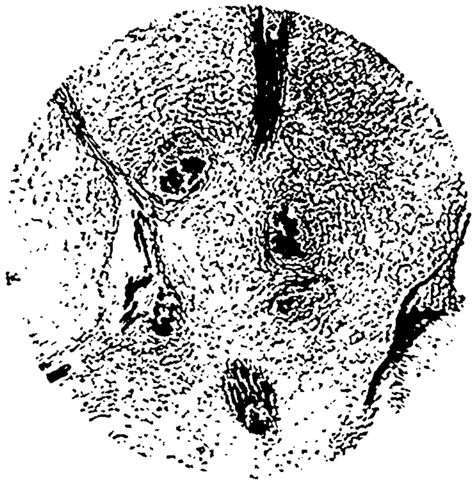

Fig.14.

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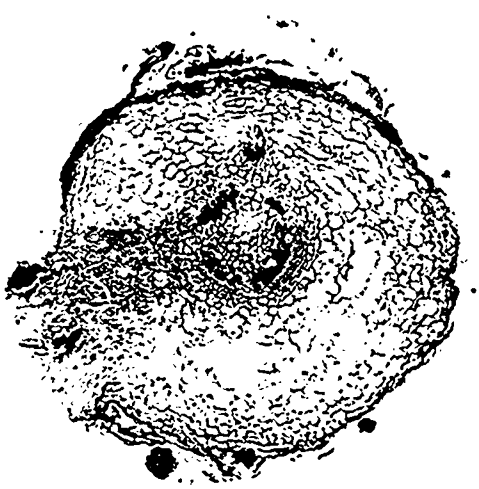


Fig.17.

Fig.18.

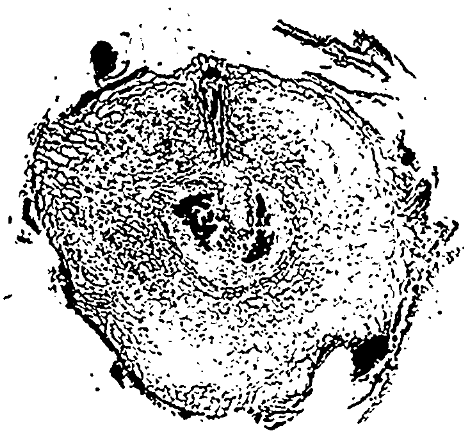
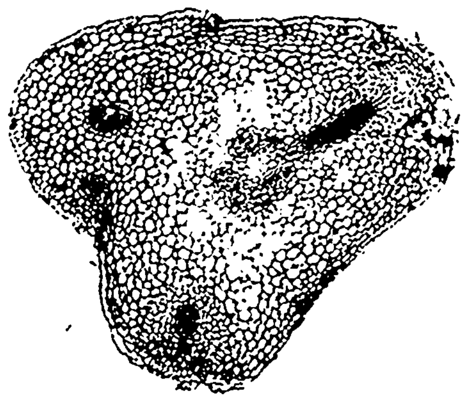


Fig.19.

Fig.20.

Fig.21.



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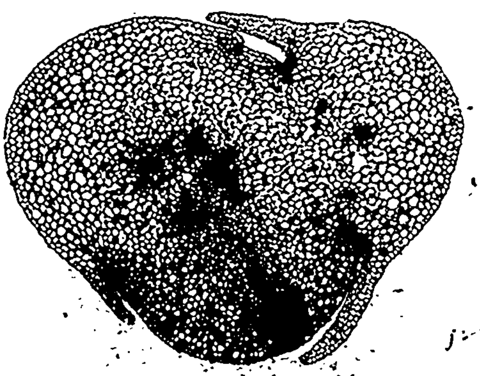

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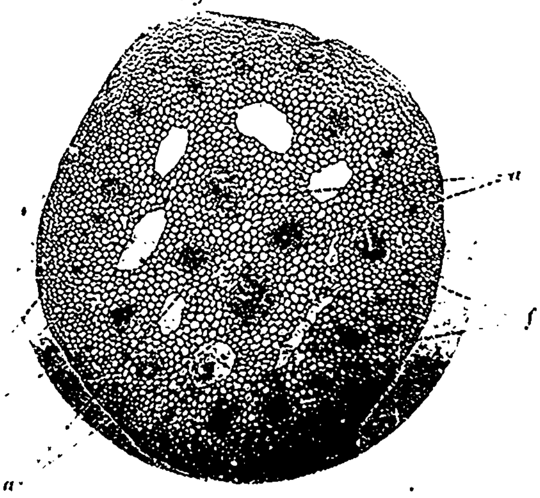

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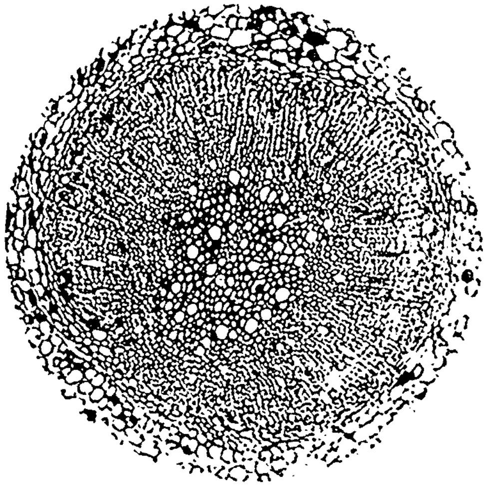

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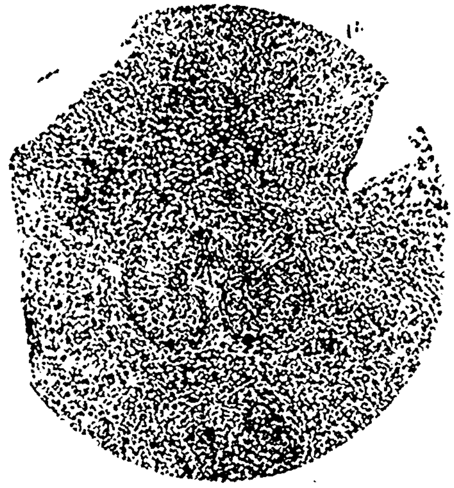

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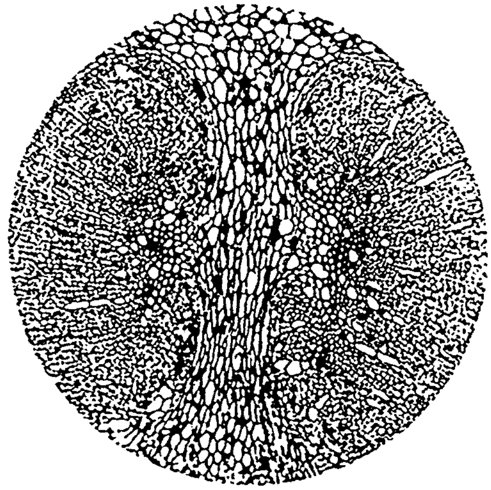

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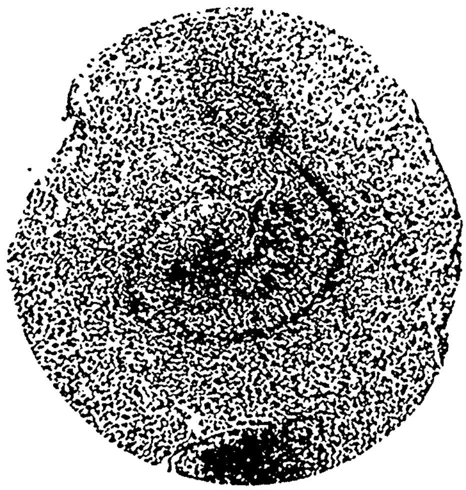

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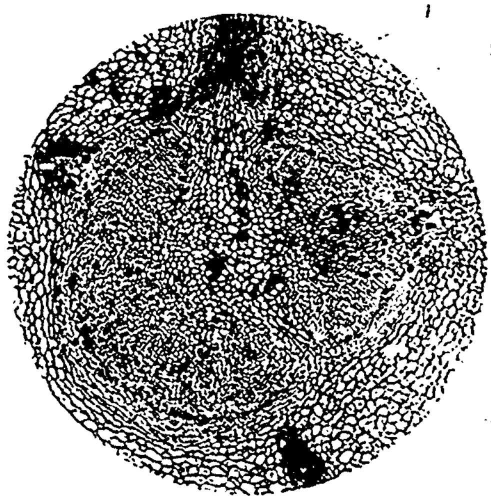


Fig. 29.

Fig. 30.

NEW SPECIES OF CANADIAN FUNGI.

By J. B. Ellis and John Dearness.

(Read May 6th, 1899.)

Cercospora Cypripedii, E and D. Mostly hypophyllous on oblong-linear, brown areas of the leaf bounded by the veins. Hyphæ pale brown, continuous, subgeniculate, $10-30 \times 4-5\mu$, solitary or sparingly fasciculate. Conidia sublinear, 5–6 septate, deciduous, $30-150 \times 3\frac{1}{2}-5\mu$.

On living leaves of *Cyprepedium spectabile* and *C. pubescens.* Shore of Lake Huron near Southampton and Komoka. (D. No. 2883.)

Cercospora Epigææ, E and D. Spots dark brown, small, (1 – 3 mm.), definite. Fertile hyphæ cæspitose, continuous, brownish, entire or imperfectly toothed above, $15-22 \times 3\mu$. Conidia slightly tapering above hyaline, continuous $40-60 \times 3\mu$.

On living leaves of *Epigæa repens.* Shore of Lake Huron near Southampton, Ont., August 1898. (D. No. 2882.)

Phyllosticta palustris, E and D. Spots irregular in shape, subcircular, brown or purplish brown, 2 – 4 mm. in diameter, inclosing one or more small, round, white spots, ½ – 1 mm. in diameter. Perithecia solitary, epiphyllous, one in the centre of each white spot, punctiform, minute, black. Sporules oblong-elliptical, minute, $3-4 \times 1-1\frac{1}{4}\mu$.

On living leaves of *Stachys palustris* at Birr, near London, Ont., July, 1898. (D. No. 2869.)

This species has smaller sporules than *Phyllosticta Stachydis* Brun., and also differs from that in its solitary perithecia.

Dothiorella Canadensis, E and E. Stroma suborbicular, about 1 mm. in diameter, black, suberumpent, cracking the closely adherent epidermis in a substellate manner. Sporules oblong-elliptical, hyaline, $20-26 \times 12-13\mu$, on stout pedicels about as long as the sporules.

On dead poplar branches. Ottawa, Canada, Nov. 1898. (Macoun, No. 463.)

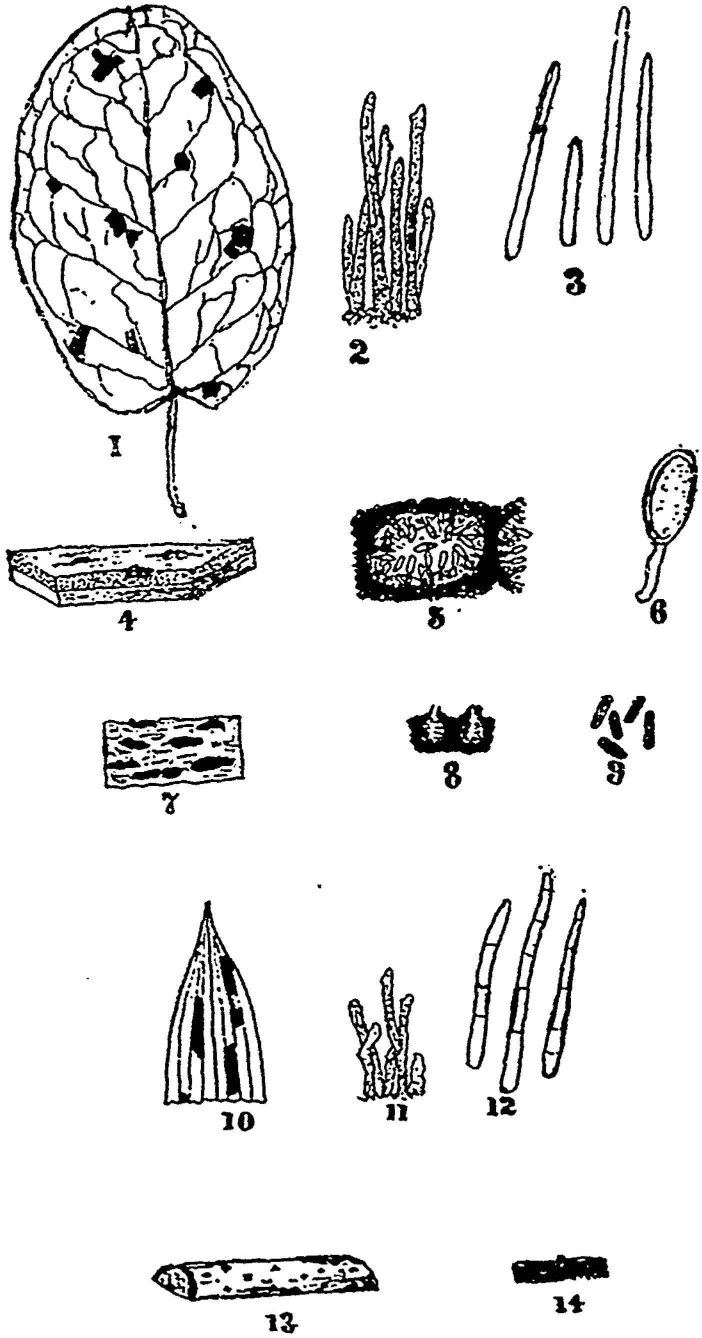
This differs from *Dothiorella quercina*, Pk., principally in not being distinctly erumpent.

HAPLOSPORELLA STAPHYLINA, E and D. Stromata orbicular, 1–1½ mm. in diameter, or linear 2–4×1 mm., black, mostly flat or concave above, surrounded by the erect, free margin of the ruptured epidermis. Perithecia sunk in the stroma with only their apices projecting, sometimes semi-erumpent; two to four or more in a stroma. Sporules oblong, brown, obtuse at the ends, 13–25×6–8μ.

On dead *Staphylea trifolia*. On the mountain above Montreal. Nov. 1898. (D. No. 2901.)

DIPLODINA MACROSPORA, E and E. Perithecia scattered, sub-cuticular, about ½ mm. in diameter, hemispheric, prominent, covered by the blackened, partially adnate epidermis which is pierced, or oftener transversely split by the papilliform ostiolum. The perithecia are seated on the surface of the inner bark and but slightly sunk in it, and in the areas occupied by the perithecia the epidermis is loosened and paler. Sporules oblong-elliptical, hyaline, 20–30×10–12μ, becoming uniseptate, on stout slightly swollen basidia 10–12μ long. This species differs from *Diplodia mamillana*, (Fr.), only in its hyaline, oblong-elliptical sporules.

On dead limbs of *Cornus* sp.; Bay of Islands, Newfoundland; Aug. 1898. Coll. Rev. A. C. Waghorne.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EXPLANATION OF PLATE.

CERCOSPORA EPIGÆÆ, E AND D.

FIG. 1.—A leaf showing the angular spots on the surface of which the fasciculate hyphæ are seated on minute pustules.

FIG. 2.—A group of fertile hyphæ.

FIG. 3.—Conidia × 450.

DOTHIORELLA CANADENSIS, E AND E.

FIG. 4.—A bit of bark bearing the fungus.

FIG. 5.—Horizontal section through conceptacle.

FIG 6.—A sporule.

HAPLOSPORELLA STAPHYLINA, E AND D.

FIG. 7.—Surface of a bit of bark of Staphylea trifolia, indicating the shallow eruptions produced by the stromata.

FIG. 8.—Two of the conceptacles.

FIG. 9.—A group of brown spores × 400.

CERCOSPORA CYPREPEDII, E AND D.

FIG. 10.—The tip of leaf showing linear fungus spot.

FIG. 11.—A group of fertile hyphæ.

FIG. 12.—Conidia × 450.

DIPLODINA MACROSPORA, E AND E.

FIG. 13.—A cornus twig showing eruptions of fungus natural size.

FIG. 14.—The position of a perthicium between outer and inner bark.

CELEBRATION OF THE FIFTIETH YEAR OF THE CANADIAN INSTITUTE.

The Canadian Institute celebrated its fiftieth year by holding a Conversazione in the School of Practical Science, on the evening of Saturday, 9th December, 1899. It was a brilliant gathering, graced by the presence of His Excellency the Governor-General and Major General Hutton, and embracing many of the leaders in the social, literary and commercial life, not only of Toronto, but of the Dominion. An interesting circumstance was that the three survivors of the original charter-members, Sir Sandford Fleming, Mr. Kivas Tully, and Mr. Thomas Ridout, were all present. The two former were already Honorary Members, and upon this occasion the name of Mr. Ridout was added to the roll.

The *Globe* in reporting the proceedings used the following language:—

"His Excellency the Governor-General attended the conversazione at the School of Practical Science given on Saturday evening by the council and members of the Canadian Institute in celebration of the fiftieth anniversary of the foundation of the society. The function was attended by over one thousand persons, and it will rank as one of the most interesting affairs in the social history of the city. The invitation list included the names of those most prominent in the world of science, of art, of literature, of learning, and the gathering was a vast assemblage of distinguished men and women. The Canadian Institute stands in the front rank of the public bodies in the city, and its membership roll consists of the leaders in scientific thought. On December 8th, 1850, its first annual meeting was attended by a few zealous supporters of the cause of science. Its fiftieth annual meeting was graced by the presence of many distinguished men in every walk of life, with the representative of the Crown as the chief speaker.

"The School of Practical Science was changed for the occasion from an ordinary seat of learning to a temple of beauty. Flags, banners and bunting were abundantly used, and the staircase and principal corridors were resplendent with the national colors. The guests began to arrive shortly before eight o'clock, and were conducted to the assembly hall, where a short programme of congratulatory speeches was carried through. Afterwards the laboratories and museums of the school were thrown open and highly interesting experiments were conducted by the students, who were present in force. The Band of the 48th Highlanders was stationed in the lower hall, and excellent music was rendered as the guests threaded their way from one entertaining scene to another. Members of the Council of the Canadian Institute and several students of the School of Practical Science pointed out the places of interest and gave information regarding the working of the scientific apparatus. Questions were profusely asked and liberally answered, and each guest found many objects to which he might devote attention. Surprise and wonder were mixed with intense curiosity as to the purpose and use of the many wonderful instruments which constitute the equipment of Ontario's greatest scientific institution. The attractive features of the evening's varied entertainment were discussed to the accompaniment of delicious refreshments, served by Webb in the draughting rooms. Half an hour before midnight the conversazione was brought to a close, and the delighted guests showered congratulations upon their learned hosts."

The chair was taken by the President, B. E. Walker, Esq., F.G.S., who spoke as follows :—

Your Excellency, Ladies and Gentlemen:—

We are to celebrate to-night the fiftieth anniversary of a scientific society. This would not be a very notable event in an old country, but it is a most unusual one in Canada. Fifty years in a rapidly growing young country is long enough to give comparative antiquity to the early years of the period, even if the past half century had not been so prolific in scientific achievement.

In 1849 the population of Upper Canada was less than 800,000 and of Toronto less than 25,000. We had practically no manufactures, only a few miles of railway, few banks—with very trifling deposits. All that we had in plenty were land and debts. The religious quarrels over our early universities were abating just enough to make first attempts at higher education possible, and the future school systems were slowly taking shape. Our Geological Survey had been established six years, and there was not, I think, a scientific journal in Upper and Lower Canada. True, the Literary and Historical Society of Quebec had published Scientific papers as early as its first volume in 1829, but it did not continue to do so, while the first volume published by the Natural History Society of Montreal appeared in 1857.

Must we not wonder at the little band who thought there was a prospect for science in Upper Canada? Like our first Governor Simcoe, who was quixotic enough to plan colleges and even universities while he followed the Indian trails in our unbroken forests, these founders of our Institute, three of whom are with us to-night, were also quixotic enough to believe in a future to our civilization which might support the claims of science. But indeed the British Empire was created and is being enlarged by the dreamers—by the Quixotes who in the day of small things see so much farther into the future than the pessimists who smile at their enthusiasm.

Sir Sandford Fleming will perhaps tell us of our day of small things and how nearly the spark went out, but to-day we are able to point to a continuous series of publications for fifty years and this, in Canada, is no small boast. From time to time the character of our publications has waxed and waned, but when, in a few weeks, the Memorial Volume, which marks our fiftieth year, reaches the world of science, I think we shall be able to claim that it would not only reflect credit on any scientific society, but that it surpasses, in original investigation, any scientific journal ever published in Canada.

During these years we have been gathering, as the result of exchanging our publications with those of other learned societies, a large library of a character quite unique in Ontario, and destined to be invaluable in the future as a public educator. When we have regular post-graduate courses in our Universities, when original research is extensively carried on in Canada, when our Province establishes a natural history and geological survey, the true value of our library will be realized. In the meantime those who are caring for it are carrying on a species of public trust, the importance of which I think they recognize.

But for all this we need money. There have always been men willing to give their time and zeal to such work, but their task would be enormously lighter if the roll of membership did not reflect so much indifference on the part of the general public. The existence of the Institute has been possible largely because of the generous help of the Ontario Government, and I take this opportunity of thanking the Premier and the Minister of Education for their practical sympathy, but is it not time for our intelligent citizens to show their appreciation by becoming members? I must not take too much advantage of the opportunity afforded by this occasion, and yet I must be frank enough to express my conviction that it is the duty of every prominent citizen in Toronto to be an ordinary or a life member of the Institute.

On an occasion of this character the personal element in the history of the Institute claims our attention. The roll of Presidents is so illustrious that I scarcely know whether to be more proud or alarmed at filling, for the moment, an office held by so many distinguished Canadians. The first President, after incorporation, was Sir William Logan, who was also the first Director of our Geological Survey. He was followed by Gen. Sir J. H. Lefroy, Sir John Beverley Robinson, the Hon. Geo. W. Allan, the Hon. W. H. Draper, Sir Daniel Wilson, Sir J. H. Hagarty, the Rev. John McCaul, Sir Oliver Mowat, the Rev. Dr. Scadding, President Loudon and others.

I have mentioned that we have with us to-night, three of the first members of the Institute, Sir Sandford Fleming, Mr. Kivas Tully and Mr. Thomas Ridout. Sir Sandford Fleming was our first Secretary, and the real founder of the Institute. It was because he would not submit to failure that the Institute survived, and during these fifty years he has been its unvarying friend and supporter. In joining with us in celebrating the jubilee of the Institute, I hope you will associate with it, in your minds, the three original members who are present with us to-night.

Before asking the Governor General to address you, permit me to thank His Excellency for his presence and to greet most heartily all those who are here to-night as the guests of the Institute.

His Excellency the Governor-General was accorded a warm reception on coming forward to address the gathering. He said :—

Ladies and Gentlemen,—

I am very glad to have an opportunity of congratulating the Canadian Institute on its fiftieth birthday, for though the Institute is still on the youthful side of its fiftieth official anniversary (as it was not, I understand, in existence under royal charter till November, '51), it may justly, I think, consider to-night its jubilee, dating from the summer of '49, when those few active minds, to which not only the Institute, but Canada also, owes so much, first drew up their prospectus.

The Canadian Institute came into the world with no flourish of trumpets, like many other great societies. Its success has grown out of small beginnings. It has had to fight its way in its early days against want of support, want of public appreciation, and want of funds, but always gaining ground and earning increased recognition, till it attained the high position it now occupies.

Ladies and gentlemen, it is no intention of mine to attempt to enter into any detailed consideration of the scientific cause of the Canadian Institute. I should be incapable of doing so, even if I wished it. I can only presume to recognize as one of the public the high aims it has had in view, and the good work it has done.

As I have already said, the Society originated from a small beginning; in its early days it may be said to have been of a professional character; it was originated by a few ardent spirits engaged chiefly in surveying and engineering, in the hope of drawing together those interested in the same object, who, by discussion and interchange of views, might be able to increase and benefit their professional experience, but enthusiastic as was the conception on which the Society was founded its promoters soon recognized that its rather narrow professional organization was obtaining only a flagging interest, and they boldly ventured upon broader lines. They determined that the purely professional characteristics of the Society must give place to those of greater scope, and in 1851 the Canadian Institute was incorporated by royal charter, its accepted object being "the promotion of pure and applied science," a definition which goes far to indicate the encouragement of all that detailed knowledge of professional trades, literature, and art which helps to ensure a nation's greatness.

The Institute has sought successfully by various methods to carry out the higher aims it has in view. It has sought not only to encourage scientific study, but to encourage investigation and the application of it to practical results, and by the careful publication of its own proceedings, and by an interchange of these with the proceedings of kindred societies all over the world, it has placed a vast amount of varied knowledge at the disposal of the public, and not only that, it has earned for itself a claim to respect which any Government would gladly welcome in regard to its possible recommendations for those matters of public utility with which science is so frequently connected. No doubt you all recognize how great a part science has played in the history of the world, and looking around us in Canada and the vast undeveloped resources of the country, we must realize how much the future must depend on the application of scientific knowledge, and cannot be too grateful to the learned founders and members of the Canadian Institute for the opportunities of scientific study they have so ably placed within the reach of a rising generation.

Sir Sandford Fleming, K.C.M.G., LL.D., spoke as follows :—

Your Excellency, Mr. President, Ladies and Gentlemen :

It is my happiness to be the medium to convey to the members of the Canadian Institute, on this auspicious occasion, the congratulations of Queen's University.

As the official head of a seat of learning in another part of Canada, I bring the warmest felicitations. On the shelves of our library in Kingston, we have the very best testimony of the useful work upon which this association has been engaged for half a century. We have only to open these thirty-four volumes and examine the many papers relating to the intellectual and material development of the country, and to matters of common interest to all countries, to find special cause for thankfulness that the Canadian Institute has been essentially a working society for so long a period as fifty years, and that it is now firmly established.

We recognize that every society, such as this, is a human agency employed to shape and develop movements for the common good. On this pleasant planet we find everywhere a field for such agencies. Each individual member of such societies is an agent. He is given an opportunity of co-operating with his fellow-members in investigations, in acquiring information, or in assisting in disseminating knowledge obtained. In one way or another, every right-minded person, by becoming a member, can extend a helping hand in promoting the general advantage. Members of the Canadian Institute have accepted the opportunity offered them, and we come to recognize that their united efforts have been crowned with a full measure of success.

This society, as its name implies, is neither sectional nor local ; it occupies a wide sphere of activity and usefulness. One of its functions has been to encourage workers in all parts of Canada, however remote, to induce them to bring forward the result of their investigations, and to have those results of sufficient importance placed on record.

For half a century the Institute has diligently followed its broad, elevated and patriotic aims. Its published proceedings have regularly found their way to kindred societies in every civilized country, and by being placed in the great public libraries of the world they are made accessible to all peoples. Inquiry into the published proceedings goes to show that the society has given much attention to questions of public concern, and by its successful efforts in extending the domain of knowledge, it has been the means by which great benefits have been conferred upon the scientific and general public, both within and without the Dominion. We must, therefore, recognize the valuable and permanent services rendered to Canada by the society which we are now assembled to honour.

Queen's University cherishes a warm sympathy with the aims and the aspirations of the Canadian Institute. All the friends of Queen's rejoice in this celebration, and no greetings are more cordial than those I bring from the City of Kingston and from our graduates in all parts of the Dominion. Our earnest hope is that each succeeding year will bear witness to the steady progress in usefulness of this society, and that the name of the Canadian Institute may acquire increased lustre as the events of each succeeding generation pass into history.

Mr. President, it is not simply as the official head of a Canadian University that I have come to pay tribute to the good work done by the society over which you preside.

I am highly privileged in being called upon to address you in a two-fold capacity. It is my happiness, as an early member of the Canadian Institute, to bear testimony to the progress made and the benefits which have resulted from the work which has been achieved.

This is the fiftieth annual meeting. There are not many who can look back with me through the heat and haze of fifty Canadian summers and the snows of fifty Canadian winters to the beginning of this society in the year 1849. The first annual meeting was held on Saturday evening, December 7th, 1850. At that date, the close of the first year of the society's existence, the membership counted sixty-four persons. Eight of these early members are still alive, and of the eight who survive, I am delighted to find in this assembly, three who took an active part in founding the Canadian Institute so many years ago. I rejoice again to meet at an annual meeting of the Institute my old-time co-workers, Messrs. Kivas Tully and Thomas Ridout, both so closely identified with its early days. It will suffice if I mention that in the office of Mr. Tully, the Canadian Institute was cradled, and it was to Mr. Ridout we were under great obligations in connection with the Royal Charter.

These old friends will, I am sure, kindly permit me, on their behalf and my own, to express the very great gratification it gives us to be here to-night. I am afraid, however, I can only feebly and imperfectly put in words the feeling of genuine thankfulness we experience in being permitted to see realized the very sanguine expectations we long ago formed. It is a matter of profound satisfaction to find our society, after fifty swiftly-passing years, so prosperous; to see rallying round it so many distinguished men, and to be privileged to bear witness to its development and progress in the presence of the representative of our Most Gracious Sovereign the Queen.

It is fitting that the society should celebrate th beginning of a new half century of useful work. It is proper that its nembers should take a retrospective glance at the past, in order the better to pursue their useful and elevated aims. To-night we may be said to be taking stock. We are reckoning up the net result of the work in which the busy members of the Institute have been engaged for fifty years. To use another business expression, we are examining the balance sheet, and in connection with this very proper duty I might be tempted to take a general survey of the whole field of work accomplished. You would not, I fear, greatly thank me if I yielded to the temptation, as it would involve a *résumé* of much which has been achieved in Canadian letters and science. Neither shall I at any length presume upon your kind indulgence by entering upon various new matters which suggest themselves to my mind as befitting the consideration of the Institute. There are several important subjects which I would wish specially to dwell upon, but I shall best fulfil my duty, on an occasion like the present, by limiting myself to a few brief words on two subjects which seem to me to be of general interest. I select these two on the ground that, in the wide diversity of intellectual activity in this age, there is a well-known disposition to give a foremost place to matters directly relating to everyday life.

This society has, from the first, kept in view the establishment of a public museum. Many valuable and interesting specimens have every year been added to the collection which had long since been commenced. New gifts will continne to be added from time to time, so that in the event of provision being made for the proper care of all, the collection may grow and develop into a national museum worthy of the name.

It is not alone in the domain of letters and science that the Institute may benefit the public. Some may be of the opinion that Art is beyond the sphere of this society. I venture to differ from that view. Science and Art are frequently, indeed, they are commonly, associated, and it seems to me quite within the functions of the Canadian Institute to promote any subject which tends to uplift the mind and advance the common happiness.

'I have long thought that the Canadian Institute might take a leading part in preserving in the most pleasing and instructive form the events of the past. I have felt that in the interest of Canadian patriotism there should be a national gallery of paintings, which would represent the most important epochs of our history. Our history provides the materials in abundance for its full development. We have indeed a two-fold inheritance—on the one hand, the record of two centuries of discovery and adventure under French rule; on the other hand, the events chronicled for a century and a quarter under British rule. The existence of the primitive race should also be remembered. To carry such a proposal into effect would undoubtedly assist greatly in cultivating a healthy, national feeling. National feeling, we all know, is but a sentiment; but sentiment is recognised to be the most potent influence, and patriotism is the sentiment which influences the world. It is the cohesive power which gives strength and vitality to a nation. Clearly it is our duty to cultivate this marvellous vitalizing force. What society in the Dominion could more effectively inaugurate such a movement? It is quite true that Ottawa, Montreal, and perhaps other cities may each lay a claim to be the seat of such a collection of works of Art, but where could a national gallery of historic pictures be more appropriately placed than in the chief city of the wealthiest Province?

It remains for me to make a passing reference to a question of great scientific and general interest, a question which first engaged the attention of the Institute twenty years ago; and, on the action taken by the society, a discussion was inaugurated which extended itself to scientific and other societies throughout the world.

The circumstances of the age demanded an investigation into the matter of time-reckoning. Through the good offices of His Excellency, the Governor-General of Canada (Lord Lorne) the deliberations of the Canadian Institute were brought to the notice of the official and scientific authorities, first of Great Britain, and, subsequently, of all civilized nations. By this means the simplification of a complex system of reckoning time, admittedly open to well-founded objections, was achieved. Action on the Memorials of the Institute, through the intervention of His Excellency and the British Government, led to the substitution for the old complex system of one which not only offered a solution of the evils universally experienced, but one free from any of the causes of international jealousy which had hitherto neutralized the efforts of scientific men to remedy.

The unimpeachable character of the conclusions and recommendations of the Canadian Institute were recognized by the highest scientific authorities in Europe and America. In all their features they have been found practicable. The essential principles have been adopted on the five continents. It is only with respect to a secondary feature that there has been hesitation in its adoption anywhere, and this hesitation is wholly due to a divergence from an old and indefensible usage. I allude to what is known as the "twenty-four hour notation," and I avail myself of this opportunity of pointing out to the civic authorities of Toronto, that it would be fitting on their part to advance the movement by adapting the public clocks to the reform within the municipality whose interest they guard. The twenty-four hour notation is no vain experiment—it is in use by astronomers all over the globe. It has been tested for fifteen years on our national railways; it has been endorsed by a conference of representatives of twenty-five civilized nations; it has been promulgated by law in several countries in Europe and Asia. Moreover, it has been placed on the statute book by the Parliament of Ontario. Obviously it would be eminently fit and proper that Toronto, where the scientific reform can trace its origin, should, among the cities of this country, be the first to provide for its adoption. I ask, would it not be a graceful compliment to the Canadian Institute? Would it not be a fitting civic recognition of the utility and standing of this society, if the City Council caused to be adapted to the new notation, at the beginning of the new century, the clocks to be placed in the great tower of the new Municipal Buildings approaching completion on Queen Street?

My concluding words shall be an appeal to the members on the roll of the Institute to-day. The name which your Society bears, the articles of your charter, indicate the widest range of subjects for discussion; they suggest the cultivation of the spirit of investigation in order that additions to knowledge may be made to the common stock; they invite research in every field; they admit of the initiation of desirable movements in matters of general concern. The publications which have been widely circulated by the Institute, the hundreds of foreign societies which regularly send their proceedings in exchange, are memorable evidences that the Canadian Institute has done much to make known the good name of our country.

Young members, this is no ordinary occasion; entering on a new half-century, let me remind you that you are the heirs of fifty years of useful effort. It is for you to keep alive the lighted torch and pass it on to those who may come after you. It is for you to bequeath to another generation a record of work well done.

In order that Canada may take her place worthily among the nations making up the British Empire, it is for you to see that she contributes a generous share of all that is best in Letters, in Science, and in Art. On you is now placed a responsibility which I feel assured you will find pleasant to bear. It rests with you to do all in your power to foster and promote, as the years roll onward, every agency which has for its object the advancement of our country and our race.

Professor Maurice Hutton, M.A. said:—

Your Excellency, Mr. President, Ladies and Gentlemen:

In the unavoidable absence of the President of the University, and in the absence also of Prof. Ramsay Wright, who is spending his sabbatical year in Europe, it has devolved upon me to represent the University this evening.

Perhaps I may snatch one consolation and advantage even from the unfortunate conditions under which I appear.

We are gathered here to-night to congratulate the Canadian Institute on attaining its fiftieth year of life and usefulness.

Now, Sir, it might perhaps be more difficult for the President or for Professor Wright to represent the University here and to congratulate the Canadian Institute disinterestedly, heartily and without stint; and for this reason: not only have the University and the Institute been closely linked from the beginning, but these two members of the University in particular, the President, and the Professor, have been in person specially linked with the Institute; and therefore, if in their representative capacity, as representatives of the University, they had referred to the history and the trials and the good work of the Institute, and had touched with pride upon the part which the University has played in that moving history, the "*quorum pars magna fui*" as it rose to their lips, might have seemed to be prompted by personal rather than representative memories, and so might have stuck in their throats, or never have passed "the barrier of their teeth" (as the more ancient and the more graceful idiom has it.)

But in my own case, who in my representative capacity represent specially the ancient languages, and in my personal capacity am the least of all the members of the Institute, and am not worthy to be called a member, it will not be invidious for me at least to claim for the University an honest pride in the celebration of this evening, and a share in all your past successes; and I at least can say "quorum pars magni fui" without scruple and without reserve. Sir, the University and the Institute have ever been intimately linked as I have said: they have been—I hope it may be said—lovely and pleasant in their lives. Certainly in their birth they were not divided but were twins. In the early days of the Institute its history is largely a history also of the University Professoriate; the names that occur, the genii locorum, were the same; they are such names as McCaul, Cherriman, Hincks, Chapman, Croft, and last, but by no means least, the venerated name of Sir Daniel Wilson: or if not the names of University Professors, they are the names of University Officers; John Langton, Vice-Chancellor of Toronto University; the Hon. George Allan, Chancellor of Trinity College; Chief Justice Hagarty of the same College; or the names of Professors of Trinity College, Parry, Irving, Harris. Why, Sir, I think only one perhaps of those early Presidents was not himself a member of the staff of either of our Universities, though his son is a member of our Toronto staff to-day, Sir Henry Lefroy.

And so again in more recent times among the Presidents of the Institute have been the names of Loudon, Wright, Ellis; of van der Smissen and Macallum, and it is still true I suppose, that half of the Proceedings of your Institute are contributed by the University staff.

I do not know, Sir, whether I am to account it a happy accident or a sign of the times that you who grace the Presidential chair to-day are not also a member of the University staff.

It is at any rate a happy accident since it makes our University congratulations to you more easy and more natural; it is not so like the right hand congratulating the left.

But it may well be also a sign of the times, Sir; with the growth of this great city, and the growth therein of the number of University graduates, it ought to be less and less necessary for a learned Society such as yours to depend upon Universities: you, Sir, must increase: and we—the academic element in the Institute—must decrease; relatively at least to the fraction we constitute of your numbers.

The Canadian Institute, I understand, Sir, is not specifically devoted by its charter to any special form of learning; to science more than to literature; and among its early contributors and early contributions were literary men and literary papers; but naturally, Sir, the Institute has taken the colour of its age, has caught the spirit of its times, and has devoted itself mainly to that Science, Physical, Mathematical or Mechanical, which is the living passion of this day; nay, which inspires, as one of your members and a Professor in this building has lately well said, even the very poetry of this generation: so that the newest and the greatest living poet of our Empire is not merely the poet of Empire but the poet of Science.

And for this very reason, Sir, I, as the representative of that learning which was once "the new" and now is very old, I had almost said effete; as the representative of the dead languages, as the representative of that one among all the sister institutions here gathered to-night, which may specially be called "the silent sister," in the busy modern world; the sister who sits faded and humble in shabby attire, struggling to revive the ancient embers of a dying fire, another Cinderella but without a fairy Prince; as the representative of that side of University life of which the poet and critic spoke, when he described Universities as the homes of lost causes and impossible loyalties; as the representative of all this I can with the better grace, with the more complete impartiality, congratulate the Canadian Institute on its success; you have surmounted Sir, the initial difficulties which beset even the career of Science; you have outlived the years of leanness which once threatened the life of the Institute, even as they threatened the life of the young and Scientific University of Victoria, in the City of Manchester, where, twenty years after the foundation of Owens' College its Governors met to consider whether they should close its doors; you also have never closed your doors, and we congratulate you on the scientific work and scientific hopes, fifty years of which are gathered here to-night.

Sir, in the ancient civilization of Greece there was once a great and famous organization, originally founded by the supreme passions which stir men's natures, religious and political ideals; and yet that organization, as time went on, as ancient religion flickered out, and ancient political systems ceased to be, dwindled at last in Nature's irony into only a literary and scientific club.

It is otherwise with Science to-day. That which begins in the student's chamber as the dream of the explorer, the vision of the solitary thinker, the hope of the savan, is to-morrow transferred to the world of action and is in everybody's mouth. The triumphs of the electrician, the physicist, or the mechanician, the discoveries of the student, are to-morrow the concern of practical men, are embodied in our workshops and factories, are translated into realities in our commerce, find even their place amidst the sternest and most practical of all experience upon the soldier's battle-field.

Sir, it has sometimes, by wise men, been accounted the part of wisdom to set themselves against the current of their days' thinking

> Who, rowing hard against the stream,
> Saw distant gates of Eden gleam,
> And did not dream it is a dream.

But it has been the wisdom of other wise men, not less numerous or less wise, to throw themselves into the enthusiasm of their age, whatever be its objects, nay, its idols; to echo and encourage in all ways, all faith and all hope as making all for good.

This, Sir, the Canadian Institute has done in its devotion to Science; and it is not for me to-night, on such an occasion and before such an audience, to question whether you have chosen the better part.

Hon. G. W. Allan, D.C.L., Chancellor of Trinity University, spoke of the debt of gratitude which the country owed to the Canadian Institute. He said that the most optimistic of the members could not have hoped to see such a glorious celebration of the fiftieth anniversary, and he wished that it would be only an augury of better things to come.

Mr. Kivas Tulley, C.E., said:

May it please Your Excellency, the President, Officers and Members of the Canadian Institute, Ladies and Gentlemen:—

As one of the three surviving original members, I thank God I have been spared to participate in the celebration of the semi-centenary of the Institute, and to tender my hearty congratulations on the uninterrupted success and progress attained by the Institute to the present time.

When the Architects, Engineers and Surveyors, practising in Toronto, met at my office on the 20th of June, 1849, for the purpose of forming themselves into a society for mutual improvement and advancement, they could not have imagined or foretold that after fifty years a meeting of the Institute should have been held in this city, honoured by the presence of His Excellency, the Governor-General, and the Major-General commanding the Militia of the Dominion.

When the Institute was incorporated by Royal letters patent in 1851, it apparently lost its professional character, and the Architects, Engineers and Surveyors became separately incorporated, and partially ceased to attend the meetings of the Institute.

During the last year an Engineers' Club was formed, professing similar objects to those of 1849, and the first resolution passed was to congratulate the Canadian Institute on its attainment of fifty years, which the club hopes may be continued to the end of its century and further for the benefit of the members.

The Ottawa Field Naturalists' Club sent the following Resolution:

"On behalf of the Ottawa Field Naturalists' Club, the Council has much pleasure in presenting its hearty greetings and congratulations to the Canadian Institute, Toronto, on the occasion of the celebrating of the fiftieth anniversary of the founding of that Institute. In recording the result of observations and original research, bearing upon the natural history, geology, ethnology, and kindred topics in British North America for half a century, the Canadian Institute has accomplished much that is praiseworthy.

"The Council of the Ottawa Field Naturalists' Club, which has just reached the twenty-first year of its existence, trusts that marked activity and progress will crown the efforts of the Canadian Institute in promoting the interests for which it was originally formed, and in extending those avenues of research to which it has given attention since its organization."

The Natural History Society of New Brunswick sent the following:

"The Natural History Society of New Brunswick and the Ladies' Association Branch connected with it, extend to the Canadian Institute their heartiest congratulations on reaching the fiftieth anniversary of its useful life, with warmest wishes for many years of added prosperity."

The President closed the formal proceedings by thanking those present for their attendance.

NOTE.

ON THE EARLY DAYS OF THE CANADIAN INSTITUTE.

The writer of the first article in this volume was obliged to leave for England on public business without having so full an opportunity as was desirable to correct proofs and make emendations. He returned to Canada after the article passed through the press, and since his return he has found in an old trunk which had remained unopened over thirty years, a number of papers relating to the Canadian Institute in its early days. These records in no way conflict with the facts stated on pages 1 to 24 of this volume. They, however, furnish additional evidence of interest in support of the statements made. Among the papers found a few may be mentioned, viz:

(1.) Original prospectus of the Canadian Institute, in the handwriting of the then secretary, Mr. J. Stoughton Dennis. This prospectus was circulated before September 22nd, 1849. It is referred to on page 3, par. 2.

(2.) Pencil design for the seal of the Institute precisely as it appears on page 6. It was designed by the writer and engraved by Mr. John Allanson, an associate, who gave his services as engraver in lieu of a year's subscription.

(3.) Rough draft of the Royal Charter in the handwriting of the writer. This obviously is the original of the draft furnished privately to the Attorney-General through Mr. Thomas Ridout for the information and use of the former. It corresponds, as far as it goes, with the Charter granted by the Crown. (See page 8, par. 1.)

(4.) Draft letter to Captain Lefroy, seeking his co-operation in advancing the Institute and asking permission to nominate him as first Vice-President. This document is in the handwriting of the late Colonel Fred. W. Cumberland, then an active promoter of the Society. The letter was written before May 27th, 1852, the date when Captain Lefroy joined the Institute and was elected 1st Vice-President. (See page 8.) In view of the high esteem in which he was held and his services to this Canadian Society in its early days, it is with a feeling of great satisfaction that the letter which led to the connection of this distinguished officer with the Institute has been found. It will be read with interest.

SIR—Enclosed I beg to hand you copies of the Royal Charter of the Canadian Institute, of the regulations and by-laws adopted in accordance with it, together with a list of the present members.

By a perusal of these papers you will perceive that the Society has been established for the purpose of promoting the physical sciences, for encouraging and advancing the arts and manufactures, and for effecting general objects of a kindred character.

As Secretary, I submit these papers at the request of some of the members, who are most anxious that the Society should be strengthened by your name and influence. They are aware that the Institute being still in its infancy, cannot in itself offer any sufficient inducement to you to join it, but they venture to urge this request, being desirous of securing the co-operation of those whose position will give weight to their proceedings and increase the utility of the body.

They have accordingly directed me to request that you will permit them to nominate you to the highest office in their gift, (1st Vice-President) the Charter having appointed Mr. Logan, the Director of the Geological Survey to the office of President for the first year, and I am charged to add that your acceptance thereof will be very gratefully acknowledged by them.

I have the honour to be etc.,

SANDFORD FLEMING, *Secretary.*

(5.) Letter in the handwriting of the Honourable Robert Baldwin, the Premier of the Province, dated April 24th, 1852. It relates to his own membership and expresses the desire that his son, Mr. William Willcocks Baldwin, be elected a member.

(6.) Note in the handwriting of the writer, without date, but from the context it evidently was prepared directly after the second conversazione in April, 1852. It is in substantial agreement with the facts collected from other sources and from memory, as they are submitted in the sketch in this volume (pages 1 to 24.) The only additional interest it can claim is in having been prepared when the facts were fresh in the mind of the writer, and in having been found after the lapse of nearly forty-eight years.

(7.) These and other papers, of no great importance, found with them, shall be sent to the Secretary, and along with them the original letter from Mr. Robert Stephenson, accepting the invitation to the banquet given him in the old Parliament Buildings, Toronto, August 26th, 1853, referred to on page 23. This letter has recently been placed in the hands of the writer by Mr. Thomas Ridout, Honorary Secretary of the Banquet Committee.

The following is the text of number 6:

As the early history of the Canadian Institute may not be uninteresting in after years when the Society has assumed that position which we have hopes will be found for it, a brief outline of its origin and infantile existence ought now to be recorded before such be completely veiled in obscurity.

The Canadian Institute, like many other Societies of a similar character, dates its origin from small beginnings. One or two individuals whose inclination led them to seek for that intercourse between persons of a more practical and scientific turn of mind than is generally found in ordinary debating societies, and being themselves connected with the surveying and engineering professions, they were induced to believe that the formation of a Society consisting of gentlemen in those professions would draw together many kindred minds, and offer an opportunity to persons engaged in those pursuits of accumulating such knowledge as is necessary for the diversified practice of their professions, and of mutually benefitting each other by the interchange of individual observation and experience.

With the view of considering the establishment of such a Society, a few surveyors, engineers, architects, residing in and near Toronto, met on June 20th, and on July 20th, 1849; at the second meeting a prospectus of the proposed Society was agreed on and ordered to be forwarded to members of their profession generally throughout the Province with a view to their advice and co-operation. The following is a copy of the prospectus in accordance with the principles of which the Society was first organized on September 22nd, 1849.

PROSPECTUS OF THE PROPOSED CANADIAN INSTITUTE.

To be composed—

First—Of Provincial Land Surveyors, Civil Engineers and Architects, practising in the Province, as members.

Second—Of Members of the same profession not practising in the Province as corresponding members.

Third—Of men distinguished in Science and the Arts residing in the Province but not belonging to either of the above professions, as honorary members.

Fourth—Of Students under articles as Graduates.

The officers of the Institute to consist of a President, and Vice-President, Council, Secretary and two Auditors, to be elected annually.

The Treasurer to be a Chartered Bank in the City of Toronto.

The rooms of the Institute to be situate in the City of Toronto.

Libraries to be formed and collections made of Maps, Drawings, Models, etc.

A Museum to be established for the collection of Geological, Mineralogical and other specimens.

Professional discussions to be held and papers read.

Transactions to be published.

Standard instruments to be kept for reference.

Philosophical observations to be made and registered.

A Board of Arbitration to be established for the settlement of difficulties arising between members in the practice of their professions.

The subscription of members to be one pound per annum.

The subscription of graduates to be ten shillings per annum.

Corresponding and Honorary Members, and Members joining the Institute after September 22nd, to be admitted by ballot.

Graduates to be admitted on recommendation of the Council.

From this it will be seen that the proposed Society, although now greatly modified, was at first strictly of a professional character. The prospectus was transmitted to nearly 500 persons throughout the Province, accompanied by a suitable circular in reply to which from twelve to fifteen letters only were received. The promoters were disheartened, the monthly meetings were thinly attended, although notices of such meetings were regularly sent to all concerned, the sanguine expectations of many of the members were damped, and by some the Society was entirely abandoned at a time when their assistance was most needed. At last the attendance dwindled down to two persons, and then the prospects of the young Institute were gloomy indeed. At this small meeting various schemes were talked over as to the ultimate chances of success, and it was then considered that by opening out the Society to those whose pursuits and studies were of a kindred character, and by holding regular weekly meetings for the reading and discussing of papers, the Society would gradually take a practical and proper footing. The weekly meetings have been held regularly since that time during the winter months, and the attendance has occasionally been good although often dispiriting. Several interesting communications of professional and general interest have been read and some of them have excited spirited discussion. Many of the meetings have been occupied by discussions connected with proposed changes (since confirmed) in the "constitution" and "regulations" of the Society; at last on April 12th, 1851, it was resolved that the proper steps be taken for obtaining such a Charter as the Society now enjoys, for promoting intercourse and knowledge among men throughout Canada. By this step, the hitherto strictly professional association was changed to one of a general character and the way paved for the Canadian Institute as it now exists.

On May 10th last year, (1851), the first Conversazione was held. The Royal Charter of Incorporation was granted on November 4th, 1851, and by it W. E. Logan, Director of the Geographical Survey, was decreed first President. The remaining Officers and Members of the Council required by the Charter were elected on the March 27th, last; they accepted office on the following week at a conversazione. Prior to the election of officers, the weekly meetings were occupied in the usual manner and in preparing and maturing a proper code of laws in harmony with the requirements of the Charter for the future government of the Institute.

Such is a brief history of the Canadian Institute, up to the acceptance of the Royal Charter. By the unceasing perseverance of its founders it has already taken root. By the Charter of Incorporation its establishment and character has been permanently confirmed, by each increase of numbers it receives a new impulse, by the zeal and unity of purpose of its promoters, the practical efforts of its members, and the fostering hand of an enlightened legislature, the future prospects of the Society are, we trust, many days of usefulness and uninterrupted prosperity.