TRANSACTIONS

OF

THE CANADIAN INSTITUTE.

VOLUME I., 1889-90.

TORONTO:
PRINTED FOR THE CANADIAN INSTITUTE
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1891.

PREFATORY NOTE.

The Canadian Institute was incorporated by Royal charter in 1851, and immediately began the publication of a record of its transactions under the name of "The Canadian Journal." The first series was in quarto form and terminated in 1855. It comprised three volumes. The second series was in octavo form, began in 1856 and terminated in 1878. It comprised fifteen volumes. In 1879 the name was changed to "Proceedings of the Canadian Institute," and of this third series seven volumes were issued, terminating in 1890, making in all twenty-five volumes.

The Government of Ontario having three years ago commenced the making of an annual grant to the Institute in aid of archæological research, the annual archæological reports have been published as appendices to the Report of the Minister of Education in the same form as other government reports, and therefore could not be bound up with the "Proceedings." As it was desirable that these Reports should be incorporated with the other publications of the Institute, with the view of attaining this object it has been decided to enlarge the page and issue a new series under the name of "Transactions of the Canadian Institute." The archæological Reports which have already been issued may be bound up with the first volume of the "Transactions," and subsequent ones with the succeeding volumes as they appear.

CONTENTS.

ROYAL CHARTER OF INCORPORATION OF "THE CANADIAN INSTITUTE," GRANTED 4TH NOVEMBER, 1851.

PROVINCE OF CANADA.—ELGIN AND KINCARDINE.

VICTORIA by the Grace of God of the United Kingdom of Great Britain and Ireland, Queen, Defender of the Faith, &c. &c.

To all to whom these presents shall come, greeting.

Whereas William E. Logan, John O. Browne, Frederick F. Passmore, Kivas Tully, William Thomas, Thomas Ridout, Sandford Fleming, and others of our loving subjects in our Province of Canada, have formed themselves into a Society for the encouragement and general advancement of the Physical Sciences, the Arts and 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 subjects, and otherwise smoothing the path of Civilization; and also being the Arts of directing the great sources 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 of the Industrial Productions 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, and have subscribed and collected certain sums of money for these purposes.

And whereas, in order to secure the property of the said Society and to extend its useful operations and at the same time to give it a more permanent establishment among the Literary and Scientific Institutions of this part of our Dominions, we have been besought to grant to the said William E. Logan, John O. Browne, Frederick F. Passmore, Kivas Tully, William Thomas, Thomas Ridout, Sandford Fleming, and to those who now are or shall hereafter become members of the said Society, our Royal Charter of Incorporation, for the purpose aforesaid.

Now know ye that we, being desirous of encouraging a design so laudable and salutary, of our especial grace, certain knowledge, and mere motion, have willed, granted and declared, and do by these presents for us, our heirs and successors, will, grant and declare that the said William E. Logan, John O. Browne, Frederick Passmore, Kivas Tully, William Thomas, Thomas Ridout, Sandford Fleming, and such others of our loving subjects as now are members of the said Society, or shall at any time hereafter become members thereof according to such regulations or by-laws as shall be hereafter framed or enacted, shall by virtue of these presents be the members of, and form one body politic and corporate for the purposes aforesaid, by the name of "The Canadian Institute," by which name they shall have perpetual succession and a common seal, with full power and authority to alter, vary, break, and renew the same at their discretion, and by the same name to sue and be sued, implead, and be impleaded, answer and be answered unto, in every court of us, our heirs and successors, and be forever capable in the law to purchase, receive, possess, and enjoy to them and their successors, any goods and chattels whatsoever, and also to be able and capable in law (notwithstanding the Statutes of Mortmain) to take, purchase, possess, hold and enjoy, to them and their successors, a Hall or House, and any Messuages, Lands, Tenements, or Hereditaments whatsoever, the yearly value of which, including the site of the said Hall, shall not exceed in the whole the sum of Two thousand pounds, computing the same respectively at the rack rent which might have been had or gotten for the same respectively at the time of the purchase or acquisition thereof, and to act in all the concerns of the said body politic and corporate for the purposes aforesaid as fully and effectually, to all intents, effects, constructions and purposes whatsoever, as any other of our liege subjects or any other body politic or corporate in our said Province of Canada, not being under any disability, might do in their respective concerns.

And we do hereby grant our especial license and authority unto all and every person and persons, bodies politic and corporate, otherwise competent, to grant, sell, alien, and convey in Mortmain unto and to the use of the said Society and their successors any Messuages, Lands, Tenements, or Hereditaments, not exceeding such annual value as aforesaid. And our will and pleasure is, and we further grant and declare, that there shall be a General Meeting of the Members of the said body politic and corporate, to be held from time to time as hereinafter mentioned, and that there shall always be a Council to direct and manage the concerns of the said body politic and corporate, and that the general meetings of the Council shall have the entire direction and management of the same in the manner and subject to the regulations hereinafter mentioned. But our will and pleasure is, that at all General Meetings and Meetings of the Council, the majority of the members present, and having a right to vote thereat respectively, shall decide upon the matters propounded at such meetings, the person presiding therein having, in case of an equality of numbers, a second or casting vote.

And we do hereby also will, grant, and declare that the Council shall consist of a President, not more than three nor less than one Vice-President, and not more than eleven nor less than three other Members, to be elected out of the members of the said body politic and corporate, and that the first Members of the Council, exclusive of the President, shall be elected within six calendar months after the date of this our Charter, and that the said William E. Logan shall be the first President of the said body politic and corporate.

And we do hereby further will, grant and declare that it shall be lawful for the Members of the said body politic and corporate hereby established to hold General Meetings once in the year or oftener, for the purposes hereinafter mentioned—viz., that the General Meeting shall choose the President, Vice-Presidents, and other Members of the Council; that the General Meeting shall make and establish such by-laws as they shall deem to be useful and necessary for the regulation of the said body politic and corporate, for the admission of members, the establishment of Branch Societies, the management of the estate, goods, and business of the said body politic and corporate, and for fixing and determining the manner of electing the President, Vice-Presidents, and other Members of the Council, and the period of their continuance in office, as also of electing and appointing a Treasurer, two Auditors, and two Secretaries, and such other officers, attendants, and servants, as shall be deemed necessary or useful for the said body politic and corporate, and such by-laws from time to time shall or may alter, vary, or revoke, and shall or may make such new and other by-laws as they shall think most useful and expedient, so that the same be not repugnant to the laws of England, to these presents, or to the laws and statutes of this our Province of Canada, and shall and may also enter into any resolution and make any regulation respecting any of the affairs and concerns of the said body politic and corporate as shall be thought necessary and proper.

And we further will, grant and declare that the Council shall have the sole management of the income and funds of the said body politic and corporate, and also the entire management and superintendence of all the other affairs and concerns thereof, and shall and may—but not inconsistently with or contrary to the provisions of this our Charter or any existing by-law, the laws of England, or the laws and statutes of our said Province of Canada— do all such acts and deeds as shall appear to them necessary or essential to be done for the purpose of carrying into effect the objects of the said body politic and corporate.

And we further will, grant and declare that the whole property of the said body politic and corporate shall be vested, and we do hereby vest the same, solely and absolutely in the members thereof, and that they shall have full power and authority to sell, alienate, charge or otherwise dispose of the same as they shall think proper; but that no sale, mortgage, incumbrance, or other disposition of any Messuages, Lands, Tenements, or Hereditaments belonging to the said body politic or corporate shall be made, except with the approbation and concurrence of a General Meeting.

And we lastly declare it to be our royal will and pleasure that no *resolution or by-law shall on any account or pretence whatsoever* be made by the said body politic and corporate in opposition to the general scope, true intent and meaning of this our Charter, the laws of England, or the laws and statutes of this our said Province of Canada, and that if any such rule or by-law shall be made, the same shall be absolutely null and void to all intents, effects, constructions and purposes whatsoever.

In testimony whereof we have caused these our Letters to be made Patent, and the Great Seal of our said Province to be hereunto affixed.

Witness our Right Trusty and Right Well-beloved Cousin James, Earl of Elgin and Kincardine, Knight of the Most Ancient and Most Noble Order of the Thistle, Governor General of British North America, and Captain General and Governor-in-Chief in and over our Provinces of Canada, Nova Scotia, New Brunswick, and the Island of Prince Edward, and Vice Admiral of the same, &c. &c., at Quebec, this fourth day of November, in the year of Our Lord One Thousand Eight Hundred and Fifty one, and in the fifteenth year of our reign.

[L. S.] W. B. RICHARDS,
Attorney General.

By Command,
E. A. MEREDITH,
Assistant Secretary.

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SPECIAL NOTICE.

Respecting the Publications of the Canadian Institute.

In answer to numerous enquiries concerning the Publications of the Canadian Institute, and applications for missing numbers, the attention of Members and Correspondents is requested to the following :—

1. The FIRST SERIES began August, 1852; concluded December, 1855; contains 41 numbers in 3 vols. 4to. It has for title, "The Canadian Journal; a Repertory of Industry, Science and Art; and a Record of the Proceedings of the Canadian Institute." Vols. II. and III. of this series can still be supplied. Vol. I. is nearly out of print.

2. The SECOND SERIES began January, 1856; concluded January, 1878; contains 92 numbers in 15 vols. 8vo. It has for title, "The Canadian Journal of Science, Literature, and History." This series can still be supplied, except Part 5 of Vol. XV., which is quite out of print. Of Vols. X., XI., XV. but few copies remain.

By inadvertence, No. 85 (November, 1873), Vol. XIV. of this series immediately follows No. 79. There is, however, no *lacuna* between these two numbers, as is shown by the fact that the paging is consecutive.

3. The THIRD SERIES, commenced in 1879, concluded April, 1890, contains 20 numbers in 7 vols. Its title is "Proceedings of the Canadian Institute." Parts 1 and 2 of this series are entitled "The Canadian Journal: Proceedings of the Canadian Institute."

Vol. I.,	Third Series,	contains	5	Fasciculi.	
" II.,	"	"	3	"	
" III.,	"	"	4	"	
" IV., V., VI. and VII.		"	2	"	each.

Of Vol. I., Parts 1 and 3, and of Vol. II., Part 1, are out of print. Of Vol. II.. Part 2, very few copies remain. Of Vol. III., Part 1 and of Vol. IV., Part 2 are out of print.

4. The FOURTH SERIES commenced October, 1890. Its title is "Transactions of the Canadian Institute." Vol. I., containing Parts 1 and 2, has been published.

5. Only four Annual Reports of the Institute have been published in a separate form, viz., for 1886-87, 1887-88, 1888-89, and 1889-90.

6. Missing numbers will be supplied on application, except those mentioned above as out of print. The Institute will be glad to exchange the back volumes of its publications for an equivalent of those of any Society with which it exchanges.

7. A liberal price will be given for the following:—Vol. I. First Series, Vols. X., XI. and XV., and especially Part 5, Vol. XV., Second Series, Vol I. Parts 1 and 3, Vol. II. Parts 1 and 2, Vol. III. Part 1, Vol. IV. Part 2, Third Series. Persons having any of the above, and being willing to part with them, will please communicate with the Assistant Secretary.

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Transactions

—OF—

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CONTENTS.

ARSENIC AND SULPHUR AS METALLURGICAL AGENTS IN THE TREATMENT OF CANADIAN AURIFEROUS AND ARGENTIFEROUS ORES.

BY R. DEWAR.

(Read 13th March, 1890.)

We are all too well aware of the direful results on amalgamation caused by the presence, in the ore operated on, of arsenic and more especially sulphur, as their capacities for neutralizing the mercury and thus rendering it useless to hold the gold or silver that passes over it, are very great. These troublesome elements are got rid of at the present time by roasting, but this causes expense, and metallurgists even hint at a loss of the precious metals by this treatment. I differ with them so far as to say, that if there is any loss, which there may be, the same is so minute that practically there is none.

The chlorination process as it is variously applied according to the different patents granted for it, has a drawback in the treatment of these ores, in its restriction to those only in which the metals are in a state of fine division, therefore in ores like some of ours in which the metals are in larger bodies, it is rendered useless; but in any case the ores must first be roasted to get rid of the arsenic and sulphur, as they form troublesome salts with the chlorine. Now, it is quite apparent that if part of the treatment could be dispensed with, it would be the means of increasing the returns in a great many mines at present in operation. Why then could we not dispense with the chlorination, and do the work with the roasting alone? It may seem impossible at first as the roasting is merely a preliminary to the chlorination which is the principal.

There is a law of metallurgy which has been greatly neglected, and I may say has not been paid the attention or given the research due to it. That law expressed is that when a metal is alloyed with one or more of the other metals, the resultant alloy has a lower melting point than the mean of the several melting points of the constituents taken together. Let us take an example, for instance, an alloy of 1 part lead, 1 part tin, and 2 of bismuth, the melting point of lead is 325°C, tin 227·8°C, bismuth 259°C; their sum is 811, their mean, 270°C. This will melt at 100°C, which is just 170°C below the mean. Is this not sufficient proof for this law? Let us take another example, that of an alloy of lead and platinum. Platinum does not melt even in the highest temperatnre obtainable in a blast furnace, but only in the flame of the oxyhydrogen blowpipe, and the calorific intensity of oxygen burned in hydrogen = 3,154°C. Now if we take for granted that the heat absorbed by the nitrogen of the air is equal to the extra heat generated by the blast caused by the forcing of the gases through the nozzle, which consequently causes a more rapid combustion, hence a higher temperature, these figures represent the blowpipe flames' temperature, hence the melting point of platinum. Those calculations of mine are not mathematically correct to the fraction of a degree or so but are quite accurate enough for our purpose. Now the melting point of lead added to that of platinum = 3479, therefore the mean = 1739°C. I have melted such an alloy at 1000°C, that is 739°C below the mean; is this not a magnificent example? This law is confined to no special one but holds good for all alloys.

Why, then, if this is a general law of alloys, is it not applicable in the case of arsenic, sulphur, silver, and gold? You will object that arsenic and sulphur are not metals proper. That is quite true of the sulphur but not so of the arsenic; but still that would not incapacitate them to form alloys with the metals. They may either be as a salt, such as a sulphide or arsenide, or be in molecular proportion to form chemical compounds, or in excess or deficient for such, and only form mechanical mixtures, or one contained in solution in another, or in an allotropic state; but still they are alloys and in proof of this we have only to look at shot lead, which is an alloy of arsenic and lead; copper also alloys with arsenic as a greyish brittle metal; and has not galena the resemblance and properties of an alloy?

In consideration of this I hold that arsenic, sulphur, silver and gold do alloy and that therefore the temperature at which they melt is lowered in virtue of their being alloyed with the sulphur and arsenic.

In accordance with this, we will now consider the following data:—

As—melts at 220°C. We will say that although it oxidises at that temperature, therefore its melting point must be lower.

S—melts at 115°C.
Au— " 1102°C.

Their sum is 1,437, their mean, 479°C; therefore this would seem to indicate the melting point of this alloy. This corresponds to a temperature below incipient red, as it is according to Pouillett 525°C, dull red being 700°C. I do not mean to insinuate that gold alloyed with arsenic and sulphur will be reduced to such a ridiculously low melting point, but I do mean to say that it is lowered considerably, as I have melted them at about an incipient cherry red, corresponding to a temperature of about 800°C, and perhaps a few degrees lower, so that I can vouch for it as being correct. If the melting point of silver be added, namely, 1023°C, the sum will = 2460, the mean, 615°C. I may say I have melted them at such a temperature and below it.

Many of our ores carry sufficient S and As for this law to be taken advantage of in their treatment; but before we can see in what way it would be advantageous to us, we must consider another law. That law is namely the spheroidal form given to small portions of metals or alloys under three different modes.

This is a law which none of the works as yet published on Metallurgy have mentioned, and I don't think that any of our profession have paid any attention to it, and that some are even ignorant of its existence. We shall consider the modes under which this form is given.

1st. When metals in a thin body or sheet, such as gold leaf, are exposed to certain temperatures the sheet breaks up and forms into globules. This may be proven by taking any gilded work, say for instance on wood, and placing it on the lid of a furnace or common stove. When the wood begins to char the gold will be seen to form into globules. This is caused directly by the heat.

2nd. When certain metals are alloyed with others, they cause a shrinkage concentratéd to a certain spot, which acts as a nucleus around which another portion of the alloy forms a globule when cast upon a cold surface, into water, or when pressed from under or through a crust of part of the alloy solidified. This is caused, 1st, by one of the constituents cooling more quickly than the rest. 2nd. When one of the constituents has a greater shrinkage power than the other.

We can again take shot lead into account. As I have said it is an alloy of arsenic and lead. Arsenic is of nature a great shrinker or contracter, and thus it is used to give the rotund form to the lead, as it causes it to contract when it touches any solid body and form a ball. We may further prove this law by taking an alloy that is known to shrink, melt and cast into an open mould, let the top solidify, strike it two or three gentle taps with a hammer or die, having a broad striking surface, when the metal will be seen to force its way up through the crust and form globules on the surface.

The 3rd mode really belongs to the former two, but we will consider it as an independent one. It is the action of the atmospheric pressure in the promotion of a spherical form in molten metal, when in small quantities. It is the best known law of Hydrostatics that a fluid will flow until it finds its level; but pour water on any highly heated surface and instead of flowing until it finds its level and keeping in a body, it will break up into little globules and either roll about or stand still, until the atmospere in its vicinity is cooled sufficiently, when it evaporates in steam.

The same may be said of the metals with a little modification, the surface will do as well if it is cold, and not so well if it is at too high a temperature, unless there be a good supply of cold air playing on the surface; but it all depends on the melting point of the metal and the rapidity with which it cools. On studying this I have come to the conclusion, that the heat radiated from the metal or alloy heats the air in its vicinity, that by the law of gravitation, the heated air having expanded and thus having a lower density than the cold air, ascends to make room for the same, that the rapidity with which it ascends partly breaks the equilibrium of the atmospheric pressure, that the pressure being less on the upper surface it is inclined to rise and thus partly kept from spreading or finding its level, that it is aided in this by a lateral pressure, if I may so express it, which is not disturbed by the ascension of the heated air. That this is true may be seen by a great many metals when cooled suddenly by artificial means, or not formed into globules until on the point of solidifying, they will be seen to have their tops (the globules) very much flattened; this shows at once that it is the exertion of the atmospheric pressure, as if they had been hot or not cooled so suddenly, their tops would not have been flattened.

Why then could these laws not be applied in the metallurgical treatment of our gold and silver ores? The sulphur and arsenic would assist to lower the temperature at which they melt, by alloying with them and any portion that did not combine with them would act as a flux. I need not extol the virtues of such a flux, it would collect any fine gold and bring it in conjunction with more, forming a globule, while at the same time the sulphur would act as fuel and produce heat, the arsenic according to its nature would cause any body of metal it happened to be in to shrink and form a globule, thus all the fine and leaf gold would be collected into bodies large enough to be easily worked, and this could be done by roasting, but not roasting as is practised at the present day, as arsenic and sulphur are considered a disadvantage and it is to get rid of them that it is practised. Allow me to quote a passage from Overman, the late American metallurgist, as it will show us the object of roasting as it exists; he says, "Roasting means to heat a metallic ore or matte to at least a red heat or such a heat that the mineral does not melt but only the volatile or combustible substances are expelled and as much oxygen becomes combined at the same time with the ore as it possibly can absorb." But we are aware of the weak affinity of the precious metals for oxygen, they are therefore reduced direct to the metals. In accordance with this he says further on, that "Sulphuret of Silver is easily liberated from its sulphur and forms metal; the same is true of gold." Roasting was resorted to but very little in the treatment of ores of the precious metals until lately, and even where it is used the benefit that might accrue from it is lost by restraining the temperature from rising above a certain point, for fear of sintering and thus causing extra expense in the working of it.

Well, to go into detail of how I intend to roast these ores. They must either be roasted in piles or kilns. I prefer the pile as a larger portion of ore can be operated on at once and more easily manipulated than if in kilns, and there is also very little outlay in preparing the bed to receive the same; but it all depends on the metallurgist who is considering the question, as one man can see an advantage where another could not. I shall go no further into details than to say that the pile will be merely the ordinary one, with special attention paid to its draught canals which shall be two feet apart. We shall commence by building up the foundation from 18″ to 2ft. in height, of hardwood, the height it is to be built depending on the amount of sulphur contained in the ore, the more sulphur the less fuel, and *vice versa* for the other extreme. The top should be easily reached so that the fines that form the covering could be easily manipulated. When the pile is all ready for lighting, we shall light it at one end only and not all round as is usually done, as the fire will spread soon enough for our purpose. When the end is well lighted let it have the benefit of a full draught by opening four draught canals (2 on each side), and clearing the fines of the top, for four feet, when the ore having this great draught will sinter; when it has pretty well sintered, turn three or four jets or streams of water on it, this will cause it to crack and crumble, then let men with long iron hooks pull the crumbling parts away so that the water may the better get at the other parts, and keep continually clearing away as it is possible to do so; when within one foot of that part of the pile, whose draught canals are not open, stop putting on water, open two on each side, pull fines off top as before, let sinter, put on water, and pull and clear away as ready, repeating this until the pile is finished.

The ore which has been done in the meantime is carried off to the mill and fed to the stamps; there may be sluices having hardwood riffles, leading from the mill to settling tanks, or it may be stamped dry, and the work of cleansing left to the buddles, but the wet way is to be recommended as it will save a great deal of work in the buddles; the battery may be cleaned out every hour or a less period of time, according to the amount of ore that has accumulated in it, and carried to the round buddles to be selected. All the gold and silver will be left in the battery, except, perhaps, those fine shots which may be ejected by the stroke of the stamps, and which will be intercepted by the hardwood riffles; as for the tailings, they will be found to contain practically nothing.

Naturally you will have come to the conclusion that the arsenic and sulphur which were alloyed with the gold and silver, will still remain with them and be troublesome impurities, which can only be got rid of by refining, thus causing a further outlay of time and capital. This will depend principally on the temperature to which the ore has been exposed. If the temperature is only risen to that point at which the gold and silver melt, they certainly will contain these elements as an alloy, but if on the other hand, they are risen to that temperature which is obtainable in any roast pile, the gold and silver will be found free of even traces of these elements. In proof of this I shall make mention of an experiment by which I demonstrated it. I took ore known to contain both arsenic and sulphur and divided it into two portions, which we shall call A and B. I raised A in temperature until the gold was seen to form on the surface in globules and no higher. B I raised in temperature until it sintered. I afterwards made analysis of several of the globules from each portion; in A I found both arsenic and sulphur, and in further proof of my statement that arsenic and gold alloy, I found it (the arsenic) in the metallic state. I do believe that this could not have been confirmed more conclusively than by the finding of the metallic arsenic present. In the several globules from B, I found neither arsenic nor sulphur, thus shewing that the high temperature to which the ore had been exposed had oxidized them.

The oxidization is accomplished as follows: the extreme heat of the roast pile, when sintering, sets the sulphur and arsenic on fire, producing arsenical and sulphur fumes; the arsenical fumes combine with the oxygen of the air forming arsenious acid, $As.O_3$, of the old nomenclature, or arsenious anhydride of the new, $As_2.O_3$, and with the sulphur as sulphur dioxide, or sulphurous anhydride $S.O_2$, and also combine together to form the sulphides, the orange realgar $As.S_2$, and the yellow orpiment $As.S_3$. I found the former predominated. Also when the water is thrown on the ore it helps greatly the oxidization of these elements, and clears away almost all traces of them.

Now allow me to draw your attention to the advantages to be derived from this process. In the first place you must all be aware that the matrix of an ore, it matters not whether it be quartz, calc-spar or any other mineral, when heated to redness and either suddenly immersed in water, or water thrown over it, will be rendered quite brittle, and will fall to pieces with the least concussion or blow, and even with some the disintegration is so great that they will break up during their immersion or while the water is being thrown over them.

Now this would be a source of great and general economy, the stamping expenses would be reduced ; for instead of each stamp doing one ton per diem, they would do five tons ; five days' work would be done in one ; consequently saving five days' tear and wear of plant, also five days' steam and fuel, besides five days' wages to the workmen and other items of which I shall make no mention, unless to say that the returns would be quicker, thus making it a point of great importance.

I am of the opinion that many men of our profession are ignorant of the cause of the loss of a portion, if not all of the gold and silver in an ore, by assay, when treated by the amalgamation process, and which they call free gold, and which appears so to the eye, but in reality is covered with a thin film of sulphur which renders it impervious to the mercury to form an amalgam. I seems strange this has never been discovered before, but my father and I have proved it to be true, and were intending to publish a paper on it, but were anticipated by Mr. Skey, analytical chemist for the New Zealand Geological survey, who published a paper on this subject under the title of "The absorption of Sulphur by Gold and its effects in retarding amalgamation." Now, this sulphur can be got rid of by roasting at the proper temperature, and as to expenditure have I not shown the advantage in less labor and mechanical power being required in the further treatment of these ores ?

Another cause of great loss is the carrying away by water of the float gold. The cause of its floating is that, although it has the highest specific gravity or density of all the metals, except platinum, iridium, and osmium, which are 21·50, 21·15, and 21·4 respectively, gold being 19·50 and thus almost twenty times heavier than water, it has such a great surface in comparison to its weight that the water resists its sinking, and also the hydrodynamical force of the water in carrying it away even was it inclined to sink, keeps it in suspension and prevents it from doing so ; thus it is carried over the amalgamated riffle plates and lost. Now had the ore containing this fine gold been treated according to the process I have described, the fine and leaf gold would have been converted into globules, and even were the globules only the size of a pin's point they are bound to sink as their surfaces are not to be compared with their density and the water cannot resist them; they will all either remain in the battery or on the riffles as they are too heavy to be carried away hydrodynamically.

Then there is the great loss of mercury by neutralization by the arsenic and sulphur, which I before mentioned, and also those ores the matrix of which consists of calcium carbonate, cause enormous loss of mercury as it is absorbed by the mercury and causes it to be spongy and light, and to be carried away by the water more easily than even the fine gold itself. Now the amalgamation process can be dispensed with in this treatment, thus avoiding the above named loss.

As regards the presence of lead or any other of the baser metals in the ore to be treated, the lead would alloy and assist to collect the gold or silver; as to zinc, antimony or others they would be completely oxidised.

In conclusion, I would lay special stress on the point that all ores should be selected, and not as is at present done, all rushed through as they come and by the same process, but arranged systematically and treated accordingly.

SOME POINTS IN THE NATURAL HISTORY OF GROUND WATERS.

By P. H. Bryce, M.A., M.D.

(Read 1st March 1890)

To the President and Members of the Canadian Institute:

Gentlemen,—In choosing a title for my paper, while recognizing fully how much has been said and written regarding drinking water, I have felt that the enormous importance which attaches to it as one of the necessaries of life demands that public attention should repeatedly be drawn not only to the sources from whence pure and wholesome supplies are obtained, but also to the dangers which are associated with its pollution, and the ways by which this is brought about.

I propose in this paper to indicate briefly the physical characters of, and the phenomena associated with, ground waters, and thereafter to discuss some of the practical points which attach to their use for drinking purposes.

I.—THE SOURCE OF GROUND WATER.

We are aware that precipitation on land and sea of the moisture of the clouds is the method by which the water borne into the air by evaporation is returned to the earth. The yearly amount of rain which falls in Ontario is commonly more than 30 inches; but the amount of this that becomes ground water, that is sub-soil or subterranean water, is, owing to its rapid flow from the soil where it falls to the water-courses and to evaporation, probably somewhat less than half of the amount. That this amount which reaches the creeks and rivers is not wholly lost, but to some degree becomes a source of supply to subterranean waters, we shall, I trust, later on produce facts to show.

To refer to the ground waters of Ontario more particularly, let us recall the geological character of the strata in which these waters are found. The Laurentian band of gneissoid rock runs in a north-westerly direction, with its western edge in the neighborhood of Kingston, thence running to the south of Muskoka Lake, thereafter going to form with the Huronian series the islands of the Georgian Bay. Upon this, and varying in extent and thickness, we have limestones, slates and sandstones, and limestones again succeeding each other until the Detroit River is reached. These have a general westerly dip or incline, varied, however by escarpments, anticlinals and synclinals, probably to a much greater extent than at present we have any idea of. Thus the Guelph limestone is about 900 feet above the sea, the Niagara escarpment reaching in some places nearly 1000 feet, while along the Detroit River and Lake Erie the rock level does not exceed, if it reaches, 600 feet, descending again from this at the level of Lake Ontario to but little more than 200 feet above the sea level. Overlying these rock surfaces of varying elevation, we have deposited in widely extended areas along the lower Lake Huron and Detroit River district, the whole of the Lake Erie shore, and a large portion of the Lake Ontario shore far east beyond Toronto, the boulder or Erie blue clay, overlaid in differing degrees of regularity and thickness by Saugeen clays, everywhere interspersed with layers of sands and gravels. On the higher levels, as of the Guelph plateau and the Oak Ridges, we have deposits of varying consistency from the tenacious argillaceous gravels of the central plateau, as at Guelph, to the arenaceous gravels of portions of the Oak Ridges and the stony and sandy soils of the lands dipping towards Georgian bay.

In addition, however, to these broad divergencies in the post-glacial deposits overlying the rock strata, we have the innumerable local differences, nowhere better marked than about Toronto, depending upon the denuding agencies which have hollowed out the whole Lake Ontario basin and produced the valleys of denudation such as the Humber and Don valleys, and the many smaller ravines distinctive in the sharp-cut outlines which deep erosion of these blue clays everywhere presents.

From this *résumé* it will at once appear that an endless variation in the conditions regulating the direction, depth and amount of the flow of ground-waters must exist, and we have two problems everywhere presenting themselves for investigation: the geological and the topographical. Let me give one or two illustrations.

The little river Avon, beginning on the high ground eastward from Stratford at a probable height of 900 feet or more, takes a general southwesterly course, flowing into the east branch of the Thames, which receives a similar stream at London, and passing westward through Chatham empties into Lake St. Clair some 575 feet above the sea. There are abundant outcrops of rocks along the Thames at St. Mary's and elsewhere in the vicinity, while at Chatham it is reached by borings at from 40 to 80 feet below the surface alluvium. Apart from the synclinal or depressed area, which practically forms the oil-boring region of

Ontario, there is the general incline of strata from the central plateau south-westerly. At Woodstock, at St. Mary's, at London, at Thamesville, at Chatham, and indeed all along the westerly part of this region, there is evidence of the enormous body of water flowing westerly from the higher ground to the east and north in the presence of artesian or flowing wells in greater or less degrees according to the accidental height of the soil as compared with the general level of the locality.

On the other hand, as an evidence of topographical influences, we have the fact that along the ridge of gravel which runs for many miles east and west along Lake Erie, at times touching the lake, at others being several miles away, and broad enough to have located upon it such towns as Ridgetown, Blenheim, etc., numerous springs may be seen issuing from either slope, in places only a hundred or so yards apart, those to the south flowing into the lake, the others tending towards the valley of the Thames some ten miles away.

To give but one other illustration, a gentleman who resided at Norway (near Toronto) for several years informed me that an old well had there been sunk in the sandy soil some fifteen feet and gave a fair supply of water. Its location being inconvenient to the house, he had another well sunk nearer, and within one hundred yards of the other well, and he had to go down some sixty feet in blue clay before what was probably the same bed of sand was reached : it yielded abundant water.

We have already referred to the source of subterranean waters as being due to the rain falling upon the soil, and to the fact that a large portion of the rainfall finds its way to the water-courses without being absorbed by the soil. The balance, however, probably amounting to about 50 per cent. of the total rainfall, is absorbed, but in very unequal amounts. The amount of absorption, as will readily be understood, will depend upon, first, the inclination of the surface soil, and second, on its pervious or absorbent character. Setting the first aside as unavoidable, we have to realize that the surface soil of Ontario with deforesting and cultivation, has lost in large measure the virgin mould made up of decaying vegetable matter which, loose in its character, absorbs in large degree all the rain which falls upon it. This not only gives the underlying soil every opportunity of absorbing all the moisture it can hold, but also maintains it in a friable condition very different from the hard-baked surface which any one may notice even in sandy soils, which are exposed to the heat of the sun. Accepting, however, existing conditions, it will be seen that notable differences exist between the absorptive powers of argillaceous and arenaceous soils and the various gradations between them. We must here note a distinction of much importance in its bearing on this matter, viz., that between the capacity of a soil to hold water or its absorptive power, and its perviousness.

For instance, Prof. Schubler, of Tübingen, states as the result of experiment that—

Sand holds by attraction per	100 parts,	25	parts by weight of water.
Loamy soil	"	40	"
Clay loam	"	30	"
Pure clay	"	75	"

Thus we see that perviousness is the opposite of capacity to hold moisture, as the most impervious soils have the greatest power to hold moisture within their interstices. The fact in drainage is a familiar one that where a clay has been puddled—for instance, where the heavily loaded waggon passes over a road—the clay particles become so closely pressed together that it becomes impervious until the moisture and the frost have disintegrated it again. Deep clay soils may similarly become through pressure in large degree impervious.

Now, we have already seen how, in different portions of the Province the superficial drift deposits lying upon the rock vary notably in character, and how the layers which succeed each other may alter in some instances within a few feet. These variations have depended, of course, upon the condition which existed at the time of their deposition. Remembering that from the melting glaciers and icebergs of the post-glacial era the detritus would follow the order which we can observe after a storm in any stream, we would expect to find what we do find, viz.: that the heavier boulders, gravels and sands would settle first along shores and in the shallow waters, and that the argillaceous materials, remaining longer in suspension, would last deposit in the outer and deeper waters. Currents, variations in the outlines of the shore, and all the other phenomena seen daily in lake or stream, must be looked to for an explanation of the local variations, to which we must add the denudation and innumerable rearrangements due to the floods of primeval mighty rivers, and the varying levels which have given us our system of lakes of varying levels.

This importance of the order of post-glacial materials has an interesting and very practical bearing upon the volume and direction of ground waters. To refer once more to the illustration given, we find the general character of the soils over Waterloo and Perth to be calcareous sands and gravels. Where these lie upon the rock we can see that there will be water-bearing strata of pervious layers, which may be continuous for many miles, and thus supply a *vis a tergo* pressure of enormous power. This will, however, depend upon the character of the superjacent layers If pervious, the water will on account of this pressure tend to rise to the surface. If, on the other hand, tenacious clays overlie these pervious layers, as is the case over a large portion of the Province, then these waters will rise to the surface only where denudations and erosions exist, as in the case of river valleys, causing springs, or where borings or dug-wells passing down through the pervious beds make a channel by which the tendency of the water to rise to the level of the head which it has can come into play. That this rise of waters in driven wells take place will depend, however, upon whether there is any hindrance to such underground streams following further in such pervious strata along the incline or dip which we have already supposed to exist in the underlying rock strata.

In other words, the occurrence of an artesian well depends upon the following conditions, as well expressed by Prof. Laveratt, who has examined largely into the question of public water supplies in the western prairie States:—(1) A pervious water-bearing stratum; (2) an impervious stratum below; (3) a second impervious stratum above the water-bearing stratum; (4) these strata must be inclined or have a dip; (5) there must be no adequate outlet for the water at a lower level than where the boring is made; (6) a sufficient collecting area or reservoir with superficial porous strata; (7) the collecting area must have sufficient elevation to act as a fountain-head; (8) there must be a continuity of the permeable bed; (9) there must be no flaw or break in either of the confining beds. Chamberlain has given the dip necessary as being one foot per mile. From these several conditions it becomes apparent that though one or several of them may be present, yet the conjunction of all of them is not by any means to be expected in all parts of the Province, although the numerous borings being made, especially in the western portion of the Province, for water, salt, oil or gas give evidence that such supplies of water are much more numerous than we at first might expect.

The details which we have just given are applicable in explaining the source, extent and progression of ground-waters on the broad scale. The most cursory examination, however, of the upper soils of many districts in the Province shows that the great proportion of ordinary well water is as yet got from comparatively shallow wells, there being present in most districts alternating local pervious and impervious strata, making wells yielding water possible within fifteen to fifty feet of the surface. In other parts, as in many portions of the western peninsula, shallow excavations through alluvium down to impervious clays becoming reservoirs for surface waters, have till very recently supplied the great bulk of drinking water both in towns and country districts. Now in every instance the same laws are in force, and we have seen that they involve:—(1) A downward force of gravity; (2) a hindrance such as an impervious stratum; (3) a lateral movement of ground-water towards the lowest attainable point, whether this result in great subterranean water-beds on the rock strata, supplying conditions for artesian wells; whether in the appearance on the hill sides of gurgling springs and a saturated surface soil in the vicinity, or whether in the soakage into the nearest depression, as wells, cellars or other shallow excavations of waters, all following the general law of downward and lateral movement where obstructions do not prevent.

We have now reached the second and more important part of our subject, and the subject to which I have more especially devoted this study, viz., the constitution of ground-waters.

2.—CONSTITUTION OF GROUND-WATERS.

In addition to the chemical combination of hydrogen and oxygen making pure water, we are aware that a large number of other chemical compounds are held in solution by it, and that in its passage through the soil it dissolves out such soluble matter as it comes in contact with. We may hence speak of the chemical constituents of ground-waters as impurities, although, as we know, they owe to the mineral salts in solution their agreeable and wholesome qualities. These impurities, with minute amounts of organic matter, which from their occurrence independently of all adventitious influences may be called *obligatory* in contradistinction to the *facultative* or inconstant impurities which depend upon influences which may be removed I do not propose to refer to further here, but shall limit our study to the facultative impurities of an organic character.

Everyone is aware that water will carry in suspension, as in rivers, ponds, etc., very large amounts of organic materials, and that from these, whether animal or vegetable, it abstracts soluble matters, remaining present until decomposed into simpler constituents. To give but one illustration, the City of St. Louis, Mo., has four settling basins, holding 18,000,000 gallons of water. Their floors are paved with brick, and upon these are deposited by sedimentation the suspended, and to some extent the dissolved materials of the river water. Once in five months the sediment is flooded out of the reservoirs, and the quantity thus removed is nearly 200,000 yards, of course of largely inorganic matters. This is when the needs of the city allow only of sedimentation going on from eight to eighteen hours, while clayey matters in suspension often take one week to subside. The sources of these impurities are those common to all river waters, viz., those due to vegetable matter from streams and rivulets rising and bearing with them the soluble matters from the bogs and virgin soils whence they spring, as also in certain localities the sewage deposits which may be poured in from towns along their banks. From such causes is due the fact that river waters are commonly considered unsafe sources of public water. They not only are readily contaminated, often to an extraordinary degree, but the swiftness of their currents often bears these impurities onward before the purifying influences have time to perform their work, and hence sedimentation and filtration beds have been brought into requisition in the endeavor to bring the water into a potable condition.

We see in these operations going on before our eyes in river waters an illustration of what goes on in the purification of ground-waters, only that the stages are in the latter instance more slowly and much more perfectly performed. The rain which falls on the surface is absorbed by the ground and bears with it minute amounts of carbonic acid and ammonia due to the combustion of the organic matters of the soil. These gaseous impurities of the air, which have had their origin in the ground, become of much value in aiding the disintegration of the soil and thereby promote the percolation of water through its layers. The rains receive, however, from the upper layers, which always contain organic matter either of vegetable or animal origin, soluble materials such as the above, soluble albumen, and other products of the humus, etc., and moreover what in addition to them has been borne to the earth, living organisms of various species, notably of the bacteria which, as is now well determined, are the agents of the decomposition of organic compounds, and these are in the soil in innumerable amounts. It has been already stated that carbonic acid and ammonia are the soluble compounds resulting from the decomposition of the organic matters of the soil. Now we find that wherever albumenoid matters, especially, are present in soils or in cultures which are artificially prepared, causing the multiplication therein of bacteria, these two gases are amongst the principal products. Subsequent chemical action as by oxygen, forms carbonates while nitrates develop out of the ammonia present. Manifestly, however, this extent of the oxidising process depends upon the depth of the organic materials in the soil, its porosity as regards movement in it of ground air and the depth to which the bacteria are found to have extended. Now while the first two conditions are interdependent and to some extent condition the depth at which bacteria are to be found, they show us that there are several other factors in the problem which must be considered.

Duclaux has stated that of the agencies which render water sterile, "the first, the oldest known and without doubt the most potent is the capillary action of the soil. Filtration practically retains in the capillary interstices the matters in suspension in the water, and with them the germs of microbes. It is a fact well demonstrated on which I shall only insist in order to attempt to indicate slightly what one calls capillary filtration . . . . It is only proper to remark at the outset that the capillary character of the channels in which circulates the water of rain, has only the effect of augmenting the extent or surface or the volume of water which leaves them, that is to say of multiplying the chances which a solid particle in suspension in water can have of encountering a portion of wall on which it fixes itself, drawn by a force analogous to that which fixes coloring matter in a tissue placed in a color solution. The effect would be the same if the chances of contact were found to be increased by any other cause. It could also happen and sometimes does happen, moreover, that a long repose causes to adhere to the walls of a vase the particles held in suspension in the liquid it contains. It can happen, and without doubt does happen, that a slow filtration through a great length of non-capillary spaces aids and even somewhat largely produces the same result as through capillary spaces shorter and narrower."

We thus see that the rate at which water passes downward through the soil which as Hofmann found at Leipsic in some virgin soil, was at the rate of 6·2 millimetres daily, or at 2·26 metres per annum, and which water, as Duclaux says, may remain six months or more as subterranean water before appearing on the surface as springs, gives ample time for sterilization. Exceptions to this sterilization of ground-water exist, as may be seen in calcareous soils, in which the action of carbonic on the chalk has caused by solution the formation of fissures often of great depth and extent, thereby allowing the carrying of contaminations to great distances. The conditions which regulate filtration in soils are, as Pettenkofer remarks. sufficiently constant for general laws to be made regarding them. He remarks that "the volume of the pores does not vary much in different soils, and may be considered to occupy one third of the whole. The dimensions of each pore may however vary considerably in different soils. In soils which contain large pores the water percolates rapidly; a compact soil in which the pores are very fine is essentially hygrometric or retentive. The level of a subterranean water may hence be uninfluenced by the heaviest rainfalls, if the water stratum be deep and separated from the surface by layers which may retain the heaviest rainfalls without allowing a drop to pass through. It is apparent, therefore, that with allowances for different kinds of soil, we have roughly different areas, or, as Hofmann calls them, different zones, viz., the upper or evaporating zone, which may even hold the rainfall of a whole year, and becomes the receptacle of all kinds of organic impurities, the culture medium for germs of every sort. Hygienically, this is of all the most interesting and important. The second, or intermediary zone, always humid, reached at varying depths, may give passage to waters very slowly, and only gives passage to the surplus over saturation derived from the upper layers. While, generally speaking, this area is beyond the influence of surface operations, yet it will readily be seen that in the degree that the superficial layer becomes by the leaf mould of forests, drainage and cultivation, more pervious, the greater the amount of water that is absorbed, and the more readily will the underlying zones be influenced from it. Drainage and the cultivation of grasses, now that the forest areas have disappeared, are essential to the conservation of the level of ground-waters, since through their agency perviousness of soil is maintained, and the retention of pluvial waters where they fall is made possible.

The third zone in compact soil is only a few inches thick, increasing in depth where upper soils are more pervious. This is the supersaturated layer along and through which flows the underground stream. The depth of this stream or the thickness of this zone is slowly or rapidly influenced according to the compact or porous character of the upper soils, the extent of the watershed above any given point, and the inclination or dip of the more or less impervious stratum or hard-pan along which this underground stream flows. An illustration as in the instance of the London West flood in 1883 demonstrates this, while on the other hand the greater hygroscopy and retentiveness of clays with their closer texture, as already shown, will prevent surface influences readily showing themselves.

The remaining cause influencing these subterranean streams is that already referred to as existing here and there in those instances where the surface stream, as some river or lake, has waters at the same level as the subterranean waters. The rise and fall of these surface waters caused by heavy downfalls of rain, and by winds raising or lowering the level at different parts along our lakes (*e.g.*, at Owen Sound, Goderich, Lake St. Clair, Moulton Township), shows how the ordinary conditions governing these underground streams may have local extraordinary influences contravening the general law.

Returning to the consideration of the conditions which govern the existence and multiplication of microbes in the soil, we have to recollect the inconceivable richness of the superficial layers of organic matters in microbes. Two millions to a centigramme of soil, as Duclaux gives it, but imperfectly conveys any idea of their number. Take the instance where in heavy clay soil the autumn and spring rains have saturated it almost to the surface. Here the small amount of air in the upper soil prevents oxidation in large measure of the organic matters. The lack of oxygen impeding the multiplication of bacteria is notably aided by the low temperature of this soil induced by evaporation. Parkes indeed found a difference of 12 ° F. in the temperature of the upper layers of two contiguous pieces of bog land, one of which was drained while the other was not. Now, however, when the ground-water falls, the air follows, and with moisture and warmth nitrification goes on. But this favorable condition may be temporary. The heat of summer rapidly bakes such surfaces, air does not penetrate the deeper layers, and the moisture being deficient the multiplication of bacteria is again limited. Clearly, however, the recession of ground-waters from the surface with increasing temperature, as after the spring rains, means an increase in depth of the area to which nitrification extends—or in other words the depth at which bacterial infection of the soil is present. *In fairly pervious soils the roots* of species of the clover and pea family have been found ten feet below the surface, while the roots of trees following the area of perviousness and nitrification, run laterally, and spreading out obstruct tile drains, and reach into wells at a depth of twenty feet or more. Duclaux remarks, the extension of germs downward in the soil ought theoretically to take place by a general extension, by increase from point to point, by gradual growth, causing invasion of the deeper layers, and in carrying life into regions which as we know remain sterile. He then asks, Why this sterility? Fraenkel has pointed out that the temperature at two or three metres below the surface is an absolute obstacle to the multiplication of the bacilli of typhoid and cholera, yet inasmuch as microbes may through cultivation acquire an ability to grow at lower temperatures than those normal for them, Duclaux *affirms that the low temperature is not sufficient* to explain the phenomenon. Further, the absence of nourishment cannot be given as a sufficient explanation, since microbes can live and even multiply in distilled water, living, as Pasteur says, on their own tissues. A most potent cause exists, however, in the absence of oxygen, which is more rare the deeper we go into the soil. Instead of oxygen, we find in such layers carbonic acid relatively in excess, and Léone of Munich, of Pettenkofer's laboratory, has by experiment found that Munich waters, which at the place of origin contained 115 microbes per centimetre contained 10,500 in 48 hours, and 500,000 after five days. At the end, however, of another five days, he found that in this water, in which the carbonic acid due to decomposition had so greatly increased, the number or microbes had fallen off to 87 per cent. centimetre. That this gas has a specific influence in preventing the increase of microbes was proven from the fact that if replaced by a current of hydrogen there occurred a rapid increase in the number of microbes.

Whether or not, however, anaerobies or microbes which multiply in the absence of oxygen, can multiply in these deeper layers, experiment is as yet lacking to determine. Certain it is that these waters flowing in the tertiary zone or stratum of supersaturation with a slow uniform movement depending upon their depth, the weight of water and dip of the underlying impervious bed, end by arriving at the surface as springs, or in wells (either dug or driven) in a sterile condition. Arrived here, the water comes in contact with air, sometimes with light, also with infected soils as of the mould of the surface or the organic matter which finds its way into wells, and, the conditions of sterility having disappeared, it becomes again inoculated with microbes

As may be readily understood, the farther from such underground conditions a water proceeds the greater are the possibilities of its inoculation and of the variety as well as the number of the microbes in it. As natural waters in different regions vary in temperature and in the amount and character of the organic and mineral constituents in them, it is very natural that different species of these microscopic plants should be characteristic of different waters. Winogradsky has studied the species of sulphur water, while Fazio and others have found species peculiar to the waters of Naples, Castellamare, etc.

How extended are these differences of species and what the peculiar influences favorable to each, has not yet been investigated. Indeed it may be said that this study of species is little more than begun. When classification has become possible, the still more difficult matter of deciding which are pathogenic and which are innocuous will yet remain.

Work with a view to determining under what circumstances these sterile underground waters can be obtained pure for drinking purposes has recently been carried on by Carl Fraenkel of Berlin, and some interesting results have been obtained. I shall take the liberty of introducing here a condensed abstract of his experiments, as they are found to be wholly in accord with the views, which reasoning, based upon the physical characters of underground waters in relation to geological conditions and to the known facts regarding bacterial life, has led us to deduce.

Fraenkel's investigations were undertaken to determine if it were possible at all to remove with complete success infective material which had once gotten into a well.

He notes the two forms of wells, so called kettle wells (kesse[illegible]unnen) from which the water is obtained by bucket or pump, and the artesian wells (rohrenbrunnen). These two forms are exposed to different methods of infection.

The kettle wells are exposed first to infection from above; secondly they never possess walls of such a character as to exclude infection from the surrounding soil. Experienced well-diggers assure us that no kettle well, even those with the best cement or asphalt walls can be depended upon to remain absolutely tight. They constantly act in relation to the surrounding soil as powerful drains which not only receive the ground water, but also the surface water. They are protected of course to a certain extent from surface infection by the filtrating power of the soil. Superficial layers, however, are much more loosened up (artificially and naturally) than lower layers, consequently the power of filtration is not so great.

Tube or artesian wells are not exposed to such danger of infection from upper openings as kettle wells. From the outside, from the nature of their construction, they are completely free from dangers of infection.

Both kinds of wells may be infected, if such infection exists, from the ground water.

He reviews the subject of the germ contents of ground water, considers the results as unsatisfactory and consequently in this paper takes up the question anew.

The artesian wells, which were used for the experiments, were two in number, situated in the court of the Berlin Hygienic Institute, in a part of the city which has been inhabited for a number of centuries, and within a few hundred metres of the Spree. Both had been placed in position about two years and a half previously, and had been little used. At the time of investigation the wells had not been touched for several months; the ground water stood at 4·48mm, average day temp. 12° C.

Water first removed contained in 1 ccm. 10,800 germs. This large number is explained by the stagnant condition of the water.

		Amount pumped.	Number of microbes.		
April 10th, 1888.	Litre	2	7,200	per	ccm.
	"	50	560	"	"
	"	100	154	"	"
	"	200	120	"	"
	"	500	54	"	"

Next day—

		Amount pumped.	Number of microbes.
April 11th, 1888.	Litre	1	7,000 per ccm.
	"	50	140 " "
	"	100	160 " "
	"	200	84 " "
	"	500	42 " "

April 12th, third day, practically the same result even when double the amount of water was taken out; results about the same.

April 13th.	Litre	1	Plate fluidified.
	"	50	130
	"	100	150
	"	200	42
	"	500	20
	"	1000	18

It was apparent from the sudden fall from litre 1 to litre 50 in number of germs that the number in the first litre were due to development in the well itself. This is shown by tables in which every litre up to the first ten was examined.

April 16th, 1888.	Litre	1	6,400
	"	2	5,000
	"	3	4,200
	"	4	1,400
	"	5	800
	"	6	800
	"	7	450
	"	8	380
	"	9	360
	"	10	320
	"	500	360

The same day, six hours later, the well was again examined, and gave—

Litre	1	6,800
"	5	3,800
"	10	620
"	100	80

It is evident that an extremely energetic washing was necessary to remove the masses of bacteria in a purely mechanical way (amount of water actually in well calculated at 5 litres, depth of well 8 metres).

The continued appearance of bacteria after the removal of so much water may be explained by the continual entrance of fresh germs in the incoming ground water at the bottom of the well. But it may also be due to the formation of a zooglea membrane by the bacteria which stick to side of tube and small portions of which being given off to water which passes through would give rise to the constant appearance of germs. It was necessary then to determine the character of the ground water by thoroughly disinfecting the tube.

On April 27th, water showed the following—

Litre	1	11,200
"	100	110
"	500	22

On the 28th the pump was taken out and placed for two hours in a two per cent. watery carbolic acid solution; the tube itself was thoroughly washed by means of the long handled brush, and finally five litres of 5 per cent solution of Laplace's mixture of raw carbolic acid and sulphuric acid (equal parts of each) was poured into the tube. It quickly sank into the well until finally the water stood at its original height.

Next day the well was pumped out and the water examined. After 100 litres no trace of carbolic acid, either by odor or by ferric chloride reaction; also at 500 litres. Gelatine plates from the water remained sterile. Well remained sterile for seven days after disinfection. There was the possibility that carbolic acid still remained in ground water and so destroyed organisms there present. It was not likely as it must be present in such small quantities as not to affect development. Direct experiment showed that sterile water if artificially infected had no injurious affect on organisms; this sterility of the water was due to the disappearance of organisms from tube.

After seven days the well was left for one day without pumping. Next day germs had reappeared. Evidently due to infection from above. Water having been left in undisturbed condition it had had time to develop and form zoogloea stages.

A second experiment was disinfection with 4 per cent. sulphuric and carbolic acid mixture. Tube was not mechanically cleaned. The results were that same remained germ free for six days. Then there was a gradual reappearance.

Third experiment, less carbolic acid mixture taken, but concentrated (2 litres). Taste of acid noticeable for several days after, but gave no reaction with ferric chloride. Remained sterile four days, but not till the twelfth day did germs appear in litres 500.

Further experiments undertaken with artesian wells gave results completely in accord with above.

Fraenkel notes here that the sterility of water might be due to the fact that carbolic acid had sterilized a layer of soil at base of tube, which for several days filtered away the organisms in ground water, but that finally they penetrated this layer and then appeared in well. To overcome this objection he caused the well, some days after the complete re-establishment of the germs in it, to be thoroughly cleaned out by scrubbing it for half an hour with a long-handled brush. Then water examined gave the following result.—

Litre	1	Innumerable
"	100	780
"	500	Sterile,

and the well remained sterile for the four following days.

It was evident that germs originated from the sides of tube itself, and not from ground water. Mechanical cleaning was sufficient to remove them.

He concludes therefore that except in certain cases (dependent upon soil) the ground water may be looked upon as germ free. Conditions which might lead to an infection of ground water, are character of soil above the water, layer rather loose in character; water layer too close to upper surface of ground, occurrence of drains in water layer which were not perfectly tight, or finally, the presence of muddy wells.

He finally studied the effects of the disinfection of artesian wells upon spores of bacteria. He could not use anthrax spores from their dangerous nature, but used almost equally resistant hay bacillus spores, and spores of blue milk bacillus, as well as the micrococcus prodigiosus.

Results were all favorable; sterilization was easy. He tried the disinfectant characters of lime, but found there was not sufficient amount of water in artesian well to dissolve it, and danger of spoiling well by the formation of a sort of mortar which could not be easily removed.

He next started a series of experiments on two kettle wells, also situated in the court of the Hygienic Institute, and each containing about 1·3 cubic metres of water.

KETTLE WELL I. May 10th, water showed as follows :—

Litre	1	320
"	100	130
"	500	70

May 11th. Two litres containing sulphuric and carbolic acid poured into the pump and left till following day. Then first water showed strong carbolic reaction, and it could be noticed in water for about a week, gradually becoming less intense.

May 12th. Water apparently sterile.

May 13th. Litre 500, 17 colonies.

May 14th. All three (1-100-500 litres) contained colonies, and an increase in number was noticed from that time in spite of the still considerable amount of carbolic acid in water.

May 19th. 10 litres—carbolic mixture poured in, pump tube brushed out and wat. in well thoroughly mixed up. Results were even more unsatisfactory.

May 20th. Germs were in water in spite of intense c lor of carbolic acid water of a brownish yellow color, and ferric chloride test gave a very marked reaction.

May 21st. Germs had increased to an extraordinary number in spite of presence of considerable carbolic acid. Explains want of success in above experiment as follows.

In kettle wells, where there is always a considerable amount of water present, a sedimentation takes place in the stagnating contents, and the formation of a thick layer of mud on the bottom. In addition, there is the formation of a much larger amount of the zooglea layer on the wall than in the artesian wells. There is a very much larger number of bacteria in the second experiment than in the first, explained by the fact that before the first experiment the well had stood untouched for a long time, consequently the water had, as it were, been exhausted of all its food material by the bacteria which were in it, and they had all been converted into spore form, and had sunk to the bottom, forming a thick layer in mud.

The pumping out of the water had allowed fresh water to stream in, and the stirring in connection with the experiment had disturbed the material at bottom of the well.

The carbolic acid had destroyed the germs in the water itself, but had not reached those in the mud at the bottom of the well.

This also explains the first appearance of organisms in the 500 litre sample, i.e. in lower layers of water.

Another experiment on the same well contained a large amount of sulphuric carbolic acid mixture (10 litres conc.) with as thorough as possible disturbance of the mud layer. The result was not much better, water sterile for two days, then reappearance of germs with continued presence of carbolic acid.

The next experiment was on kettle well 2, which was not walled over, but simply closed by a stone which could be lifted.

May 16.	Litre	1	6,400
	"	100	920
	"	500	180

May 17th. Stone cover lifted; mud at bottom 7·83 cm. thick. By means of a stick with heavy T piece at end, the mud was mixed up with water as thoroughly as possible. Then 10 litres conc. sulphuric carbolic acid was poured in, and the contents of well further stirred up, and the water pumped.

May 18. Germ free.
May 19. " "
May 20. " "
May 21. Germs appeared first in litre 500.

He concludes that well was not thoroughly sterilized.

A second experiment gave similar results, but somewhat sooner reappearance of germs, possibly due to sudden rise in temperature.

It is evident that sterilization in above manner is not practicable, especially as the long continued presence of the carbolic acid in the water prevents its use.

He therefore endeavored to find the value of lime as a disinfectant for wells, because, 1st, its presence in water does not prevent its use. 2nd. It has shown itself especially useful in cases where it was a question of the removal of suspended organic matter.

June 9th. 10 kgrm lime was shaken up with 4 kgrm water, and the whole poured into well 2. Then the well contents were thoroughly mixed mechanically, and finally the water raised to the top of pump in order to disinfect it also.

June 10th. Sample intensely alkaline. Water for the four following days contained a considerable amount of lime in solution.

But three days after disinfection germs appeared in litre 500, and the moment the free lime disappeared from the water.

June 14th, a tremendous increase in germs was noticed.

Results, therefore, were unsatisfactory.

A second experiment with 25 kgrms of lime gave same results.

Experiments similar to those on artesian wells with spores of hay bacillus and blue milk bacillus, and culture of micrococcus prodigiosus, showed that 20 kgrms lime was capable of removing them from water.

It is evident from above experiments that a complete disinfection of kettle wells is impossible by means used, but that for the destruction of germs which might possibly get in from above, immediate use of considerable quantity of lime be recommended.

He concludes that the evidence against the kettle wells is very strong, agrees with Pflugge (Zeit. für Hygenic Bd. II. s. 406) in calling them "hygienic monsters."

He strongly recommends their replacement in all cases by tube wells.

These experiments are to me intensely interesting, published as they were at a time when I had undertaken to determine, with such time and ability as were at my disposal, the bacterial relationships of waters existing under a number of different conditions.

On the 5th of July last the works were opened at the London Asylum in connection with the sewage farm intended to dispose of the sewage from that Institution. Under the superintendence of the public works department, the plans prepared by Colonel Waring were completed. The sewage was to be pumped daily to the farm by Webber's centrifugal pump, which finely divided the solids it contained. At the farm the sewage was turned into a number of open ditches 2 feet deep by 6 at top and 2½ at the bottom. Alternating with these were flat beds 12 feet wide graded to a level surface. Under each alternate bed was a field tile drain 4 feet deep, increasing to 6 at the further end of the field, where they join a common effluent tile, this leading to an open ditch known farther down as Carling's creek. This flat bed is composed of a very sandy soil some five acres in extent, and is supplemented by a field of some ten acres graded for surface irrigation. One-third of the ditches were flooded each day, but the extremely dry weather prevented even a portion of the field from becoming saturated during July and August, and so prevented the attainment of one object of the experiment, viz., the comparison of the biological character of the water running from the effluent tile as compared with the several other waters which were examined. The water samples were taken under the supervision of Dr. N. H. Beemer of the medical staff of the asylum in sterilized and capped tubes sent to him from week to week. The examinations made the succeeding day, while not giving the exact number of the microbes in the water at the time of taking, would yet give the comparative results of the different species and the results of the different week's examination of the few drops of water taken from any water, this being all that is needed for an examination. I may say that the successive samples of different waters showed surprising constancy of forms, both as regards species and number. For instance :—

No. 1. Tile drain, 14 forms—10 liquefying, 4 non-liquefying.

No. 2. Effluent from sewage farm, 6 liquefying, 3 non-liquefying.

One week only.

No. 3. East creek. All portions of culture showing innumerable slowly liquefying spots, all the same form apparently; probably M. candicans.

No. 4. Carling's Creek. All portions of the gelatine show innumerable liquefying points with whitish granular particles in the larger liquefactions.

Nos. 5, 6, 7 were practically sterile, showing as they did only one or two forms which were not moulds—possibly got from the air of the tank rooms. I shall say nothing more regarding their species, except that they were few in number, some seven in all in the whole series of cultures. The notable fact gained was, however the innumerable bacteria present in the open water of creeks. Samples taken again and again from both Carling's creek and East creek always produced one form in great abundance —probably M. candicans—in the latter in greater abundance as the water with the drought became less and more impure. It was always with much satisfaction that our inoculations of London city water indicated practical sterility, taken as it is from springs appearing at some height above the river bank below the city and gathered in a small collecting gallery. The samples were taken from a city tap. The same sterility was found in the water coming from a faucet in the pump-house at the asylum, the water coming from a bored well of considerable depth. The water from the tank at the top of the building showed occasionally a mould or two as would be expected from a tank in a confined space at the top of the house. No less interesting is the fact that the water arriving at the mouth of the tile yielding sub-surface drainage from a field was practically free from bacteria. The effluent water from the tile drain leading from the sewage farm, the one week that a sample could be obtained, showed as great freedom from contamination as did the other tile water.

Of course there had been no time for polluting the soil and this was probably common sub-surface water. It shows however that the field, some five acres in extent, was capable of absorbing more than 100,000 gallons daily without supersaturation in dry weather. A letter received to-day from Dr. Beemer says so far the farm, during this whole winter, shows no surface collection of a notable character, although the soil as we know has everywhere been in a condition of almost complete and constant saturation.

Now, without making any positive statements, I think that as regards this whole matter of natural waters we may fairly draw the following general conclusions :—

1. That while the atmosphere as compared with the soil is relatively free from bacterial life, yet rain-water bears to earth from the air and gathers from the roofs, etc., the elements of auto-contamination, and finds in the organic matters gathered from roofs, etc., abundant nutriment for them.

2. That falling on the surface of the ground waters become loaded with bacteria of the soil, whether those indigenous to it or which have been borne to it from a distance.

3. That of these contaminated waters about 50 per cent. are not absorbed but follow the surface inequalities into brooks and thence into the larger streams and great lakes. The brook as it passes through virgin soil collects much albuminoid matter which affords abundant nutriment for microbes, borne into it from every side, and when the stream reaches a part where barnyards, and other sources of sewage pollute it, it is likely—nay, certainly will—become contaminated with bacteria of a dangerous character.

4. Where gathered into the great lakes, deep and hence very cold, with constant aeration going on and constant exposure to sunlight of their great areas, there follows a great diminution in the bacteria of the water through a lessening of the organic nutriment for microbes, and hence a great halt in their multiplication, owing to the low temperature, aeration and exposure to sunlight.

5. Rivers, shallow lakes and bays along the great lakes, and these especially during those periods when, by evaporation, their volume is so greatly diminished by evaporation, are likely to become very impure and the causes of their impurities are likely to remain more or less permanent.

6. The fifty per cent. of rain water which is absorbed by the soil has a different history. Loaded with impurities in the upper layers of

the soil, it passes slowly by percolation downward and loses gradually through capillary attraction, less ned nutriment, decreased amounts of oxygen and increased amounts of carbonic acid, its previous bacterial pollution, and with few exceptions appears in sp.ings and subterranean waters, where tapped either by tube or the common pit wells, as absolutely sterile or wholly devoid of bacterial life.

7. That in the tube wells, with careful driving of the iron tube to prevent soakage along the outside, and a brief pumping to carry off the contaminating bacteria which reach the inside through aerial contamination, we can obtain a practically sterile water of first quality for drinking purposes.

8. Through organic soakage in the upper and most readily accessible direction for the lateral movement of subsoil waters, such waters carry abundant nutriment for bacteria, which are carried in the same manner and by the filthy washings of the top and from the air which occupies the pit, with little aeration and the absence of sunlight and a temperature in shallow wells affected by external temperatures, conditions most favorable for the development of bacteria exist. Hence these wells under ordinary circumstances, but especially where found in back yards, under kitchens, in barnyards or as shallow dug outs in the black soils of the west and all newly-settled countries, are veritable pest-holes, more dangerous to the health than probably all other local sources combined in those seasons when low temperatures do not prevent bacterial development. They are really what Pflugge calls them, "hygienic monsters."

I conclude this paper on a subject which is exhaustless, in the words of Duclaux, "One suspects more a water which receives a minimum quantity of excrementitious matters than a water which might be charged with germs after the water had run over a desert region. This question of the nature of germs is too important for us to dream of limiting it by the length of this review already too long, in which we have wished to study the question of quantity. But in waiting that one may find the means of indicating in a water the hurtful or pathogenic germs which it contains, and having found in this way a measure of the degree of their nocuousness, we confess that the only waters to be recommended are those which contain no germs at all."

THE DÉNÉ LANGUAGES.

Considered in Themselves and Incidentally in their Relations to Non-American Idioms.

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

(Read 19th April, 1890.)

INTRODUCTION.

Among the allied sciences which concur in lending ancillary aid to Ethnology none can be compared to Philology. Anthropology's services are valuable, it is true; yet its investigations tend to the solution more of racial than of ethnic problems. Archæology can hardly be regarded as an infallible criterion of ethnological certitude, since we find among peoples confessedly heterogeneous implements and sometimes monuments of striking similarity. Mythology or Dæmonology can still less aspire to the first place in the ethnologist's esteem; for, not to speak of the universality of certain myths or beliefs, a people's legends and its very theogomy itself are liable to yield to the latent pressure exercised by foreign nations through migrations, captivity or commiscegenation. Sociology can lay claim to great importance indeed; still it cannot be assigned the first rank among Ethnology's satellites, since we find among such ethnically different peoples as the Jews and the Caffirs, observances the identity of which would lead to false conclusions were Sociology allowed supreme importance in the decision of ethnological questions.*

Such is not the case with philology. "Nothing is more characteristic of the intellectual existence of man than language," says Gallatin.† "It is found to be a more enduring monument of ancient affinities than the physical type, and there is no tribe, however situated, from which this proof of affiliation should not be obtained." This opinion is corroborated by a contemporaneous author, Horatio Hale, in a paper read some years

*The most striking instance adducible in confirmation of these and the following remarks is that of the Nabajoes of New Mexico and Arizona. Those aborigines who are geographically surrounded by heterogeneous tribes, and inhabit a country some 1,500 miles south of the most southern Dénés' hunting grounds differ in physical type, natural dispositions, manners and customs from our Indians. Their legends, myths and religious observances have no equivalents here, and yet their speech stamps them at once as an offshoot of the great Déné family.

†Am. Ant. Coll., Vol. II.

ago before the American Association for the Advancement of Science, the fundamental proposition of which is that "the only satisfactory evidence of affiliation or direct relationship of two communities, apart from authentic historical records, is their speech."*

Well might that multifariously-gifted philosopher Leibnitz deplore the carelessness of the explorers of his time, who did not think it worth their while to collect vocabularies of the languages spoken by the nations they pretended to make known to the civilized world. "C'est un grand défaut," he says, "que ceux qui font des descriptions de pays et des relations de voyages oublient d'ajouter des essais des langues des peuples, of car cela servirait pour en faire connaitre les origines.' † This reproach the German philosopher, though addressed to travellers in foreign lands, might be construed as applying with even a greater degree of force to those who, like the missionaries, are by the nature itself of their avocation bound to reside among the natives of the countries they evangelize. Not to deserve it, I, for one, shall attempt to unfold to the appreciation of the indulgent philologist the beauties of the languages spoken by a family of American aborigines who, if low in the social scale, still possess in their native dialects vehicles for thought more expressive, and, in their own way, richer than that of many civilized nations. I mean the languages of the Déné Indians, of whom I have given a sociological outline in a late fasciculus of the "Proceedings" of the Canadian Institute.‡

For the benefit of those who may not have read it, let me state that by Dénés I mean that large family of Indians more commonly known under the inappropriate§ names of Tinné, Tinneh, or Athabaskan. It extends west of the Rockies from the 51° latitude north and east of that range of mountains from the Southern Branch of the Saskatchewan to the territory of the Esquimaux. Apart from the Nabajoes of New Mexico, who are ethnologically connected therewith, it is divided into a dozen or more tribes speaking as many dialects.

For the sake of briefness, all the aboriginal terms unavoidably used in the course of this monograph shall b unless otherwise noted, in the dialect of the Carriers, the most important of the Western tribes. I shall also, to facilitate the intelligence of some of my remarks, occasionally point out the relations of these idioms to the principal other linguistic groups, especially the classical tongues.

*Am. Antiquarian, IV., Nos. 1 and 2.

†Leibnitz, *Monumenta varia inedita, ex Museo J Feller*, tom. IX., p. 595, Jena 1717.

‡Proceedings of the Canadian Institute, Octob. 1889, p. 109 and seq.

§See "The Western Dénés"; Proc. Can. Inst. Oct. 1889, p. 109, note 2.

CHAPTER I.

PHONETICS AND GRAPHIC SIGNS.

And first a word concerning the Déné Alphabet. To be complete, it should count—apart from reduplicated but phonetically unchanged letters—no less than 60 graphic signs, 13 of which to represent vowels, 39 for simple and 8 for double consonants.

The vowels are a, â, æ, e, é, è, i, î, o, ô, u, û, ü. They are all pronounced as in French except *æ* which corresponds to the French *e* in *je*, *te*, *le*; *é* which is sounded as the *e* in the French word "*mets*"; *è* as that of the English "ten"; *e* and *u* which have the Italian and *ü* the German sound. The use of the latter is confined to a few insignificant bands of Aborigines who have made the Rocky Mountains their home.

The 29 simple consonants are *b*, *d*, *f*, *g*, *j*, *k*, *χ*, *ḳ*, *l*, *ł*, *m*, *n*, *ñ*, ɴ, *p*, *q*, *q̣*, *r*, *ɹ*, ʀ, *s*, *ṣ*, *t*, *ṭ*, *v*, *w*, *y*, *z*. They are all sounded as in English with the exception of the following: *h* is strongly aspirated; *j* is pronounced as in French; *ñ* as in Spanish*; ɴ is nasal; *ł* is a lingualo-sibilant which is obtained by the emission of a hissing sound on both sides of the tongue curved upwards previous to its striking the lingual letter; *r* is the result of uvular vibrations; *χ* and *ɹ* are respectively *k* and *r* pronounced with a very guttural inflection; ʀ is the common *r* of the Romance languages, and is proper to a handful of Rocky Mountain Dénés; *q* corresponds to the hard *c* in the words "*cœur*, *curé*" such as pronounced by North-western Frenchmen: it can be described as approaching the sound of *ty* both letters being consonants and sounded simultaneously. The dot in *ḳ*, *ṭ*, *q̣*, adds to the regular pronunciation of those letters the exploding sound peculiar to most Indian languages. *ṣ* is phonetically intermediate between *s* and *sh*. The *f* and its co-relative *v* are found only in the speech of a few Eastern tribes.

By double consonants I do not mean the mere succession or grouping of two or more of the above letters retaining their original value as *tl*, *kw*, *kfw*. I have in mind those consonants which, either are differently pronounced when agglomerated, as *ch*, or represent sounds which, though phonetically one, cannot be expressed by any of our consonants taken separately. There are eight such double consonants: *sh*, *ch*, *th*, *kh*, *kr*, *ḳr*, *ṭs* and *ṭl*. The first two are pronounced as in English; *th* and *kh* are equivalent to *t+h* and *k+h* but are produced by a single emission of voice·

* It is proper to a few Northern Dénés.

Such is the case with *kr* and *kr*, save that the sound of the *r* in this phonetic compound is perceptible only for the natives and those who may have made a specialty of the study of their language. *Ts* and *tl* have the exploding sound and their value can hardly be taught otherwise than *viva voce.*

To the foregoing should be added the hiatus (') which has the effect of abruptly interrupting the pronunciation and slightly elevating the tone of the syllable it follows.

There is no accent in Déné.

Besides, the Déné dialects possess two genuine diphthongs: *au* and *ai* pronounced respectively as the German *au* and the English long *i* in such words as "fire, mire," etc. A peculiarity of the language is that it avoids the succession of two vocalic sounds with as much care as the Polynesian idioms do the accumulation of consonants. Thus "Leo" is pronounced "Leyo" and "Noah, Nowah" by our Indians.

Among the consonants *b* and *p*, *d* and *t*, *k* and *g* are respectively undifferentiated through the whole Déné linguistic group. They can be interchanged without in the least affecting the sense of the word, whilst *t* and *q*, *p* and *v*, *ts* and *kw* or *kfw*, *ts* and *kw* are co-affin and transmutable from dialect to dialect and particularize the tribe to which the orator belongs. The same remark applies, but in a broader sense, to the vowels, all of which admit of the possibility of being transmuted with another, no matter how great its phonetical dissimilarity. This last peculiarity will no doubt strike the comparative philologist as an important point of resemblance between the Déné and the Semitic languages. Non-transmutable consonants characterize the idiom and lexically differentiate it from other mother tongues or linguistic families, while the vowels specify the dialect and change from tribe to tribe. A few examples will illustrate my meaning:—

MAN is *kiat* in Kitikson or Abna (Skeena River idiom) and *twne* in Carrier, the language of the Kitiksons' eastern neighbours. BEAVER is rendered by *tswmillih*; CANOE by *mwl*; RAIN by *wish* in Kitikson, while the Carriers use the words *tsa, tsi,* and *chan* respectively to express the same ideas. These terms being roots in both languages, the dissimilitude of their main constituent part, the consonants, suffices to immediately arouse in the mind of the philologist a suspicion of diversity of language, which a prolonged investigation does not fail to confirm.

Let us now examine the same root words in the various Déné dialects.

MAN is *twne* in Carrier, *twni* in Chifχohtin. *tènè* in Sékanais; *tana* in Nabajo, and *déné*, *danè*, *denu*, *dine*, *dune* in other eastern dialects.

BEAVER is called *tsa, tse, tsi* and *tso,* according to the dialect.

CANOE is rendered by *tsi*, *tse* and *tsu*, relatively to the different tribes.

RAIN is translated *chan*, *chon* and *chièn* in Carrier, Hare and Loucheux respectively.

Here the similarity of the consonants through the various dialects at once strikes us as suggestive of philological affinity. Furthermore, a searching analysis of the elements which concur in the formation of the root will reveal the fact that the real radical for "man" in Déné, considered as a distinct linguistic stock, is *t-n-* or its equivalent *d-n-*, while that for "beaver" is *ts-*, that for "canoe," *ts-*, and that for "rain" *ch-n*, the hyphen replacing the vowels, which as we see, have but secondary importance.

As another instance of the preponderating role played by the consonant, let us take for examination the Loucheux word *Tan*. A linguist unmindful of the foregoing might, rather than compare it with the Carrier word *TwNnge*, assign to it the same signification as the quasi-homonymous Chifχohtin *Than*. Now it happens that *Tan* means "four," while *Than* means "three," the *T* simple running through all the dialects as the chief formative element of the Déné terms for "four," *(twNnge, tingi, tinyi, tankre, tan, tî)*, whilst the *Th* performs the same function, with the help of variable vowels and non-initial consonants, with regard to the different words used to express our English "three," (*tha*, *than*, *thake*, *thage*, *thaye*, *thièg*.

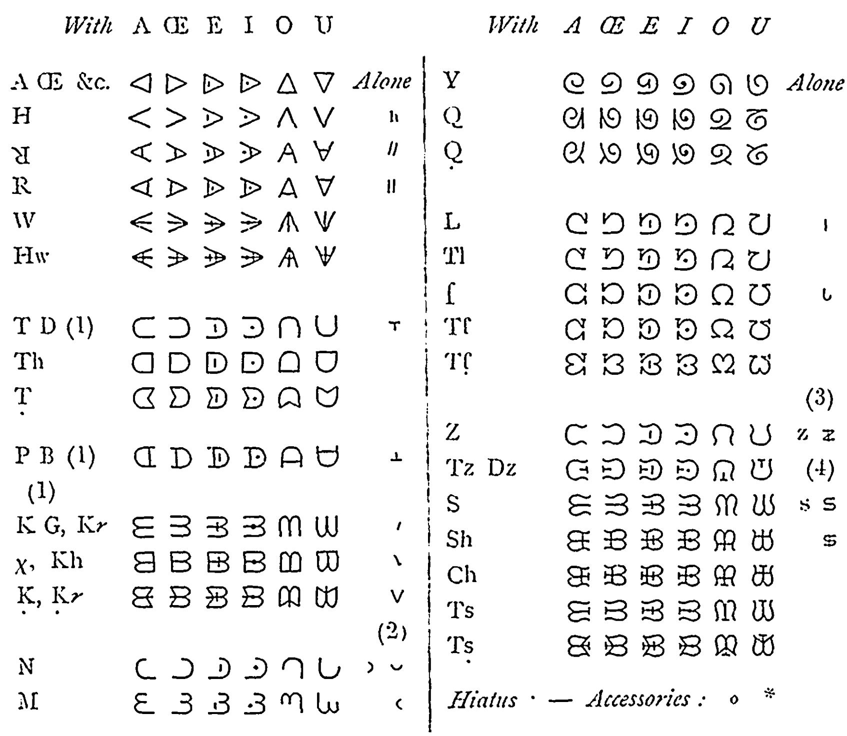
From which remarks I think I am warranted in deducing the, to me, self-evident conclusion that, in so far as the root words are concerned, the phonetical graphic signs of the Déné languages might be reduced, as in the ancient Semitic tongues, to the mere consonants.

No kind of writing ever obtained among the Dénés previous to the discovery of their country. The missionaries tried to adapt to the language of the Eastern tribes the syllabic characters invented by the late Mr. Evans. But as one of them, a pioneer in the Déné linguistic field well deserving of American scholars, the Rev. E Petitot, judiciously remarks: "cet alphabet qui est parfaitement suffisant pour exprimer les 20 lettres de la langue algonquine, est loin de répondre aux exigences de l'idiome déné-dindjié qui compte comme nous l'avons vu 71 sons phonètiques."*

**Précis de Grammaire comparée pp. XLIX. and L., Paris, Leroux éditeur, 1876.* Rev. Petitot counts as different sounds those produced by doubled or consecutive letters as *ss* and *tl* which circumstance accounts for the difference in our computation of the Déné phonetics.

Moreover, the signs of that alphabet are disposed without logic or method, which is a very serious defect when it is a question of syllabics. No effort had been made to remedy this palpable deficiency until five years ago when the writer of this paper devised the following alphabet which, thanks to the methodical disposition of its signs and the consequent facility in ascertaining their value, has since yielded the most encouraging results.

THE NEW METHODICAL EASY AND COMPLETE DÉNÉ SYLLABARY.



Explanatory Notes. — (1) These letters are not differentiated in Déné. (2) ᵕ is the nasal *n*. (3) z is the French *j*. (4) s is phonetically intermediate between s and *s*. * is prefixed to proper names, and o is suffixed to syllables the vowel of which it is necessary to render long.

CHAPTER II.

GENERAL CHARACTERISTICS OF THE DÈNÈ LANGUAGES.

It would be difficult to assign in one word the place which the Déné languages occupy among the chief classifications into which modern philologists have divided the human speech on the basis of its grammatical structure. Certain writers, and even eminent scholars, too fond of generalizations, have given as characteristics of the American languages traits which really pertain only to some of them. W. von Humboldt pointed to the agglutinative tendency of their verbs as to their chief characteristic* and Wiseman quotes in support of this view Malte Brun's remark to the effect that "this wonderful uniformity in the particular manner of forming the conjugation of verbs from one extremity of America to the other favours in a singular manner the supposition of a primitive people which formed the common stock of the American indigenous natives."† Now, it so happens that the Déné verbs are not formed by agglutination,‡ and are just as inflected as the Latin or Greek verbs.

More recently Dr. J. Hammond Trumbull, in a paper, otherwise full of valuable hints concerning the peculiarities of the American languages considered as an independent linguistic group, makes the following remarks, the first of which he emphasizes by the use of italics: "*The Indian noun is not separable as a part of speech from the verb.* Every name is not merely descriptive but *predicative*. . . In short, every Indian name is in fact a verb."§ Yet, with all the respect due to such an authority on American philology as Dr. Trumbull, I must state that there are in Déné many nouns which have no relation whatever to the verb; nay, the great majority of them is altogether independent therefrom, and they are just as purely nominative as the English "house," "lake," "bear," etc.

In a former paper I have referred to the remarkable propensity of the Déné nation for the self-appropriation of foreign practices and customs. Its language likewise presents to the investigator features so varied as to suggest a mixed origin for the whole stock, but more especially for the Western tribes. It is at the same time compounding, agglutinative, inflective, and polysynthetic.‖ Not, of course that it possesses each and

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* *Apud* Wiseman, xii Lectures on the Connection betw. Science and Revel. Lect. II. p. 82.

† *Ibid.*

‡ At least as this word is now understood and applied by philologists.

§ Transact. Am. Philol. Assoc. 1869-70.

‖ I apply to these epithets the sense given them in the 2d Edit. of Powell's Introduc. to the Study of Ind. Lang. p. 56.

every one of these attributes in each and every one of its component parts. But I do affirm that we find them all in the language considered as a whole. In other words the Déné has patent affinities with the Aryan, Turanian and Semitic tongues. This I hope to prove to the satisfaction of the reader in the following chapters.

Another assertion still more common in philological writings and, in the light of the Déné vocabulary, quite as groundless as the preceding ones, is that abstract terms and words expressive of generality and collectivity are wanting in the American languages which are represented by some superficial observers as awkward in their syntax and very limited in their vocabulary. I admit that we must not look to the Déné idioms as to models of phraseological conciseness. That most important property of a language, the power of expressing without periphrases the subtlest efforts of the human mind, is somewhat wanting in the speech of our Aborigines, whilst terms expressive of those abstract ideas the accurate rendering of which constitutes linguistic perfection are not, I must confess, over numerous. Yet the philologist who wishes to propose for the guidance of students a rule of general import should, it seems, previously examine whether it is not too sweeping in its comprehensiveness. That words expressive of abstractness are not altogether wanting in Déné will be proved by the following nouns taken from the Carrier Vocabulary :—

Tli, cold (as affecting human body)
Hoḳwœz, cold (referring to the temperature)
Sœl, warmth
T'azœl, heat (of the sun)
Hwozœl, heat (of the temperature)
Tlo, smile
Īso, weeping
Ṅi, cares
Shœn, witchcraft
Pœf, sleep
Shih, French "*essoufflement*"
Q̣an, old age
Tai, famine
Nœtî, effort (physical)
Nîni, pleasure
Ṭsus, kiss (childish)
ɣœf, diurnal revolution of time
Nûntsé, bleeding of the nose
Hoḳôs, haze
Na-ḳôs, snow-haze (lit. eye-haze)
χwœs, cough
Unih, jealousy
Nœtqœt, fear
Tsafkœs, obscurity
Yœχaih, daybreak
Unṭé, love
Nœtai, dance
Nôyé, play
Yathœk, talking
Yuyuz, whistling
Huzœf, time
Neni, human mind
Nezœl, human soul (animating the body)
Netsîn, second self

Nœta, Indian game (Chinook: *lahal*)
Atlih, Indian game (played with small sticks)
Chahwozun, hunger
Khu, vomiting
Œltoh, cramp
Tata, disease
Œltsœſ, bodily pain
ſtzi, shivering
Œtenkoh, work (to be done)
Lla, manual labor
Thih, frost
Mœssai, Latin, "*nihilum*," French "*néant*"
Nezuſ, human shade*
Hwolna, difficulty
Hwol'é, easiness
Œtata, olden time
Horwœnœta, ceremonial banquetting
Thœſ, kick
Yaſ, locomotion on two feet (human)
Kwœſ, locomotion on four feet (and of birds)
Kral, locomotion by running
Pih, " " swimming
Khe, " in canoe
Kwœz, " in sleigh, etc.

Besides, the third person singular of several verbs is also used to render our abstract nouns.

On the other hand, collecti , may be said to be expressed by such words as *tœtai*, ducks (of any species); *tœtai-yaz*, birds; *yœnnai*, animals, etc. To these might be added, *œra*, French, "*poils*," and derivatives; *ne-na*, eyes; *ne-tso*, ears; *ne-lla*, hands; *ne-khé*, feet; *ne-kran*, arms, which, though singular in form, are plural or collective in meaning.

Lastly, *neſœtsîn*, *neſthœs* mean respectively "brother" and "sister" in the indefinite or general sense; *nethœs* stands for ancestor without reference to his or her sex or degree of anteriority; *neîlken* qualifies any kinsman or kinswoman; *neke-khé* has almost the same signification, etc.

However, I must admit that the Déné languages are rather poor in such vocables. This lexical scarcity is a source of embarrassing perplexity to the student who has not yet acquired the mode of thinking proper to the Indian mind. To express, for instance, abstract ideas, one must frequently have recourse to periphrases which, as a rule, are far from rendering the exact meaning of the Aryan speaker. Not only are those languages deficient in the abstract *form* of many words, but even those sharp distinctions between the multiform operations of the human mind, those subtle and varied feelings which agitate our heart, seem to be perfect mysteries to the Déné idioms. A single sentence or periphrastic locution is all that the Carrier has at his disposal to give utterance to such varied movements as sorrow, melancholy, repen-

*See *The Western Dénés*, Proc. Can. Inst., Oct. 1889, pp. 158, 159.

tance, morosity, displeasure, etc. When moved by any of these or cognate sentiments, he will never say but : *stsî ndæta*, " my heart is sick." In like manner, such widely different moral qualities as goodness, beauty, handsomeness, holiness, liberality, magnanimity, benignity, sweetness, etc., not only cannot be expressed under their abstract form, but even when presented in a concrete shape, as a personal attribute, they have no other synonyms in Déné than *nzu*, " he is good."

Genuine synonyms in those languages are exceedingly rare. In fact I hardly know of any two words employed in one village to express exactly the same object or action. Homonyms there are, but even these are wonderfully scarce. Quite a number of words would indeed present to the unobservant linguist appearances of phonetical identity ; but no native ear will ever mistake, for instance, *sa*, " sun " for *sa'*, " a long time ;" *ntsi*, " your head," for *ntsi'*, " he is bad," etc.

On the other hand, owing to that synthetical disposition of most of the Déné verbs, which is but imperfectly developed in our idioms, perfect equivalents between that language and ours are—barring those terms which are roots in Déné—rarer than a hasty observer would at first imagine. As a proof of this assertion, let me open at random my Dictionary of Carrier Verbs. One of the first words that falls under my eyes is the French verb " Briller," to shine. As an equivalent, therefore, I have written down *pæ-sa-udænat*. Now, while that term is certainly the nearest synonymous word that could be found to render the idea represented by the French vocable, it must be confessed that it is more restricted in its meaning. *Pæ-sa-udænat* (literally : " the sun strikes it ") denotes a kind of brilliancy caused by the reflection of the solar rays upon a polished surface, and could but improperly be used in connection with an object shining at night through the agency of fire or some other cause.

A little lower down, in the same column of my dictionary, I find the word " Brisé (être)," to be broken. In spite of its 150,000 or so verbal terms, the Carrier vocabulary does not contain a single genuine equivalent therefor. But, to compensate for the lack of that term, what a prodigious exuberance of differentiating forms ! Here I must respectfully demand of the detractors of Indian languages a moment of attention. In lieu of the single Aryan term, the American dialect under review possesses no less than 110 particularizing substitutes, not one of which could be indifferently used for the other. They are expressive of—1st, the object employed to operate the breakage, viz., the fists or the feet, a stick or a whip, or of the cause of such action as the wind, the explosion of firearms, etc.; 2nd, the manner in which the object has been affected, that is whether it has been broken in one place or in many, by the middle or otherwise, purposely or by accident, violently or by gentle pressure; 3rd, the form of the object, qualified, that is whether it is elongated or spheroid, occupying a vast place or not, etc.

Moreover these 110 distinct verbs can be multiplied by four or five according as we give them the iterative, initiative, terminative, etc. forms whereby their signification is also changed. For, as we shall see further on, these forms are not mere modes in the usual sense of the word. Now, where is the Aryan or even the Semitic language which can boast of such lexical richness?

Nor should we overlook the fact that this wonderful discriminative faculty is displayed in connection with each and every instrumentative verb, and that almost any other class of conjugatable terms is even superior in the variety of its forms and the precision and nicety of its distinctions. Let us choose, for instance, the verbs of locomotion. The single paradigm of the verb "to go" includes in my dictionary verbs that are totally different according as to whether the locomotion thereby expressed takes place on two or on four feet, by running or hopping, tottering as a drunk man or with the help of a staff, creeping like a snake or jumping as a frog, swimming or floating, packing or skating, playing or in a state of madness, whistling or speaking, singing or grumbling, laughing or weeping, in sleigh or in canoe, paddling or sailing, diving down or in parallel line with the surface of the water, etc.—also according as to whether the movement is that of an empty canoe or that of the sun, the stars, the clouds, the wind, the snow, the rain, the water, the earth,(*i.e.* relatively to a per... drifting down stream), the fire, smoke, fog, ghosts, human mind, feather down, disease, news, etc.—or again, whether it is that of an object elongated or spheroid, heavy or light, liquid or liquefiable granulated, massive, soft, etc., etc.

Furthermore, let us suppose that such varied locomotion takes place in the water and *all* of these individually different verbs will be materially altered; in the fire, and a similar—not identical—variation will result. Nor is this all. By giving them the negative, usitative, causative, causativo-potential, defective, reciprocal, initiative, terminative and iterative forms, each and every one of them will thus be multiplied by the number of forms assumed. And all the other verbs of locomotion can be affected by similar mutations!

Now perhaps I shall meet with incredulous readers when I affirm that this fecundity of the locomotive verbal stems is still surpassed by the prodigious particularizing power evidenced by the objective verbs. Yet this is a mere fact. I will not attempt even a reduced enumeration of their forms. What I have already said will, I trust, give a fair enough idea of the differentiating superiority of the Déné over the Aryan languages. I shall content myself with stating that the single paradigm of the verb "to put" contains in my dictionary (which could be more complete) over 3,000 verbs all of which differ in meaning as well as in material structure. And this number is repeated in connection with almost all the other objective verbs, which are quite numerous! And to say that a child four or five years old possesses these innumerable vocables well nigh as perfectly as does his father and knows his extricate language infinitely better than any French academician does his own plain and easy mother tongue! Who will now vaunt the so much extolled mental superiority of the white race and despise the intellectual capacity of those poor "savages"?

But we must descend from the heights of admiration to the more prosaic task of rapidly analyzing the different parts which constitute this wonderful speech.

CHAPTER III.

THE NOUNS; THEIR VARIETIES AND INFLECTIONS.

There are in Déné but eight different parts of speech: the noun, the adjective, the pronoun, the adverb, the verb, the postposition, the conjunction and the interjection. Besides the verbs, the immense majority of the adjectives as well as many nouns and a few adverbs are susceptible of conjugation.

Considered in their material structure and etymology, the Déné nouns may be divided into four classes. There are the primary roots which are all monosyllabic as in Chinese. Such are *ya*, sky; *thù*, water; *tsé*, stone; *sas*, black bear, etc. They are essentially nominative: they neither define nor describe the object they designate; they merely differentiate it from another. I consider them as the remnants of the primitive Déné language, inasmuch as they are to be found with little or no alteration in all the dialects of the family, whatever may be the distance intervening between the Aborigines who speak them.

The second category comprises roots of simple import which are genuine unsynthetical substantives though polysyllabic, generally dissyllabic, in form. To this category belong words as *twne*, man; *tsèkhè*, woman; *pengræn*, lake, etc. They possess, to a limited extent, the properties of the monosyllabic roots, being likewise merely determinative and oftentimes varying but little with the change of dialect.

The third class contains composite nouns formed, as a rule, by compounding, though sometimes by agglutinating, monosyllabic or dissyllabic roots. Such are *ne-na-pa-ra* (literally: man-eyes-edge-hair), eye lashes; *tœpe-té*, wild sheep horns; *mai-re*, vegetable oil, instead of *mai-ḳe*, literally fruit-oil. These nouns being mere compounds of roots belonging to the two former categories have the same degree of relative immutableness with regard to the various dialects as the radicals which enter into their composition.

The fourth and last class is made up of verbal nouns which, as their name indicates, are nothing else than verbs in the impersonal or personal moods employed to qualify objects of secondary import with the help, sometimes of a radical noun, sometimes of a pronoun, and always of a prepositive particle prefixed to, or incorporated in, the verbal substantive. Of this description are the words *pe-yœn-œlqœl* (lit. with-earth-one-cleaves), plough; *u-kwœt-tsœzta* (lit. it-on-one-sits), seat; *œten-pa-yœ.ı* (lit he-works-for-house), work-shop. These and similarly formed words are the only terms which fall under the too comprehensive remark of Dr. Trumbull quoted in the previous chapter.

Of these four classes the first may be said to comprise about two-fifths of the whole aggregate of nouns, the remainder being distributed in almost equal proportions among the three other categories.

In the foregoing we must not fail to notice two grammatical combining processes common to some Aryan idioms, compounding and agglutination. A third process of a different nature, change of meaning by intonation or vocal inflection obtains also among some—not all—of the Déné tribes. Some of these intonations are even proper to fractions of tribes only. Thus *ya* which means "sky" in almost all the dialects becomes "louse" to a Southern Carrier when pronounced in a higher tone. Northern Carriers have another vocal inflection which is combined with the final hiatus and is also peculiar to them. Among them *œlla* means "hands" (of an animal): with the final hiatus it becomes *œlla'*, "bark" (of the spruce). *Stsé* corresponds to the English "my stone," by adding to which the hiatus inflection we obtain *Stsé'*, "my daughter" (as named by the father).

Judging by the restrictive notes contained within the parenthesis we perceive that the Déné nouns are no exception to the rule common to most Indian languages which ascribes to the substantives the property of connotiveness in addition to that of denotiveness. But I must hasten to remark that, apart from the polysynthetic compounds which are connotive by reason of their synthetism, this rule applies only to a limited number of nouns. Among the essentially connotive nouns we find the names of the parts composing the animal body. Thus, although the real root for the word "heart" in its indefinite sense is *tsi*, this monosyllable is never employed alone. Though you may not specify it in English, the word used in Déné particularizes the nature of the heart referred to, viz., whether it is human, or simply animal. In the first case, the root (*tsi*) must be preceded by the particle *ne*, the radical element in *tœne*, man. Were we to replace this by the prefix *œ* which contains an idea of vagueness or indefiniteness, we would thereby refer to the heart of a dead animal such as that which might lie before a surgical student for the purpose of dissection.

This last prefix (*œ*, *é*, *i*, *a*, *u*, *ko*, *kwo*, etc., according to the dialects,) constitutes the only semblance of an article of which there is any trace in the Déné languages. It precedes certain monosyllabic roots or compounds of monosyllables such as, in Carrier, *œtaṇ*, leaf; *œtọ*, nest; *œra-pa-tsœl* (lit. hair-for-awl) needle. It has some affinity with the Hebrew prefix article הַ הָ הֶ. That would-be article, like the לְ of the original לְ הַ is assimilated by the vowel of the possessive pronoun or the desinential letter of the words with which it is agglutinated. Thus, "his nest" is said *u-tọ* instead of *u-œtọ*, and the prefix *œ* likewise disappears in such compounds as *soh-tọ*, "robin-nest," *tœrœs-taṇ*, "aspen leaf," etc.

The Déné dialects lack declensions of any description. As in the modern analytic tongues of Aryan descent, the office of the cases is, with one single exception, filled by prepositions or rather *post*positions; for in Déné, as in the Turanian idioms, it is a general rule that the governed word precedes the governing. The exception is the genitive or possessive, which is expressed as in English by first designating the progenitor or possessor and then prefixing the possessive pronoun in the third person to the word denoting the offspring or the object possessed. Thus *Wil-yam u-yœn* has exactly the same signification as the semi-Saxon "Wilelm hys lond," a disintegration of the original "Willelmes lond," which has come down to us under the modern contracted form "William's land."

The possessive pronoun affects some nouns to such an extent as to impart to them a genuine inflection, in fact an inflection which, viewed in the light of the Déné phonology is even more radical than that of the Greek or Latin cases, since the element thereby inflected is not, as in those languages, the vowel which in Déné is unimportant, but the consonant which constitutes the quintessence of the word. For instance *li* is the Carrier monosyllable for "dog," which, when affected by the possessive pronoun becomes *s-lœk*. Its Chilχohṭin equivalent *tlin* is equally changed into *sæ-llik* when in contact with the possessive pronoun of the first person singular. *ye* means "grease" the possessive of which is *u-rwe* at third person singular.* Were there no other cases of consonantal inflection in the languages under study, I think these might suffice to confirm the truth of Horatio Hale's assertion that "the opinion which prevails widely among scholars . . . that the languages of the Aryan and Semitic families are the only tongues in which genuine inflections are to be found . . . is utterly erroneous."†

In common with the Mongolian idioms, the Déné has no genuine plural. When absolutely necessary, that number is expressed, not by the adjunction of a pluralizing consonant as the *s* of many modern Aryan languages, or by a vocalic inflection as in Latin and Italian, but by the adjunction of such adjectives as *łai*, "many," or *tsiyauh*, "all." This rule applies to all the nouns (except *łi*, dog) expressive of non-human beings. Personal names form their plural by suffixing the particles *khé*, feet (which is also applied to *łi*), or more frequently *ne*, root of *tæne*, man. Only two nouns of the Carrier dialect *tsèkhè*, woman, and *tekhé*, relation, undergo a vocalic mutation when in the plural number, becoming respectively *tsèkhô* and *tekhô*.

As in Hebrew—but *minus* any suffix corresponding to the Semitic dualic increment—the names of those objects which are twofold by nature, as the eyes, the hands, etc., are intrinsically dual in meaning though singular in form. To obtain the grammatical singular, one must add to the Déné vocable the participle *kæz*, contraction of *ækæz*, "half." Therefore *ne-lla* refers to both (human) hands, and to get the singular we must say *ne-lla-kæz*, "(human)-hands-half."

Grammatical gender is likewise unknown in Déné, and this is again a link of affinity with the Turanian languages. When necessity requires a generic distinction, it is obtained as in Japanese, by the use of the words "man" and "woman" which, for the purpose become adjectives and mean "male" and "female." Here I cannot resist the temptation to point out the remarkable terminological analogy existing between the Japanese word for "male" and that used by the Chippewayans, one of the most important of the Déné tribes. This term is *yu* in both languages. The Chilχohtins replace it by *yosz* which also reminds the linguist of the Japanese *osz* which has the same signification.

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* To fully appreciate the inflectiveness of these and similar words one should bear in mind that there is in Déné as much difference between *l* and *ł* and *s* and *r* as between any two non-transmutable consonants of the English alphabet.

† *The Development of Language*, Proc. Can. Inst. Oct. 1888, p. 114.

The names of some mammals, however, change with the sex, and a few have even a neuter gender, as is the case with the name of the caribou which in Carrier is *hwotsih* for the neuter, *œtœtcn* for the masculine, and *œmma* for the feminine genders.

The peculiar differentiating tendency which we have already noticed in the verbs, extends also to the names of a few fur-bearing animals. Among these we find the beaver whose name is *tsa*. His offspring, when under two years of age is called *tsa-tsœl* in Chifχohtin. But when the animal has seen two winters, it receives the name of *khoq*, which after its third winter is exchanged with *œtqal·il*, which alludes to its being of age to be mated.

The Déné dialects possess diminutive and amplificative forms which are obtained conformably to the Japanese method with this difference that, while the Japanese *pre*fixes to the nouns the words *ko*, "child," and *o*, "big," the Déné *suf*fixes thereto the words *yaz* and *cho* which have exactly the same signification.

CHAPTER IV.

THE ADJECTIVES AND THE PRONOUNS.

As heretofore stated, the quasi totality of the Déné adjectives are genuine verbs. Indeed the only real adjectives that do not admit of the possibility of conjugation, are, in the Carrier dialect, *œyu*, another, and *tsiya*, all. *Œstœl*, naked, *yuya*, ashamed, *tannrwœz*, cylindrical, *tsachœskhœœn*, red hot, might pretend to the title, but their native form and use are more that of adverbs than of real adjectives.

This being the case, it follows that intrinsic forms of the comparative and of the superlative are no more possible in that dialect than in Hebrew. Their function is filled, as in the Semitic tongue, by some circumlocution. To obtain the comparative the Carriers use the adverb *onnœs*, more, before the adjective, and say, for instance: *onnœs nzu*, "more (he is) good" for better. The superlative, when suggestive of no comparison, is rendered as in English by adverbs corresponding to our "very, much." When it implies some comparison, its expression offers in Déné greater difficulty. In Carrier, we generally make use of some comparative adverb as the above mentioned *onnœs*, or more appropriately the particle *kœs*, both of which are coupled with the relative pronoun (*e*, *èn*, *ène* or *ne*) in this wise: *kœs nzu e*, "the best" (thing). Sometimes a periphrastic circumlocution takes the place of our superlative, and this is particularly the case among the Eastern Dénés. Thus, according to Petitot, to translate: "my mother is the best of mothers," a Chippewayan would be inclined to say: "mothers all anyhow my mother alone is good." The only intrinsically formed superlative is that of the locative and ordinative adverbs or adverbial-adjectives. Its distinctive element is the prefix *œte*, applied to the adverb in its natural state as *œte-no·*, the most northern; *œte-yo*, the lowest; *œte-tiz*, the nearest (in distance); *œte-tsâ* the first (in rank or age); *œte-chu*, the first (in the succession of time), etc. This genuine superlative is proper to the Carrier dialect.

A peculiar comparative of similitude obtains through the whole linguistic group. But as it is essentially incorporated in the verb, I simply mention the fact in this connection.

I deem it more relevant to associate with the regular adjectives the demonstrative pronouns which, together with the numerals, have in Déné the same material features and follow the same rules as the two genuine adjectives *œyu* and *tṣiya*. These rules have reference to their place in the sentence, viz: immediately before the noun, and their grammatical accord therewith, to understand which a word of explanation is necessary.

The broadest division of the substantives grammatically considered and the only one which affects in any way the unconjugatable adjectives and the demonstrative or relative pronouns connected therewith, is that which differentiates the names of human from those of non-human beings. It has for effect to demand the addition to the adjective of an *n*—from *tœne*—for the singular, and of the suffix *ne* for the plural of adjectives relating to human beings. Thus *œyu* means "another (thing)," *œyun*, "another (person)," *œyune*, "other (persons)."

The same remark applies—barring what has reference to the plural—to the numeral adjectives. These are quite rich in variety of forms. In Carrier *tha* means three (things); *thane*, three (persons); *that*, three times; *thatœn*, in three places; *thauh*, in three ways; *thaîltoh*, all of the three (things); *thahœlṭoh*, all of the three (persons); *thahulṭoh*, all of the three times, (places or things—massive or spacious). Most of the Eastern dialects lack all but the three first forms. Neither do they, as a rule, possess the ordinal numbers which are expressed in Carrier by the cardinal adjectives preceded by the postpositions (which for the purpose become prepositions) *pœl* or *hwoſ*, "with it," in this way: *pœſ thanœn*, "with him three" (persons) or the third; *hwoſ that*, "with it three times," or the third time, etc.

In common with the ancient Egyptians and most American aborigines the Dénés use their fingers to count upon, and their system is decimal. Holding his left hand with the palm turned toward his face, the Carrier will bend with the index of his right his little finger and all the others in succession. Then he repeats the same operation on the fingers of his right hand whose palm is this time turned outside, the number six being named on the thumb. That number is *ʗkœ-tha,* "on both it is three" (things), and eight is in like manner *ʗkœ-tœnnge,* "on both it is four" (things). The expression used for nine recalls to mind the ἑνὸς δέοντος of the Greeks. The Dénés likewise say: one is wanting (*i.e.* to ten). Ten is *hwonízyai,* "it is won," in Northern Carrier. For eleven all the tribes say ten *plus* one, etc.; for twenty, twice ten, etc., and before the advent of the whites the Carriers said for 100, *pe nahultho,* "with it one counts again."

Another analogy with the Greek language perhaps worth mentioning is that existing between the Déné interrogative pronoun *tî ?* "what?" and its Greek synonym τί; all other Carrier interrogatives are similarly characterized by the initial consonant T which corresponds to the initial τ noticeable in all the Greek pronouns of that class. But enough of this. My intention in commencing this paper was to ignore mere lexical analogies with alien languages.

Of personal pronouns all the Déné dialects possess two kinds. The first is subjective and independent from the verb. It is identical with the Latin *ego, tu, ille,* etc. The other is so incorporated into the body of the verb as to lose its own individuality. It is the equivalent of the pronominal crement we notice in the Latin and Greek verbs: *am-o, am-as, am-at,* etc., λύ-ω, λύ-εις, λύ-ει, etc. Of this last more shall be said when I come to treat of the verb.

Possessive pronouns assume in Carrier five different forms, according to the sugnification or the internal structure of the noun to which they are prefixed. The most noticeable peculiarity in connection therewith is the richness of the pronoun of the third person. While four words (his, her,its, their), seem sufficient to the English mind to express it, the Carrier idiom can boast of no less than 17 such terms which, however, when divested of their five accidental forms can be reduced to six: singular *u, hwo, yœ, tœ*; plural, *pœ* and *he.* The first of these pronouns corresponds to our "his, her, its,"—the pronouns admit of no gender in Déné. The second *(hwo)* is prefixed to nouns in regiminal connection with such words as "house, lake," and those which denote extensiveness or indefiniteness. *Yœ* refers to a third completive person as in this sentence *Pol yœ-pa i-keĺa-hwoĺtsi*, Paul paid for him. By changing *yœ-pa* into *u-pa*, we would give to understand that *he* paid for Paul. The plural of this pronoun is *he*. *Tœ* has relation to the person whose action is expressed in the sentence. It is the exact equivalent of the Latin *suus, sua, suum.*

It will easily be understood that with such a convenient array of pronominal terms, amphibology is a mere impossibility.

In a late fasciculus of the "Proceedings" of the Canadian Institute, I was struck by a quotation from Peschel to the effect that "in the American languages the connected syllables (of composite words) are always curtailed of some sound."* This is another of the many erroneous statements of philologists, who, because they have obtained some knowledge of a few native tongues, are too prone to apply to those they are unacquainted with the Latin axiom : *ab uno disce omnes*. Or shall we exculpate them from the charge of temerity and lay the blame at the door of those who being in position to acquaint the philological world with new languages, did not take the trouble to do so? Be it as it may, Peschel could hardly find in the Carrier dialect one really composite word to which to apply his own rule. Nay, I think his remark would be more to the point in reference to such a highly inflected language as Latin than with regard to the confessedly polysynthetical Déné idioms, at least if we are to take such a word as *cadaver* as an abbreviated compound formed from *caro data vermibus.*

Still, the case might have been different in pristine times as the name (*Na-ka-ztli*) of the village where these lines are written would seem to warrant us to infer. According to a local tradition, a powerful tribe of dwarfs (*atna*) once attacked and well nigh swept it out of existence. As it is situated close by the outlet of this (Stuart's) Lake, the enemy's arrows, which were diminutive in proportions as the hands that used them, floated down the river in immense numbers. Hence, to give a graphic idea of the importance of the conflict, the ancients used to say to their children : the river was covered with the floating arrows of the enemy, *Atna ka pœĺ tiztli*, which by contraction has become *Nakaztli.*

On the other hand, we find in connection with the pronouns remarkable instances of contractions whereby two words, a pronoun and a postposition, primitively independent have combined to form, not a regular composite word as those alluded to by Peschel, but a single monosyllable

* Proc. Can. Inst. April, 1889, p. 291.

possessing the meaning of the original two words. Here are examples in two different dialects.

Carrier Dialect.			Chiſχohtin Dialect.	
Sœſ, with me, for		s-p-œſ	Sa, for me, instead of	s-œp-a
Nyœſ, " thee,		m-p-œſ	Na, " thee, etc.,	n-œmp-a
Pœſ, yœſ,	him, etc.,	p-œp-œſ, y-œp-œſ	Pa, ya,	p-œp-a, y-œp-a
tœſ, hwoſ,		t-œp-œſ, hwo-pœ-ſ	nɹwa,	nɹo-p-a
Neſ		ne-p-œl	ɹwa,	ɹo-p-a
Nohwœſ		nuh-p-œſ	Kupa,	ku-pœ-pa
Opœſ, heyœſ,		opœ-pœ-ſ, hey-œp-œſ		

Of the adverbs I shall say nothing besides mentioning the fact that many of our adverbs have for equivalents in Déné non-adverbial particles incorporated in, or prefixed to, the verb as formative elements. The sequence will explain this peculiarity.

As for the conjunctions and the interjections they offer to the philologist nothing worthy of remark beyond this resemblance with the Mongolian or Tartaric tongues, that conjunctive terms are but seldom used, their number being reduced to a few indispensable words.

CHAPTER V.

THE SIMPLE OR PRIMARY VERBS.

The verb is indeed the word *(verbum) par excellence* in Déné. In fact, out of every twenty words of the language, I doubt whether there are two that are not susceptible of conjugation. Were it not for the verb the Déné grammar might be said to be devoid of serious difficulties. As it is, the multiplicity of the verbs, the varieties of their forms, the frequence of their irregularities, the intricacies of their negative elements and the almost unlimited possibilities of their combinations assign to the Déné idioms one of the first places among the most difficult languages known to Philology. The student should not anticipate in these pages a complete treatise on that most complex of the parts of speech. I am not writing a grammar and must confine myself to general outlines. Yet I hope he will miss in this and the following chapters very little of what is of real value to form a sound estimate of the chief characteristics of the Déné verbs. For the sake of perspicuity I shall treat here exclusively of the simple or primary verbs by opposition to the composite or synthetically constructed verbs which shall form the subject of another chapter.

A word concerning the modes, tenses, persons and numbers shall serve us as an introduction to the subject. As in the Hebrew grammar, there is, properly speaking, but one mode, the indicative, in the Déné dialects. The imperative can hardly be called a mode, since it is formed entirely of persons taken from the present tense and eventual future. This future furnishes also the equivalents of our subjunctive and optative. The infinitive does not exist. It is but imperfectly replaced by the impersonal.

As for the tenses, they are of two kinds: primary and secondary. The former are four in number, viz.: the present, preterite, proximate future and eventual future. The proximate future refers to the action as being on the point of taking place and corresponds to the English "I am going to." The eventual future is vague and aleatory in meaning and has no strictly exact equivalent in our languages. Each of these four tenses is expressed by a single word as in Latin and Italian. The secondary tenses are simply the primary tenses accompanied by auxiliary verbs or particles, as *înle*, *ta*, *sih*, etc.*

The Déné verbs have three numbers as their Greek co-relatives. But while the dialects of the Eastern Dénés possess, as a rule, three persons for each number, the verbs of the Western Dénés have generally but one —the first—person for the dual. *Par contre*, their verbs of locomotion and their verbs of station have no less than sixteen persons for each tense, viz.: three for the definite singular, three for the indefinite singular, three for the plural and seven for the dual. Besides, all those verbs whose radical varies with the number, as is the case with the verbs of cubation, have always—unless they belong to one of the two categories above mentioned—ten persons.

Before submitting to the appreciation of the philologist paradigms illustrative of the foregoing, it will not be amiss to give a brief outline of the internal structure of the verb in general.

Every Déné verb, no matter of what form or tense it is affected, is composed of at least two distinct integral parts:—1st. a monosyllabic root which is always the desinential syllable of the verb and is generally—not necessarily—invariable; and, 2nd, a pronominal crement which varies according to the person and the tense. This combination is identical

* In the dialects of the Eastern Dénés the tenses are, according to Rev. E. Petitot, the present, imperfect, preterite and future. In justice to the student of those dialects, I think it necessary for me to state that I am acquainted with missionaries ministering to the Eastern Dénés who speak in rather disparaging terms of that author's Dictionary and Grammar, and insinuate that, except as regards the Loucheux dialect, which he is recognized to have thoroughly mastered, both works are very faulty. Yet I hardly think that he could have erred in reference to such important points of Grammar as are the conjugations and tenses.

with that of the Latin and Greek verbs, with the unimportant difference that the formative elements in the Déné and Aryan verbs are disposed in inverse order.

Those persons who feel inclined to question the capacity of Indian languages for genuine inflections are respectfully referred to the following paradigms. I have disposed the Latin synonym side by side with the Carrier words, to show that the inflectiveness of the Déné verbs is not merely accidental, bnt pervades the whole conjugation.

PRIMARY TENSES OF THE VERB ŒSTEN, I WORK, I ACT.

	CARRIER.	LATIN.		CARRIER.	LATIN.
	Present.			*Proximate Future.*	
Sing	œs-ten	ag-o	Sing	œthîs-tiſ	I am going to act,
	în-ten	ag-is		œthan-tiſ	(almost
	œ-ten	ag-it		œthî-tiſ	acturus sum
Plur	œtsœ-ten	ag-imus	Plur	œzthî-tiſ	" es, etc.)
	œh-ten	ag-itis		œthîh-tiſ	
	œhœ-ten	ag-unt		œhœthî-tiſ	
Dual :	î-ten	ambo ag-imus	Dual :	œtha-tiſ	
	Preterite.			*Eventual Future.*	
Sing	îs-ten	eg-i	Sing	us-ten	ag-am *
	an-ten	eg-isti		oNn-ten	ag-es
	î-ten	eg-it		u-ten	ag-et
Plur	œtsî-ten	eg-imus	Plur	œtsu-ten	ag-emus
	îh-ten	eg-istis		uh-ten	ag-etis
	œhî-ten	eg-erunt		œhu-ten	ag-ent
Dual :	a-ten	ambo eg-imus	Dual :	ô-ten	ambo ag-emus

* In a vague and indefinite sense.

Imperative.

Sing.	în-ten u-ṭen	Plur.	œh-ten œhu-ṭen
Plural :	œtṣu-ṭen	Dual :	ô-ṭen

As illustrative of the formation of the secondary tenses, I shall give the following, with their Latin equivalents :

œsten înle	*Latin* : agebam
îsṭen înle	egeram
usten inle	egissem
uṣṭen sih	agam (definite), etc.

Of the primary tenses it may be said that the two futures are the most immutable in their pronominal elements, whilst the desinential root of the proximate future is of a rather changeable character. As for the preterite, instead of being invariably affected by a vocalic mutation of its personal crement, as is the case with the above example, it undergoes quite frequently consonantal variations, either in its radical or in its pronominal part, the *îs*, *ann*, etc., of which are often changed into *sœs*, *sîn*, etc.

Now for the sixteen persons of the verbs of locomotion and of the verbs of station :

Present Tense.

Definite Sing.	nœshya, I walk nînya, thou walkest niya, he walks	sœsta, I am sitting sînta, thou art, etc. sta
Indef. Sing.	nœtsiya, one walks nihya } See below nœheya }	tsœzta sœhta } See below hœzta }
Plural	nœtsœtiſ, we walk nœhtiſ, you walk nœhœtiſ, they walk	œztîſtsi tœſtsi hœtîſtsi
Dual	nœs·as, I walk (with one person) nîn·as, thou walkest (do) nœ·as, he walks (do) nœtsœ·as } See below nîtas } nœh·as, you walk (two together) nœhœ·as, they walk "	sœskré sinkré œskré tsœzkré } See below îkré } sœhkré hazkré

Some of these personal forms have no equivalents in any language that I know of, and consequently require a word of explanation. *Nœtsœ·as* and *nîtas* are distinguished practically by a slight difference of meaning only. *Nîtas* is the regular dual of concomitancy which implies that the locomotion is executed by both of *us*, while *nœtsœ as* substitutes to the idea of the first person that of the impersonal: one is walking *à deux*. *Nihya* and *nœheya*, with their co-relatives of the other tenses, also convey the idea of indefiniteness, but coupled with that of the second and the third person of the plural. For instance, a native orator, while giving orders to a group of fellow countrymen and unwilling to designate any one of them in particular, will say (in the eventual future): *nôhya*," you shall walk," meaning: *one* of *you* shall walk. Again, referring to an undesignated person in a crowd which he is not directly addressing, he might say in an indefinite manner: *nœhôya*, " they shall walk," that is, *some* unknown or purposely unnamed person among *them* shall walk.

The same remarks apply to the verb *sœsta* and derivatives. Should I say to a group of Indians: *tœſtsi*, " sit down," all my audience will at once understand me. But if, instead, I were to say: *sœhta*—the pronominal element of which has the *h* characteristic of the second person plural, though the radical retains its singular form—the natives would immediately understand that I mean only *one* of *them* to sit down, and they would be at a loss to know who is to comply with my request.

Abstracting the many irregularities of the Déné verbs, all their inflections may be reduced to three conjugations, which are characterized by the consonant of the pronominal crement of the second person singular.* *n* denotes the first, *ſ* the second, and *l* the third. The verbs above conjugated—with the exception of the last *(sœsta)*, which, in common with some irregular verbs, takes for the singular and dual the characteristics of the first, and for the plural that of the second conjugation—all belong to the first. Here is the present of verbs of the second and of the third.

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*Petitot in his *Grammaire comparée* of the Eastern dialects counts four conjugations, three of which he bases on the pronominal *vocalic* inflection, the second being in *es*, the third in *as* and the fourth in *us*, while the first he states to consist in the mere juxtaposition of a personal pronoun to an adjective, a preposition or an adverb. On this side of the Rockies, we have no other equivalents of this uninflected conjugation—if conjugation it can be called—than five or six irregular verbs as *s-ra-hwolna·* (lit. me-on-account-of-difficulty), " I am difficult." I think it preferable to treat them as so many unimportant anomalies to making them constitute a separate conjugation.

Second Conj.	*Third Conj.*
œs-thœs, I am strong, etc.	œz-chan*, I am pregnant, etc.
îſ-thœs	îl-chan
ſ-thœs	l-chan
tsîſ-thœs	tsœl-chan
œſ-thœs	œſ-chan
heſ-thœs	hœl-chan
Dual: îl-thœs, we are both strong	îl-chan, we are both pregnant.

These and similarly constructed verbs are what I may call primary verbs. Their characteristic is the pronominal consonant of their third person singular (*n*, *ſ*, *l*,), which stands alone, unsupported by any vowel, and which differentiates them from the simple, but non-primary, verbs. These, although they are uncomposite in material structure, yet possess two distinct radicals: one preceding, the other following, the personal element which invariably occupies the penult place in all kinds of verbs. The following shall serve as an illustration thereof:

I. Conjugation.	*II. Conjugation.*	*III. Conjugation.*
nd-œs-ta, I am sick	t-œs-kœs, I am black	t-œz-χwœs, I cough
nd-în-ta	t-îſ-kœs	t-îl-χwœs
nd-œ-ta	t-œſ-kœs	t-œl-χwœs
tsœ-nd-œ-ta	œz-t-œſ-kœs	œz-t-œl-χwœs
nd-œh-ta	t-œſ-kœs	t-œſ-χwœs
hœ-nd-œ-ta	hœ-t-œſ-kœs	hœ-t-œl-χwœs
Dual: nd-î-ta, we are both sick	t-îl-kœs, we are both black	t-îl-χwœs, we both cough

A noteworthy feature of the Déné dialects is that, alone among many American idioms, they possess the substantive verb "to be" in its independent form; and, what is even more remarkable, that verb is, in Carrier and Chifχotin, just as regular in its conjugation as any other verb of its class. However, it is used only in connection with a noun or the few adjectives or adverbo-adjectives mentioned in a previous chapter. Moreover, elegance demands that its use be corroborated by a kind of secondary substantive verb as in this phrase: I am a man, *tœne œstli hwe œstoh*, literally "a man I-am whereby it-is-I." Nevertheless this verb of redundance *(œstoh)* may be omitted without any change of meaning re-

*Chan means "womb," and the literal translation of that verb should read: "I *womb*, thou *wombest*," etc.

sulting therefrom, as its main object is simply to give emphasis and elegance to the sentence.

Naturally, the use of the substantive verb is incompatible with that of the Déné adjectives, which are of themselves genuine verbs, combining in their elements our personal pronoun, auxiliary verb, and adjective. I divide them into two classes : primary and secondary adjectives, the first of which, materially considered, correspond to the primary single-radicaled verbs, and as such fall under the scope of this chapter.

They usually express qualities of simple import, as "good, bad, great, small, wide," etc., and while in their primitive form they are merely denotive. All of them, in addition to the various forms which they are liable to assume as verbs, are also affectible by internal mutations connoting the nature of the object they qualify without, however, becoming objective verbs. Thus *n-cha* (third person singular of *œscha*) means "big," without pointing to any peculiarity in the subject ; *n̂in-cha* is applicable to a sphere or a spheroid exclusively ; *d̂in-cha*, to an elongated object and to vocal sounds ; *hun-cha*, to vastness or indefiniteness of proportions.* *Dœ-n̂in-cha*, without being a composite verb in the estimation of the Déné grammar, yet combines two forms, *dîn* and *nîn*, and refers to such an article as a ring which is intended for an elongated object, viz., the finger (hence *dœ*, euphonical inflection of *dîn*), whilst it is of itself circular in form (hence *nîn)*. A similar analysis applies to *hwo-d̂in-cha.* In accordance with the law of euphonic sequence of the vowels, *hun*, qualificative of indefinite spaces, is changed into *hwo* ; *dîn* has reference to vocal sounds, and the whole compound denotes the peculiar resonance noticeable in the voice of certain persons whose speech seems to emanate from cavernous depths.†

CHAPTER VI.

THE COMPOSITE VERBS.

Polysynthetism has generally been regarded, and not without reason, as the chief characteristic of the American aboriginal verbs. It pervades the languages of the remotest tribes to such an extent as to permit of their being classed under one single denomination, despite their many terminological and grammatical dissimilarities. Yet that particular feature cannot be said to be their exclusive property. Many a verb of purely Indo-

* *Hun* and its co-relative *hwo* characterize also the Impersonal.

† Identical transmutations take place in many a non-adjective verb.

European parentage, for instance, can trace to a synthetical process its original formation. For what are such terms as *de-ponere*, *re-ponere*, *pre-ponere*, *ex-com-municare*, not to speak of their synonyms and derivatives in the modern analytic tongues, if not synthetical compounds? Scholars are also well aware of the role played in the formation of Greek words by such prepositions as κατά, μετά, ὑπερ, διὰ, etc. Nor should we forget the original synthetic verbs *át-standan*, *be-standan*, *for-standan*, *under-standan*, etc., of the early Anglo-Saxon, the main root of our own English. But as no other linguistic group displays this propensity for word agglomeration in such a degree and with such varied results, its claims to be regarded as the special characteristic of the American languages remain unimpaired.

The Déné dialects which, as we have seen, are distinctly inflective in the pronominal elements of their verbs, are also thoroughly polysynthetic in the formation of composite verbal terms. Indeed, it is to that peculiarity, coupled with the multiplicity of their sense-modifying forms, that we must look for the cause of the prodigious number of their verbs. It were tedious, as well as unprofitable for the purpose in view, to enter into the details of the several processes whereby two or more dependent or independent terms are united to compose a new word. A few representative examples will, I trust, suffice to give us an idea of the whole system. I have in a previous chapter hinted at the existence in the Carrier dialect of a comparative internally connected with the primary verbal adjectives and a few other verbs of simple import. This shall serve as our first illustration of synthetism as applied to the formation of the Déné composite verbs.

The primary verbal adjective *œssul* means "I am small," and its third person singular is *n-tsul*. With the help of the proper prefixes we obtain: *ndœl-tsul*, he is as small; *dœl-tsul*, he is as small as (with a complement); *nga-dœl-tsul*, he is as small as that; *pœ-ndi-yœl-tsul*, he is as small as he; *ʗœ-ndœl-tsul*, they are both as small, one as the other; *su-ʗl-tsul*, he is small enough; *ta-l-tsul?* how small is he? *ʗel-tsul!* how small he is! We must not fail to observe that the comparative prefixes have for effect to change the pronominal part of these verbs from that of the first to that of the third conjugation. Moreover, these and all other cognate verbs are susceptible of assuming, conjointly with the above prefixes, all the internal inflections assumable by a verb as verb, not counting those they can be affected by as primary verbal adjectives.

For simpler, and perhaps more intelligible, examples we will look to the verbs formed with the help of the particle *ta*, root of *tathi*, "door." By prefixing it to such verbs as *nœshya*, "I (human being) walk," we will get, at the third person singular, *ta-nînya*, " he (hum. b.) walks in (the house)." Should we change the verbal stem, while retaining the modificative prefix, we might say: *ta-nînyût*, he drives in (the house), which, by further verbal modifications, may become *ta-nœyœk*, he usually drives in (the h.); *ta-nœtgût*, he is susceptible of being driven in (do.); *ta-nœtgœk*, it can generally be driven in (do.), etc. If we now try of the objective verbs, we may say, while still keeping the modificative particle: *ta-s·aih* I put in (the house a single object); *ta-dîstaih*, I put in (the house a single object) for my own use; *ta-taıh*, it (one single obj.) can be put in (the house); *ta-dîtaih*, it (do.) can be put in (do.) for one's own use; *ta-stle*, I put in (the house many objects), etc., etc. Let us not, however, allow ourselves to be allured by the multiplicity of forms assumable by this and similar verbs. It would lead us to the enumeration of many hundreds of verbs before the supply is exhausted. For the same reason, we shall avoid *ta-s·is*, I throw in (the house a single obj.), which is the first of a new series of objective verbs.

Selecting less prolific forms for our word-building experiences, we come on *ta-ssâ* (lit. " I cry on the threshold "), I beg; *ta-nœs·a*, I order in; *ta-hwœjyi*, I enter while playing; *ta-nœstsas*, I enter while throwing sticks on the snow;* *ta-dœzni*, I introduce my hand in (the house); *ta·-nœskra*, I introduce my finger in, etc., etc.

Some verbs of as simple formation connote an even greater number of ideas. For instance, *ntsi·*, " he is bad, avaricious," while preceded by the aforesaid prefix *ta*, becomes *ta-ntsi·*, which we cannot well translate in English by less than nine words, viz.: " he proves avaricious to those who enter his house." So that if it is true to say that a single idea expressed in one Aryan word frequently requires a periphrase in the American languages, it can be retorted that sometimes short native verbs cannot be translated by less than a whole sentence in our idioms. Nay, the Carrier dialect might even, with some respect, be adduced as a model of phraseological conciseness. As a proof of this, it may suffice to quote the conjugatable adverb *·a*, which means " promptly." To any person requiring of a native courier, for instance, to cover, in one day, a distance of 70 or 80 miles the latter might simply answer: *u·a gœnnih* (lit. it-shall-be-promptly let-it-not), the real signification of which is: " one cannot reasonably expect that I should do it in so short a time." Same remark applies to *sa·*, a long time; *ƚat*, often; *su*, well; *niƚtza·*, far; *niƚtuk*, near, etc., which are similarly conjugatable.

To return to the composite verbs. A slight analysis of the examples

* Indian game much in favor during the winter months.

given above will result in the detection of two radicals : a primary root, which is always the final syllable of the verbal stem, and contains the key to the main signification of the compound,—and a secondary radical, which precedes the personal element, and alters the sense of the primary root. Thus the *ya* of *ta-næsh-ya* indicates that a human being is walking on two feet, and the prefixed particle *ta* furthermore denotes that such locomotion takes place from the outside to the inside of a habitation.

Now if, in lieu of experiencing with a permanent initial particle, we should retain instead an immutable desinential radical, we might successively prefix thereto various initial radicals, whereby new words with new meanings would be formed. *Tzaih*, for instance, is the desinential root of such objective verbs as have for complement anything of a granulous nature. We shall prefix thereto the particle *thé*, whereby—with the incorporation of the pronominal *s*—we obtain *thé-stzaih*, (I take out (of the house gran. obj.), which may be further modified into *ha-stzaih*, I extract (gran. obj.) from ; *kæ-stzaih*, I put (do.) on ; *pe-stzaih*, I put (do.) in (a recipient) ; *hwe-stzaih*, I take (do.) away ; *hwosa-stzaih*, I bring (do.) to myself; *nenæ-stzaih*, I lay (do.) on the ground; *na-stzaih*, I drop (do., do.) ; *nîntha-stzaih*, I put (do.) in the wrong place, that is, I lose, etc.

From which we conclude the existence in Déné of two chief synthetical processes, viz., one whereby the verbal stem is changed while the initial prefix remains invariable, and the other which retains the verbal stem unaltered, while it prefixes to it divers modificative particles.

On the other hand, a primary radical may be modified by many a secondary radical, or formative particles performing the office of radicals. Instead of *ta-næshya*, for instance, we might say *ta-na-næsqa*,* I walk in again ; *ta-na-hwe·-næsqa*, I only begin to walk in again, etc.

Nor should a student, desirous of seeing in all its expansion the wonderful power of composition peculiar to the languages under review, stop at the examination of compounds resulting from the prefixing to a verbal stem of merely one or two sense-modifying particles. To give him an idea of what it can lead to, I shall introduce him to the verb *ſe-kæ-na-hwe·-shæn-dæ-thæ-næz-krok*, which is a simple word, meaning: "I usually re-commence to walk to and fro on all fours while singing." Shall we analyse it ? Let us try. *ſe* is a prefix expressive of reciprocity, which, when in connection with a verb of locomotion, indicates that the movement is executed between two certain points without giving prominence to either ; *kæ* denotes direction towards those points ; *na* is the

* *Qa* is the equivalent of *ya*, such as inflected by the iterative particle *na*.

iterative particle suggesting that the action is repeated ; *hwe·* refers to the action as being in its incipient stage ; *shœn* means "song," and when incorporated in a verb it indicates that singing accompanies the action expressed by the verbal root ; *dœ* is called for by *shœn*, said particle always entering into the composition of verbs denoting reference to vocal sounds ; *thœ* is the secondary radical of the uncomposite verb *thîzkret*, inflected from *thî* for the sake of euphony with *nœz*, the pronominal crement of the whole compound, the *n* of which is demanded by the previous *hwe·*: *œ* characterizes the present tense, and *z* the first person singular of the third conjugation ; while *krok* is the main radical altered here by the usitative from the normal form *kret*, and is expressive of locomotion habitually executed on four feet or on all fours.

To enable the student to penetrate still further into the synthetism of the Déné verbs, I give below lists of the principal word-formative particles, together with examples illustrative of their use.

The following are postpositions with regard to their complement—noun or pronoun—and prepositions relatively to the verbal stems to which they are prefixed :—

AFFIXES.	EXPRESSIVE OF	EXAMPLES.
χa, χwa*	desire	n-χa-nœszœn (lit. thee by desire of I think), I want thee
ḳé, ḳwé	love	u-ḳwé-ssâ (him-through love of-I cry), I pine after him
ḳœn, ḳwœn	reference	ho-ḳwœn-nahwœlnœk (it-about-he narrates) he relates it
ḳœnne, ḳwœnne	deference	s-ḳœnne-inṭen (me-in deference to-work), obey me
tʃ̣a	transmission	pœ-tʃ̣a-s·ai (them-in-hands-I-put), I passed to them
lla	co-operation	ne-lla-îten (us-hand in hand-he worked), he helped us
q̣a	opposition	hwot-qa-sœ-nîyût (it-opposite to me-he drives), he prohibits it to me

*When in connection with the indefinite completive pronoun *ho*, and sometimes the personal pronoun *u*, the *χ*, *ḳ*, of this and the following postpositions are inflected into *χw* and *ḳw*.

The following affixes preclude the possibility of union with a complement, and are so intimately connected with the verb as to possess of themselves no separate existence :—

AFFIXES	EXPRESSIVE OF	EXAMPLES.
hwosa	approach	hwosa-shya, I arrive (where the speaker stands)
hwe	recess	hwe-shya, I depart (from where the speaker stands)
nîntha	wrong	nîntha-nœs·en, I spoil (lit. I treat wrongly)
thœ, thœnne	ill doing	(huntsi·) thœnne-zœsten, I have done (evil)
ha	derivation	ha-shya, I come from
·œn	rejection	·œn-tîsno, I have rejected (person. compl.)
thé	exit	thé-nœshya, I go out
ta	ingress	ta-nœshya, I go in
kœ	partial break	kœ-nœshyœz, I broke (in one place)
ya	total breakage	ya-shyœz, do. (in pieces)
tha	relation to water	tha-stil, I threw (plur. com.) into the water
tsœ	" fire	tsœ-dîstil do (do) in the fire
ne	" the soil	ne-nœstla, I put (do) on the ground
na	" " *	na-stil, I threw (do) *to* the ground

Besides the above and other similar affixes, I may refer to those which are instrumental in modifying the form of the verb, and which we shall presently study.

CHAPTER VII.

VARIETIES OF VERBS.

While the whole fabric of the Déné conjugations seems to be the almost exact reproduction of the Latin and Greek verbal inflections, the many forms which modify them, and the nature of these modifications, equally remind the student of the *kal*, *niphal*, *piel*, etc., of the Hebrew grammar. I am well aware that some scholars, among them J. W. Powell in his "Introduction to the study of Indian languages,"† are inclined to assimilate these forms to mere grammatical modes. But I am loath to

*This particle, moreover, refers to a prompt action, having the soil for its terminus.

† Second Edit. p. 53.

follow them, because in Déné these alterations of the verbal structure affect the whole of both the affirmative and the negative conjugations, while some of them, as the potential, alter quite as much, if not more, the body of the verb as their English equivalent, which in all the dictionaries is regarded, not as a modal variation of the verb, but as a quite different word. Thus from the verb *kœnœshyés*, "I break," we obtain, with the help of the potential, *kœsqœṡ*, "I am breakable." On the other hand, some of these forms consist simply in the change of conjugation, which can hardly be likened to a mode.

The principal forms affecting the verbs, in the Carrier dialect, are the affirmative, negative, usitative, potential, causative, reciprocal, reflective, iterative, initiative, terminative, plural and impersonal. I shall explain, in as few words as possible, the nature of each of them.

Of the affirmative nothing needs be said, since it is the normal state of the verb. Yet it may be well to note that a few verbs, the meaning of which is essentially negative, as *hulœʌ*, "there is not;" *hullil*, "it disappeared," lack the affirmative form, and still are destitute of the elements characteristic of the negative.

The negative can, in Carrier, affect the material structure of the verb in three different ways, viz.: by the incorporation of a negative particle (*l*, *ſe*, *ſœ*, *ſî*, *ſo*, according to the tense and the letter following these particles); by an inflection of the personal syllable, and oftentimes, though not in every case, by a modification of the mutable part of the desinential radical, *i.e.*, the vowel or final consonant—the initial consonant of a syllable being, as a rule, immutable in Déné. An example will facilitate the intelligence of these remarks. Here are two tenses of the verb *nœs-·a*, "I keep in my custody," conjugated under the affirmative and the negative forms.

	Present Tense.		Proximate Future.	
	Affirmative.	*Negative.*	*Affirmative.*	*Negative.*
	nœ-s-·a	n-*œlſœz*es-*œʌ*	n-œthîs-·aſ	n-œſthœzîs-·al
	n-în-·a	n-*œlſœz*în-*œʌ*	n-œthan-·aſ	n-œſthœzan-·al
	n-œ-·a	n-*œlſœs-œʌ*	n-œthî-·aſ	n-œſthîs-·al
	n-œtsœ̣-·a	n-*œl*tsœ*s-œʌ*	n-œz-thî-·aſ	n-œſtsœthîs-·al
	n-œh-·a	n-*œlſœ̇z*œh-*œʌ*	n-œthîh-·aſ	n-œſtḣœzîh-·al
	n-œhœ-·a	n-*œlſœ*h*œs-œʌ*	n-œhœthî-·aſ	n-œſothîs-·al
D.	n-î-ṭa	n-*œlſœzî*-ṭ*œʌ*	n-œtha-ṭaſ	n-œſthœza-ṭal

This form is proper to the Western Dénés, and, when under its three inflections, to the Carriers exclusively. The other Western Dénés eliminate the negative infixes *ł*, *łœ*, etc., and if they were to keep the word unchanged by the lexical exigencies of their own dialects they would simply say: *n-œzœs-'œɹ*, *n-œthœzîs-'ał*.

The usitative form consists in a modification of the desinential radical bearing sometimes on the vowel and sometimes on the final consonant, or both. Thus *œs'ał*, "I eat," becomes in the usitative *œs'œł*, while *œs-chût*, "I take," is transformed into *œs-chœk*. This is the simplest of all the forms, in that sense that it is the only one that never affects any other part of the verb than the desinence. I should also remark, in this connection, that "usitative" is rather inappropriate when applied to the Déné verbs, and is here retained for the sake of conforming to the common wording of American philologists. I think "generalizing" would better answer the purpose.

The potential varies according to the conjugation of the verb it affects. It merely modifies the radical of the verbs of the first conjugation. So, *œ'ał*, "he eats," changes for the potential its radical *'ał* into *tał*, and becomes *œtał*, "it is edible." But if the verb belongs to the second conjugation, the potential transforms it into a verb of the third.

The difference between the affirmative and the causative is equally one of conjugation rather than of form. As a rule, the causative merely changes verbs of the first into verbs of the second conjugation. *Intso*, for instance, means "thou criest," and by giving its pronominal syllable the *ł* distinctive of the second conjugation, the result is *îłtso*, "thou causest to cry." This form, if form we must call it, corresponds to the *hyphil* of the Hebrew verbs. It is not simply a transformation of an intransitive into a transitive verb, as is shown in the following: *naînkas*, "thou sharpenest" (a transitive verb); *naîłkas*, "thou causest to sharpen." In a few cases it has for secondary effect to materially alter the final radical of the verb. Thus *te-nînzœn*, "thou knowest" (a person), when modified by the causative is *te-nîłtzœn*, "thou acquaintest with."

The distinctive elements of the reciprocal form are identical with the particles which, in Northern Carrier, characterize the negative. The difference is only one of place and of results. The reciprocal, unlike the negative, leaves both the pronominal syllable and the desinence unaltered, except when the desinence is immediately preceded by the hiatus, and in a few other cases.

Two prefixes may be assigned as the main distinctive element of the reflective form. They are either *œdœd*, preceding immediately the pronominal crement, or the particle *ɹœ*, prefixed to the modificative syllable *na*. Moreover, *œdœd* has frequently for effect to transform verbs of the second into verbs of the third conjugation. *Tînthî* signifies "thou art valuable," and *tîlthî*, "thou makest him valuable," *i.e.*, thou treatest him with consideration. Hence, *œdœd-îlthî*, "thou makest thyself important," in other words, "thou art proud." In like manner, by prefixing *ɹœ* to *nahwœznœk*, "I narrate," we get *ɹœ-nahwœznœk*, "I narrate about myself," that is to say, "I make my confession." This form is susceptible of a few irregularities.

The particle *na* characterizes the iterative form. It is prefixed to, or inserted in, the body of the verb, according to the composition of the latter. When the verb is formed of several radicals, modificative particles or completive pronouns, its place is generally immediately after the initial root and before any complement or formative syllables. Either the radical or the conjugation of the verb is liable to be thereby modified, verbs of the second conjugation being ordinarily given the pronominal elements of the third, and such desinential roots as *ya*, *yal*, *·aih*, *·al*, *·as*, *zœn*, etc., being converted respectively into *ta*, *tal*, *taih*, *tal*, *tas*, *tzœn*, etc. I must remark, in this connection, that such verbs as express an action which, to the Indian mind, is essentially reiterated, take the iterative form, even when in their normal state, as *na-skas*, "I sharpen"; *thé-na-dœs-tli*, "I pray." Divested of the characteristic of iteration, *na-skas* is reduced to *œs-kas*, which should be translated, "I sharpen for the first time a new instrument," while *thé-dœs-tli* refers either to a passing supplication, as in a moment of distress, or to the first prayer of the child.

As for the initiative and the terminative forms, they are obtained by the prefixing or infixing of the particle *hwe·* for the former and *ne·* for the latter. These affixes are generally incompatible with the present tense. They have for effect to prefix an *n* to the personal elements of the verbs which lack it while under their regular form, and *hwe·* furthermore changes the pronominal inflection *thîs*, characteristic of the proximate future, into *nthas*, the other persons of that tense being also proportionately altered. So, from *œsten*, "I work," we get for the initiative *hwe·-nœsten*, "I begin to work," and for the terminative *ne·nœsten*, "I have stopped working," while to translate "I will presently commence to work," we will have to say: *hwe·nthastil*, instead of *hwe·-thîstil*. Both forms are, as far as I know, proper to the Carrier dialect.

By plural I mean a certain form whereby a verb is made to refer to an act exercised repeatedly or in connection with several objects, without, however, having the exact signification or the material structure of the iterative or the objective verbs. Its distinctive element is *nœ*, sometimes inflected into *ne*, which occasionally slightly modifies the desinential radical. So *hwe-dœs-kés* means "I attach" (viz. to a rope hanging down), and demands a singular complement, while *hwe-nœ-dœskœz* has the same signification, but must follow a plural complement. In like manner *œ-ké-skés*, "I write" (lit. indefinite-on-I draw), points to a single sign or cluster of signs as the result of my action. By altering it into *œ-ké-ne-skœz* we obtain a verb likewise signifying "I write," but implying many words or pages as its complement. This form is applicable only to a limited number of verbs.

The last form on our list is the impersonal. It renders the verb impersonal both in structure and in meaning, and yet it cannot be assimilated to the regular impersonal verbs, because it is a mere transient modification of verbs which are of themselves personal. Its use is limited to a few verbs, as *œt-ni*, "he says," which can be transformed into *hwot-ni*; *ne-œten*, "he does," into *ne-hwoten*; *œtqa*, "he is affected," into *hutqa*, etc., the exact translation of which latter terms is impossible either in English or in French. *Hwotni* is almost the equivalent of "*on dit*," but is still more indefinite in meaning, and I confess my inability to find in either Latin, French or English synonyms of *ne-hwoten* and *hutqa*.

Besides the above modificative forms, there are in Déné what I may call double or composite forms; that is, a verb is liable to be affected by two or more forms simultaneously. Thus in *te-na-nœs-tzih* (from *te-nœs-zœn*), we have both the iterative and the usitative combined; while *na-ĩl-chœk* is simply the verb *œschût* modified by three forms: the iterative (*na*), the potential (*ĩl*) and the usitative (*chœk*).

All these forms, whether simple or complex, affect the structure of the verb in a transient or accidental manner, none of them—except, of course, the affirmative—being necessary to its existence. Should we now wish to classify the Déné verbs on the basis of the peculiarities of their terminal roots considered as normal desinences, we will find five principal groups of verbal terms, including objective, locomotive and instrumentative verbs, together with verbs of rest, which are in turn divided into verbs of station and verbs of cubation. I beg to be excused from enumerating the well-nigh numberless desinential forms assumable by each of these groups.* I shall confine myself to the following brief remarks:—

*To give an idea of their number, it may suffice to state that each locomotive verb is modifiable by no less than 78 desinential variations, which are in turn multipliable by the number of prefixes successively assumed by the verb.

The signification of the objective verbs is determined by the particles prefixed to their personal or pronominal elements, and the nature of their complement, expressed or implied, by their desinential root. This applies also to the verbs of station.

The radical of the instrumentative verbs denotes the instrument or medium employed to perform the action expressed by the verb, while the prefix points to the manner in which said action has been accomplished. As for the verbs of locomotion, their final determines the nature of the subject, while the particle preceding the pronominal crement indicates the direction or extent of the locomotion. Materially speaking, verbs belonging to the same group and having the same signification are apt to become, through their desinential modifications, almost unrecognizable. *Niya*, for instance, means "he (human being) walks," and when referring, let us say, to the human mind, it will be altered into *nœdœl-tsœt*, with exactly the same signification.

A verb modified by any of these last terminological inflections may furthermore be affected by any of the several forms which I have described above.

Lastly, considered grammatically and without any reference to their etymology, the Déné verbs may be divided into transitive, intransitive, passive, unipersonal and defective. With the exception of the defective and a few passive verbs, none of these voices have, as such, any fixed characteristic embodied in the conjugation. The passive exists in Déné, but for a limited number of verbs only. It changes a verb of the second into one of the third conjugation. Ex.: *œs·a*, "I order"; *œz·a*, "I am ordered."* Quite as commonly, however, verbs that are passive in English are of the first conjugation in Déné, as *tankœn*, "it is burnt"; *kœnthœk*, "it is broken," etc.

CHAPTER VIII.

MISCELLANEOUS NOTES.

There is hardly any difficulty worth recording in connection with the syntax of the Déné dialects, which is as simple as the machinery of their verbs is complicated. And no wonder: cases and substantival genders, which are ordinarily the occasion of syntactic irregularities, being unknown, it is but natural that the difficulties that spring therefrom be equally wanting.

*Compare the pronominal mutation of this verb with that of its Latin synonym: *jub-eo*, *œs-·a*; *jub-eor*, *œz-·a*.

Phraseological construction might at first appear somewhat puzzling to the student, yet it is as simple as that of our own English. To understand it, we have only to bear in mind that in Déné the governed word, be it direct or indirect complement, always precedes the governing. As a consequence, to translate almost any English sentence, or part of sentence, it is often sufficient to remark the order of priority observed between its component parts, and then dispose the Déné words in exactly the inverse order. The possessive and completive pronouns, being essentially connected with the nouns, are—together with the subjective substantive—alone excepted from this rule. Supposing, therefore, that we have to translate this sentence: I departed only after I had well covered with warm blankets my dear little children. We first read the words backwards, observing to join the possessive pronouns to the nouns they determine: My-children little dear blankets warm well I-had-covered-with after only I-departed. Now it simply remains with us to translate word after word, thus: *S-œzkhéhkhe yaz pœkéssi·ne tsœt sœzœl sucho pœrauzastœz hukwiťaz za hweshya.*

The nature and place in the sentence of the completive pronouns is the only syntactic particular that might be said to offer any real difficulty. Direct completive pronouns are incorporated in the verb, just immediately before the personal element, while the indirect complement is generally prefixed to the initial radical. Ex.: *s-ra-e-nîn-'ai,* "he gave it to me;" *yœ-ra-ťe-yî-'al,* "he did not give it to him." It will be remarked that these verbs combine in their formative elements—1st, the personal pronoun *(nîn, yî)*; 2nd, the direct completive pronoun *(e, yî)*; 3rd, the indirect completive pronoun *(s, yœ),* in addition to which we find also incorporated therein: 4th, the negative particle (*ťe* of the last example)

Another feature of the Déné syntax is that these completive pronouns are never expressed in connection with any but the third person singular or plural, while some verbs never admit of their incorporation into their elements unless they be of the plural number. Thus *œschût, dœsni,* etc., may mean either "I took, I told," or "I took it, him or her, I told him or her," according to the context. As a compensation, the direct completive pronouns find place in many a Déné verb, the English equivalent of which is unrelated to any pronominal complement. Thus, for "God made man," we must say, "God man made-him;" "he took his pipe," must be turned, his (own) pipe he-took-it."

These few remarks will, I hope, suffice to give an idea of the Déné syntax. Shall I now say a word about the idiotisms of the language? The task is rather inviting on account of the abundance of the material to select from. In fact, I might almost say that the Déné dialects are mainly composed of idiotisms, since, in the words of Dr. Trumbull, "it is nearly impossible to find an Indian name or verb which admits of exact translation by an English name or verb."* Among many phraseological peculiarities, we find, in Carrier, such expressions as *shœn yaťthœk*, "he speaks a song," that is: he sings an old air with improvised words; *tsiya sœlli*, "it becomes all," for: the supply is exhausted; *upa tzœɹ œdîsqa*, "I said badly for him," meaning: my words shocked him; *au spa hwe dîni hwuyaɹ*, literally: not for-me thereby thou-sayest there-is (not), which is equivalent to: I do not know what you mean.

Without cultivating rhetoric, some Dénés are genuine orators. To add to the forcibleness of their speech, they generally have recourse to comparisons drawn from their daily surroundings, and from the vegetable and animal worlds Moreover, their language itself is not deficient in figurative expressions, as the following phrases, which are in common use among the Carriers, will show:—*Pœť sœzîťre*, "sleep kills me," for: I am very sleepy; *netai angran*, "famine murders us," for: we have nothing to eat; *chahwozai hoh-nœshya*, "I walk with bare stomach," *i.e.*, I am fasting; *nakôs œsînla*, "the haze of the eyes has made me," that is: I am snow blind; *utzî-sœťsi*, "his heart is acrid," for: he is acrimoniously disposed; *sœɹ-niya*, "he walks alone," meaning: he is a bachelor; *'az sta*, "she stays out," *i.e.*, she has her menses, etc. This last expression is a reminiscence of the custom which among the Carriers forbade the use of the paternal or marital lodge to a female having her monthly flow.†

Some words of their language likewise owe their origin to fiction. Thus they call *na-pe'-tœn-kre*, "packed-back-with," a species of large-flaked snow which falls in the spring, when the migratory birds make their first reappearance, insinuating thereby that it is dropped by them upon their arrival to their summer home.

All of these words and idiotisms are proper to the Carriers. Other dialects of the same linguistic group are equally well stocked with imaged or figurative expressions which are sometimes the equivalents of the above, though more generally they differ therefrom. For, although the various dialects are so closely co-related as to present to the investigator innumerable signs of unmistakable affinity, yet it would be erroneous to imagine that they have individually no distinctive characteristics. The comparative philologist would even find therein grammatical differences which might be of the greatest importance as conducive to

* *Apud* Introd. Study of Lang. 2d. Ed. p. 62.

†See "The Western Dénés," etc., Proc. Can. Inst., October, 1889, p. 162.

the detection of the earliest and purest idiom, and thereby the ethnologist might find his way clear of many difficulties while attempting to trace the origin and describe the migrations of the tribes that speak them. It is not my intention to enter at present upon such a study ; still I can hardly close a philological paper, embracing in its scope all the dialects of the group without at least some reference to such grammatical and etymological dissimilarities.

If we must admit as a principle of comparative philology deduced from the formation of the Romance idioms of Southern Europe, that the mutations effected in a language through migrations or conquest are always in the direction of greater simplicity, or, in other words, from inflectiveness to analysis, then I think the dialects of the Western Dénés must be regarded as more primitive, because more synthetic, than those spoken by the tribes whose actual territory extends east of the Rockies. To prove this assertion, it might suffice to point to the rules governing the formation of the negative verbs in the different dialects. In Carrier we have a triple—and often quadruple—negation, consisting of an independent monosyllable and two or three inflections in the body of the verb. These internal variations are reduced to one—sometimes two— in Chiſχohtin, the verb being, as in Carrier, preceded by a negative particle, the co-relative of which is in the Eastern dialects the only particular differentiating the negative from the affirmative. Let us take as an example the verb "I pray." We have in :

	CARRIER.	CHIſχOHTIN.	CHIPPEWAYAN.
Affirm.	the-na-dœs-tli	rèn-tsa-kus-ti	yas-thi
Neg.	*au*-the-na*ſ*-dœ*zœs*-tli 1 2 3	*tla*-rèn-tsa-ku*zœs*-ti 1 2	yas-thi *illé* 1

So the Chippewayans and all Eastern Dénés simply say : I pray not. This is far, indeed, from the doubly—or trebly—inflected negation of the Carriers.

The Eastern Dénés have also lost quite a number of other inflections still existing in the Carrier verbs. Such are, for instance, the dualistic pronominal inflections of the verbs of locomotion, and of the verbs of station corresponding to the three persons of our singular, as well as the two last persons of the indefinite singular of the same verbs. Furthermore, the remarkable synthetism which we have already noticed in the comparative forms of the primary verbal adjectives (*su-ilcho*, *nd œlcho*, etc.), no less than in their six especial differentiating prefixes (*nîn*, *dîn*, *hwo*, etc.),is totally wanting in most Eastern dialects, which likewise lack such synthetically formed comparative as *œte-no·*, *œte-tiz*, *œte-ιhu*, etc Time, or some other cause, has also 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 eastwards. It is also worthy of remark that the Chiſχohtin—a Western dialect—which has many terminological affinities with the Hare (eastern) dialect, has similarly lost those terms. Nor can I find in the Chippewayan, Slave, Hare or Loucheux vocabularies any trace of the Carrier inflected numeral adjectives, *iſowh*, *nauh*, *thauh*, *uaîltoh*, *thaîltoh*, *nahœltoh*, *thahœltoh*, etc., etc.

Now, in the same manner as the admixture of foreign elements in the Latin-speaking populations of the Roman Empire had for effect to gradually disintegrate, and finally replace, by independent particles, the case-endings of the nouns, and the personal inflections of the verbs, even so it must have been with regard to the inflections and synthetical forms which are now wanting in the speech of the Eastern Dénés. On the other hand, since philological researches have taught us that the more synthetical is a language, the stronger are its claims to antiquity, we must conclude from the foregoing that the Carrier is the most ancient, and thereby the purest, of the dialects spoken by the various Déné tribes.

This comparative purity, however, should be understood of its grammatical, or organic, not lexical, features; for there are not among the Carriers two villages the inhabitants of which speak exactly the same language. Strange to say, these differences bear more especially on the most important part of speech, the verb, its conjugations, and its negative elements. Thus, while a Carrier of Stuart's Lake says: *au ſtœzœz-χwœs*, I do not cough; a native of Fraser's Lake will say, *au chatœzœ-ſœχwœs*, and a Babine Indian *sɔ· hwatœzœkiſχwœs*.

From so important dissimilarities in the actual speech of homogeneous Indians, whose country is contiguous, one might be tempted to infer that their language is not of a very stable character, inasmuch as that of some Eastern Aborigines is represented as wonderfully changeable.* Yet I hardly think it to be the case. I even believe that it can be safely affirmed that the Déné idioms have not varied more during the last hundred years than either English or French ever did during an equal space of time previous to the sixteenth century.

* Introduct. Study Ind. Lang., 2d Ed., p. 63, text and note.

To enable the reader to judge for himself, and, at the same time, to give him an opportunity of appreciating the latent forces which are acting upon the language of our Indians, I shall lay before him lists of the Carrier words that have undergone any variation during the present century.* They are of two kinds : there are those the vocalic or transmutable elements of which have been corrupted into their present form, and those that have been replaced by entirely new words. To the first class belong the following :—

Old words (100 years ago).	*New words.*
tiſ, crane	teſ
thiſ, berry-basket (bark)	theſ
ſœNn, dog	ſi
œſthœNn, bow	œſthi·
tœne-thœNn, old man	tœne-thî
chœntsœNn, pine *(Pinus resinosa)*	chœntsi
nînlœNn, it flows	nînli
tœtaNn, duck	tœtai
taltaNn, torch	taltai
nzoNn (he is) good	nzu

and their derivatives, together with a few other terms of similar desinence.

That changes in an American language are not restricted to the inflexible syllables of a word will be shown by the following terms, most of which are still understood, even by children, but have grown obsolete :—

Old words.	*New words.*
ul·en, lynx	washi
tsoNntziſ, ice breaker	œté (horn)
ni-yutsé (he barks inland), coyote	chœn-thœ-ſi (wood-dog)
χaih-pa-tsâ, red fox	nankœz tœlkœn
sœs-eɹœſ, brown or cross bear	sœs tœlkœn
ken-tsi, species of red willow	ken tœlkœn

Of these words, the first (*washi*) is evidently a loan word borrowed from the language of the Carriers' neighbors, the Skeena Kitiksons, who

* I base my computation of time upon the age of my informants. One of them, who died two years ago, was close to 100 years old, since he had clear recollection of the advent in this country of the first white men in 1793.

say *weh*, for "lynx." *Tsonntzil* is no more understood, except by elderly people, while *ni-yutsé* is still in use among some Carriers. As for the three last words on our list, they are striking instances of the tendency of a language to resolve its original synthesis into analysis whenever the people that speak it are brought into contact with an alien race. *χaih-pa-tsâ* is a synthetic compound, meaning "he cries for daybreak," and alludes to the nocturnal barking of the red fox. By dint of hearing the French or English name of that animal pronounced by the H. B. Co. traders, the Carriers have imperceptibly dropped their own synthetic vocable to adopt the foreign analytic expression, and they now invariably say *nankœz tœlkœn*, "fox (he is) red." Same remark applies to the two other words.

PHILOLOGICAL CONCLUSIONS.

Let us now recapitulate.

The philologist who has had the patience to peruse attentively the foregoing pages will find, I hope, little difficulty in deducing therefrom the following conclusions :—

1ST.—The Déné languages agree with most American idioms through the polysynthetism which pervades all their composite words, and more especially their verbs.

2ND.—They also resemble the Turanian tongues on account of the monosyllabism of most of their roots, their compounding and agglutinative processes of word-building, the formation of their plural and of their amplificative and diminutive, their law of euphonic sequence of the vowels, their innumerable differentiating distinctions, the fundamental rule of their syntax, which requires that the governed word precede the governing, the postpositive character of their equivalents for our prepositions, the scarcity of their terms expressive of relation or conjunction, etc.

3RD.—We must likewise note the following features which they possess in common with the Semitic languages : the immutableness of their initial consonants as contrasted with their vowels, which are essentially transmutable through the various dialects, the nature of their affix article, the number of the modificative forms of their verbs, and the grammatical duality of such objects as are naturally twofold.

4TH.—Lastly, the pronominal inflections of their verbs, their mode of forming the number "nine," as well as the character of all the interrogative and of some possessive pronouns, are as many traits of affinity with the Aryan languages. Furthermore, we should remember that

5TH.—They have but a limited number of words expressive of abstractness, collectivity or generality.

6TH.—Most of their root nouns are monosyllabic, though some are dissyllabic.

7TH.—The almost totality of their adjectives are regular verbs, and as such they invariably follow the noun they qualify.

8TH.—The possessive pronouns are prefixed to the nouns they determine, and constitute an integral part thereof.

9TH.—The adverbs always precede the verbs.

10TH.—The primary, or main verbal, roots are in every case the last syllable of the verb, the penult being invariably the pronominal or inflectible element, which may be preceded by a secondary radical, the negative particle, the completive—direct, or indirect, or both—pronouns, and the various accessory sense-modifying affixes.

11TH.—The substantive verb "to be" exists in its independent form.

12TH—The divisions of the verbs into transitive, intransitive, passive, etc., are purely theoretical, and have no effect upon the conjugations.

13TH.—There are three conjugations with only one mode and four primary tenses.

14TH.—The negation is, at least, triple in Carrier, double in Chilχohtin and single in the Eastern dialects.

15TH.—The Carrier is the most synthetical and inflective of all the Western or Eastern dialects.

PELOTECHTHEN BALANOIDES.

BY ARTHUR HARVEY, ESQ.

(Read 2nd November, 1889.)

In the paper on "Broad Outlines of the Geology of the North of Lake Superior," which I had the pleasure of reading to the Institute last session, I animadverted on the lack of fossils in the archæan rocks. Yet the term Azoic, as an equivalent to Archæan, has always seemed to me too hopeless, and I made a very close examination, during the past summer, of the Animikie formations (Hunt) in the mining district west of Port Arthur, for the purpose of finding traces of life.

There are few things in geology more confused than the nomenclature of these ancient rocks. The name Huronian was proposed by Sir Wm. Logan, long ago, for a series later than the Laurentian, which attains distinctive development to the north of the Great Lake of the Huron Indians. The mind gets bewildered with the *recent* Huronian sub-divisions, such as "Taconic" (Emmons), "Animikie" (Hunt), "Keewatin" (Lawson), "Keeweenaw" (Irving), and I think they ought all to be consigned to oblivion at once—as they will be in the end. The district I examined rests on a red Huronian granite, on which is a green (chloritic) slate, over which is a great thickness of black slate (argillite) with layers of chert or silicious limestone near the junctions ; the whole capped in many places by what is locally called trap—a greenstone or gabbro, an eruptive overflow.

Specimens of these rocks are in our museum, and among those presented by myself are some of what our Geological Survey calls "concretionary masses." Possibly, these are alluded to in the Sixteenth Annual Report of the Geol. and Nat. Hist. Survey of Minnesota, p. 317, where, reading of an "argillo-felsitic ground mass" near Ogiskie, Muncie Lake, we learn that "the surface of the rock is studded with spheroidal concretions, which have been cut in section, and have hollow centres, apparently by the solution of the interior portion. They are not pebbles, for they are all very similar, and, besides, reveal, in some cases, concentric lines." In Mr. A. Winchell's report, same volume, p. 239, I find that he describes, on Gunflint Lake, what he had seen elsewhere in the Animikie slate—" surfaces of *laminæ* covered by concave depressions of an ovoid or spherical character, resembling what the elder Hitchcock named *Batrachoides nidificans.* I have discovered that spheroidal concretions between *laminæ* sometimes cause such appearance." Mr. Winchell (without a word of remark on this curiously amorphous name) further notes: "Rock 828, cherty concretions, producing *Batrachoides nidificans*."

We may, perhaps, suppose the elder Hitchcock meant depressions which resemble those which are made by nesting frogs. I doubt the connection which Mr. A. Winchell traces between the concretions and the depressions—if the concretions are the same as those of which this paper treats—locally called "cannon-balls," but named by me *Pelotechthen balanoides*—an acorn-shaped thing, grown in or from mud.

The Animikie slates of the Thunder Bay district (Port Arthur) are generally but little inclined from the horizontal bed of deposition. They are often in thin *laminæ*—several to the inch—and, save that they are black, you might imagine them to be deposited in the same way as the clays of Rosedale and other points just north of Toronto. Probably they were sediments in a slowly subsiding sea-bottom, and have altogether perhaps 10,000 feet of thickness in this quarter. I find, wherever you seek for them, examples of the *Pelotechthen*. These do not, according to my observations, occur between *laminæ*, but, on the contrary, there is a clean breaking off of the layers where they touch the *Pelotechthen*, and it breaks away from the strata as a whole—as if there were some shell around it—quite smoothly. Where the miners drift past one you can often see it sticking out of the side of the tunnel.

The uniformity of shape proves these things to be a growth; they are sometimes round like an orange, oftener ovoid, and they so often have a slight protuberance on the upper side that I compare them rather to an acorn than to an orange or an egg. Their internal structure, too, proves them a growth; and to illustrate this I have had a small specimen sliced by a lapidary—which I beg leave to add to your museum. You will see that there is a very regular layer of pyrites around the nodule—thickest at about ⅛ of an inch within its outer surface and shading off with a regular decrease towards the centre. This pyritous ring I have never failed to notice, though I have broken dozens of them. Comparing them to an acorn, you might say the layer was between the shell and the meat. I asked one of our members to give the section a proper examination by a petrological microscope, but, owing to the composition of the material (precisely the same argillite as the surrounding strata), nothing additional was learned. I submit that no mere mineral nodule would attain the size of many of these spheroids. I should have thought this growth a *protospongia*, except for the conditions under which it seems to have lived, that is if it be a zoophyte.

1. It grew on the mud in a quiet sea. I do not think sponges grow or ever did grow except on rocks.

2. The formation appears simpler than that of sponges.

Imagine a thing not unlike in shape the puff-balls of our meadows, a lump or a bladder surrounded by an envelope of cellular structure, the whole enclosed in a tough skin, growing in numbers, in the dark mud—without a foot stalk : the mud would at times be deposited in such quantities as to kill the zoophytes—which would account, if nothing else did, for their differences in size : they are from the bigness of a hen's egg to that of a coal scuttle.

The fact that the ring of cellular structure has become filled with pyrites should cause no wonder, nor should the form of the crystals ; the pyrites have replaced the older filling by infiltration—a not unusual process in rocks of such great age. Examples exist of early sponges having had their *spiculæ* replaced by pyrites in much later rocks than these.

The *Pelotechthen* is found throughout the argillites for sixty miles from Thunder Cape to the Silver Mountain, and doubtless further. I have the authority of Mr. Chas. E. Eschweiler that it is not unfrequent among the rocks of the Keeweenaw peninsula—the iron pyrites there being replaced by copper.

OSSIANIC POETRY.

BY DAVID SPENCE, ESQ.

(Read 29th March, 1890.)

When we speak of Ossianic poetry, it is quite natural to think of the poems published in England in 1762 by James Macpherson, as translations of the poems of Ossian, the publication of which caused such wonder and amazement in the world of letters that they are more or less known to all who take any interest in literature. They were translated almost immediately into all the principal languages of Europe, and admired by the greatest literary characters, by Goethe and Schiller among others. The great Napoleon was in the habit of carrying a copy in his pocket during his military campaigns. In Britain they met with a mixed reception ; accepted as genuine, and placed on a level with the great works of antiquity by such eminent critics as Hugh Blair, they were, on the other hand, assailed by Dr. Johnson and others as impudent forgeries. The doctor declared that there was no Gaelic manuscript in the world one hundred years old. The passions and prejudices called into existence by the rising of '45 contributed fuel to the fire of controversy ; the voice of calm reason was drowned in the shouts of the combatants. It is generally assumed in our day that the genuineness of the poems of Ossian has been successfully assailed, and that the controversy has been closed with a verdict against Macpherson. This is by no means the case. There are men of equal eminence in Britain and on the Continent of Europe to be found on opposite sides of the question. There is hardly a critic in our day, even among the opponents of Macpherson, who regards him as the sole author of the poems ; the question being how far he tampered with and changed the materials which came into his possession. These questions I purpose in the course of this paper to discuss. It is generally taken for granted also that Ossianic poetry is exhausted by the publication of Macpherson's Ossian and the "Seann Dana" of the Rev. Dr. John Smith, of Campbelltown. This also is a mistake. From Sir James McGregor, Dean of Lismore, in 1512, to John F. Campbell in 1872, there were at least twenty-six collectors of Gaelic Ossianic poetry, exclusive of Macpherson and Smith. These twenty-six collected in all 54,169 lines ; Macpherson 10,332, and Rev. Mr. Smith 5,335. Macpherson, therefore, collected only one-sixth of the whole. The poetry collected by the twenty-six differs very much in language and form from that published by Smith and Macpherson, being more of the ballad form, and evidently intended in many cases to be sung and recited on particular occasions, while that of Macpherson especially is of the Epic style. As to the genuineness of these ballads there can be no question ; they may not go back to the third century, but many of them are undoubtedly hundreds of years old.

THE DEAN OF LISMORE.

Of the large manuscripts, the oldest is that of the Dean of Lismore, which was written not in the old Gaelic letters, but in the current handwriting of the time. It bears date 1512 ; but it does not appear to have been finished till about the year 1525. It contains in all over eleven thousand lines, of which 2,665 are Ossianic. As it is written phonetically it is extremely difficult to decipher ; but we are indebted to the great industry, patience, and scholarship of the late Rev. Dr. Thomas McLauchlan, of Edinburgh, for the publication of a considerable portion of the text in its original form, with translations into English and into modern Gaelic. Some of these poems seem to be very old, dealing as they do with matters belonging to the fifth and sixth centuries, and nine of them are ascribed to Ossian himself. In my opinion they are, however, far inferior to those published by Smith and Macpherson. The discovery of this volume disposes effectually of the contention of Dr. Johnson in reference to Gaelic manuscripts.

THE SEANN DANA : REV. JOHN SMITH, D.D.

These were first published in Gaelic in 1787, an English translation having previously appeared. The authenticity of these poems was also assailed, but the doctor's own statement in reference to them seems quite reasonable and in accordance with the facts. He states that the material was written down in fragments from recitation ; that he rejected what was manifestly spurious ; compared the different portions and joined them together, he in some instances furnishing the links. In this short paper it is impossible to deal in detail with all the collectors. I shall accordingly consider only the collections made by Macpherson and by Campbell.

JAMES MACPHERSON.

James Macpherson, having in 1759 published " Fragments of Ancient Poetry," was prevailed upon by Lord Elibank, Dr. Blair, and others to undertake a journey to the Highlands in order to gather more Ossianic poems. He, along with the eminent Gaelic scholars, Lachlan and Ewen Macpherson, travelled through the Highlands in 1760 for this purpose. Lachlan took down many poems recited by various persons in the Highlands, and copied some manuscripts. In 1762 Macpherson published what he termed English translations; and at once the great war as to their authenticity began. It is certain that Macpherson collected a great number of poems from recitation, and that he rescued a large number of manuscripts written in the old Gaelic characters, which bore all the marks of antiquity. These documents were seen in his possession by men whose word is above question. In 1796 James Macpherson died, leaving a large amount of money by his will toward the publication of the Gaelic poems from which, as was alleged, the English translation was made. A copy of the poems prepared for the press in his handwriting, or that of his friends, was found among his papers; but not a scrap of the manuscripts, or of the original copies of the poems taken from recitation could be found. He had at one time placed these documents in the han dsof Becket, a London bookseller, and advertised that any one wishing to satisfy himself might see them there. It must not be forgotten that nearly forty years had elapsed before a search was made for them by the Highland Society. They may have been in the meantime mislaid or lost, or condemned as a nuisance by some tidy housekeeper, and consigned to the flames.

On the death of Macpherson the Highland Society of Scotland began in earnest to gather evidence from every available quarter as to the authenticity of the poems. Their secretary was Henry Mackenzie, the author of "The Man of Feeling." The inquiry was conducted in the most judicious spirit, and their report, published in 1805, embodies the results of the investigation.

It is extremely difficult for those who regard Macpherson as the author to explain away the vast array of facts contained in this Report; and it is to be feared that some of them have unconsciously presented a garbled statement of the evidence. W. F. Skene, one of the greatest authorities on the early history of Scotland, says in his introduction to the book of the Dean of Lismore (1799): "Andrew Gallie, of Badenoch, sent to the Highland Society a part of the Gaelic of Fingal, which appeared in the Gaelic version subsequently published. He said that he had taken it from a manuscript he had received, 'written by a friend, who was at that time with Macpherson and me; a gentleman well known for an uncommon acquaintance with the Gaelic language and a happy faculty for writing it in Roman characters.' On being pressed to say who that friend was, he says his name was Lachlan Macpherson, of Strathmashie."

Now the evidence of Rev. Andrew Gallie is far stronger than it is represented in the above statement; and he is only one of those who reported to the Highland Society. He and James Macpherson being old friends, the latter, along with Lachlan Macpherson and Captain Morison, remained at his house in Brae-Badenoch on their return from the Highlands, arranging and translating the manuscripts procured, which he said were poems of Ossian.

In a letter (dated 12th March, 1799) to Charles McIntosh, a member of the committee of the Highland Society, he wrote that he remembered perfectly that at the end of some of these volumes was a statement that they had been collected at the end of the 11th century by Paul MacMhuirich; that they thought the writing had been done by an ecclesiastic, for the characters and spelling were most beautiful and correct; that every poem had the first letter of the first word most elegantly flourished and gilded; some were green, some red, some blue, and some yellow; that the material seemed to be limber dark vellum bound in strong parchment, and that Macpherson got them from Macdonald of Clanronald. He said also that they were written in the old Gaelic characters, which he could read, though with difficulty; that he amused himself in reading these poems while Macpherson was busy with his translations, and that they differed at times as to the meaning of certain words in the original. He sends sixteen lines taken from the manuscript, in the original Gaelic with a literal translation, and his statement as a whole is most circumstantial and minute.

The statement of this clergyman is so simple, so ingenuous, and so natural that it is impossible not to believe him. Now, it is to be noted that these very lines appear in Macpherson's "Fingal," with the orthography modernized but otherwise unchanged. The translation given by Mr. Gallie is as follows:—

Man was opposed to man and steel to steel,
Shields sounding, men falling;
Like hammers of hundreds on the son of the embers,
Swords rose and fell.
Gaul went on like a blast descending from the height,
As he destroyed heroes.
Swaran was like a flame of the desert,
That consumes the sounding heath of Gormal.
But how shall I relate in song
The heavy death of spears that was there?
Terrible was the strife of battle,—
High flamed my sword.

Malcolm Macpherson makes a declaration that his brother gave Macpherson a quarto Gaelic manuscript of poems, 1¼ inches thick. Sir Adam Ferguson saw manuscripts stained with smoke in Macpherson's possession. Rev. Dr. Cameron and four other Catholic clergymen make a very important declaration. They say that Rev. John Farquharson, lately prefect of studies in the College of Douay, was, in his youth, a missionary in Strathglass in Invernesshire, that he commenced to collect Gaelic poetry before 1745 ; that he filled a folio volume three inches thick; that all these gentlemen saw it in his possession from 1763 to 1777 ; that Macpherson's translation was sent to him at Douay ; that Mr. McGilvray, one of the declarants, saw it there in 1777, tattered and torn, tossed about by the students who knew nothing of its value, and who tore leaves off it to light their fires. Bishop Cameron thought that it was destroyed when the Revolutionary army carried off the papers of the College.

From all the evidence it is highly probable that Macpherson found manuscripts, of which we know nothing, which he may have changed and modernized in many respects and placed together, supplying the links, as did Rev. Dr. Smith. He may have destroyed the original in his possession for some reason unknown to us. It may also be observed that we have not these poems even as Macpherson left them ; for the Highland Society, in appointing Rev. Thomas Ross to edit them, instructed him to conform the orthography to the system used in the translation of the Scriptures. The longer poems appear to have been made up of shorter ones by Macpherson or some preceding poet. There are portions that seem the creations of some great genius, while other parts are commonplace. The ground work or subject matter of the poems is admitted by the ablest opponents of Macpherson's claims to be extremely ancient, and portions contain legends and myths common to the whole Aryan world. There are poems, such as the "Battle of Gabhra," in some versions called the "Death of Oscar," which have been found current among the most illiterate people in various parts of Scotland. A copy was printed by Gillies in 1786 ; 286 lines were taken down from recitation in the Isle of Skye ; 2 versions are printed in the Dean of Lismore's book ; and a version was found in Ireland and printed by Miss Brooke. This is believed to have been a real battle fought more than thirteen hundred years ago, and it forms the subject matter of a considerable part of Macpherson's "Temora."

JOHN F. CAMPBELL AND HECTOR MCLEAN.

Just one hundred years (1860) after the tour of James Macpherson to the Highlands, John F. Campbell and Hector McLean, both of the Island of Islay, began to collect Gaelic tales and poems in the Highlands. The work was done in the name of Campbell, a gentleman of good family and of the highest character and culture, and a good Gaelic scholar. His co-worker, Hector McLean, is a man of great ability, a profound critic, and one of the best Celtic scholars in Britain. He had a large share in collecting and translating the tales. A considerable number of men were employed in different parts of Scotland collecting manuscripts and writing poems and tales from oral recitation. The names of the collector and reciter, with notes of time and place are given in every instance.

These men sought particularly for poems like Macpherson's, but although they found many dealing with the same incidents, they could find none of similar language and form. Strange as it may appear, some of these tales were found to be the same in substance as those collected in Germany, India, and even in Northern Africa. Four volumes were published in 1862, giving the Gaelic versions with English translations. A folio volume, closely printed, of 224 pages of Ossianic ballads was published in 1872, under the name of "Leobhar-na-Feine." The poems printed from manuscript are published just as Campbell found them. His opinion as to the controversy seems to be that Macpherson fused some old Gaelic ballads into epics, or that some other great poet, with a profound knowledge of the Highland people and of old ballads, composed these poems between the time of the Dean of Lismore, 1512, and the time of Macpherson; and that Macpherson found the manuscript, modernized and published it. In his latest criticisms he seems to lean to the opinion that this work of fusion was done by Macpherson himself.

His reasons for not going beyond the time of the Dean of Lismore seem to be based on negative considerations. There might have been manuscripts in existence of which the Dean never heard. There was but little known of the Dean's own manuscript till it was brought into notice by the Ossianic controversy. The Rev. A. Clerk, the latest editor of Ossian, states there are in the Advocates' Library alone upwards of sixty Gaelic MSS. from three to five hundred years old, not to speak of the "Book of Deer," which is of still greater antiquity. How many literary men, even in Scotland, know much about these manuscripts? Hector McLean thinks that Macpherson composed his English Ossian first, and subsequently translated it into Gaelic; but the weight of authority is against him. He bases his opinion on his discovery of English idioms in Macpherson's Gaelic. Now, it is, of course, possible, that as to the original portions—the "links" or "joints"—the English may have been first composed, and a Gaelic translation afterwards made, but the great body of the poems which bear the stamp of genius, bears also the mark of their purely Gaelic origin.

AUGUST EBRARD.

There are scholars of great eminence, both in Britain and on the continent of Europe, who still believe in the authenticity of Macpherson's Ossian. The late Rev. A. Clerk, editor and translator of the last edition of Ossian, may be mentioned as representing British scholarship on the side of Macpherson. August Ebrard, an eminent German scholar, who made Celtic a special study, examined the texts of Macpherson minutely in both Gaelic and English, compared the narratives therein with the state of society in the third century (the supposed era of the *Feine*) and found the correspondence so remarkably exact that he was fully convinced that the poems of Ossian are genuine productions of that age. He gives many instances from the poems of beautiful Gaelic sentences changed in the English version into sheer nonsense owing to Macpherson's ignorance of the meaning of the Gaelic texts. He notices among other things that the *Lochlanaich* are always represented as carrying brown shields, while the Gaels bear blue ones, thus corresponding with the fact that the former in that age used bronze while the latter used steel. He points out that the war between Fingal and Swaran has been proved to be a historical fact. Ossian represents Swaran as landing in Ireland with a mighty host. Cuchullin, the guardian and regent of the young King Cormac, gives battle, without waiting for his allies, and is defeated. Fingal arrives by sea with his heroes, renews the war, and defeats Swaran, but provides him with a safe return to his own country. Suhm, the Danish historical investigator, proves in his Danish History that there was a king of West Gothland named Swaran, who, after several piratical voyages, fell into a war with Gram, King of Norway, in the year 240. Suhm places this voyage to Ireland in 238.

Another great German, Ehlert, takes an opposite view, and designates the poems of Ossian "the most magnificent mystification of modern times."

THE SUBJECT MATTER OF THE POEMS.

The Ossianic poetry deals with the mighty deeds of the heroes of the Feine, their generosity, magnanimity, hospitality—heroes who always resisted the proud and powerful, and gave protection to the weak under their swords. Their foes are various, among them "The King of the World," by which name may be designated the Emperor Severus. The Lochlanders were their sturdiest foes, and single combats between their respective kings, and great battles between their respective armies are described with a force and vigour never excelled in literature. Their victories are always won by personal strength and prowess ; never by great generalship. Strangers are always protected ; even their bitterest enemies, if found without friends in their territories, are unharmed. The prevailing sentiment was :—

" My foeman's life I never sought
If he desired to leave in peace."

This scrupulous hospitality is the sentiment that Sir Walter Scott ascribes to Roderick Dhu, when he describes him as protecting Fitzjames till he reaches Coilantogle Ford, and then challenging him to mortal combat. This was the sentiment of the starving peasants of Scotland, who for nine months protected the unfortunate Prince Charles with thirty thousand pounds " blood money " on his head.

These ancient songs lead us into a new and wonderful world : a world without Christianity, without formal religious belief ; where all modern ideas vanish ; a world without cities, or civilization in the modern sense of the word. Iron, steel, and implements of war are found in the country. The poems in many cases are full of genius, and are entirely free from the slightest tinge of immorality. The deaths of the heroes are delineated with the most exquisite tenderness ; their love is pure, disinterested affection, without the faintest taint of coarseness ; and they always afford protection to women, even at the risk of their own lives.

Gibbon, referring to a battle between the Emperor Severus and the Caledonians, supposed to be the subject of one of the Ossianic poems, where "the son of the King of the world," Caracal, fled from the arms of the Caledonian hero "along the fields of his pride" has the following :—

" Something of a doubtful mist still hangs over these Highland traditions ; nor can it be entirely dispelled by the most ingenious researches of modern criticism ; but if we could with safety indulge the pleasing supposition that Fingal lived, and that Ossian sung, the striking contrast of the situation and manners of the contending nations might amuse a philosophic mind. The parallel would be little to the advantage of the more civilized people, if we compared the unrelenting revenge of Severus with the generous clemency of Fingal ; the timid and brutal cruelty of Caracala with the bravery, the tenderness, the elegant genius of Ossian ; the mercenary chiefs, who from motives of fear or interest, served under the imperial standard, with the free-born warriors, who started to arms at the voice of the King of Morven : if, in a word, we contemplated the untutored Caledonians, glowing with the warm virtues of nature, and the degenerate Romans, polluted with the mean vices of wealth and slavery."

The topography of Scotland in almost every district, especially to the north of the Clyde, bears testimony to the prevalence in ancient times of Ossianic ideas. Every man, every woman, and I might say every child in the Highlands, even at the present day, is familiar with the names and deeds of the Fingalian heroes. Perhaps no name has ever been so familiar to Highlanders as the name of "Blind Ossian" (for it is believed that he was blind in his old age). I am told that this is also the case in Ireland, where the name is pronounced with the accent on the last syllable. In 1567, when Bishop Carswell printed the Gaelic prayer book, the first book printed in the Gaelic language, he complained that the people were so much taken up with the tales of the Feine that the clergy could not command their attention. "The Celts," he says, "desire and accustom themselves more to compose, maintain, and cultivate lying worldly stories concerning Finn MacCumhaill and the Feine rather than teach and write the faithful words of God." The clergy, if any, had good reason to denounce the tales in which the people took so much delight; and from which they found it so difficult to turn their attention to the Gospel. For at least five centuries, then, these names have been familiar throughout Scotland. We can see the grand figure of the Ossianic characters receding back into the ages till they were lost in the mists of antiquity, and have, to use the beautiful language of Tasso,

"Vanished to a fable and a sound."

The Book of Leacan contains a poem in very old Irish, which, probably, has come down from some period beyond the eleventh century; and which has been translated as follows :—

Whence the origin of the Gaidhil,
Of high renown in stiff battles?
Whence did the mighty stream of ocean
Waft them to Erin?

What was the land in which they lived?
Lordly men, the Fene;
What brought them for want of land
To the setting sun?

What was the proper name for them
As a nation?
By which they were called in their own land—
Sguitt or Gaidhil?

Why was Fene said to be
A name for them?
And Gaidhil—which is the better?—
Whence was it derived?

In the opinion of this writer the terms Gaidheal, Scot, and Feine were applied to the same people ; but the history of their origin was then as much a mystery as now. The opinion was that they came by sea, but the country whence they came was unknown.

Who then were the Feine? and what is the origin of the name? It has been suggested that it may possibly have some connection with that of the Finns : for the name Oscar is common in the North and is a royal name in Sweden. Or it may, say some, indicate a connection with the Pœni or Phœnicians, who in early times were frequent visitors to the British Isles. An old poem, published by the Ossianic Society of Dublin, on the battle of Gabhra (which there is every reason to believe was a real battle fought over thirteen centuries ago) speaks of "the Feine of Erin, the Feine of Albin, the Feine of Britin and Lochlan," as taking part in the conflict. W. F. Skene quotes this poem to prove that the Feine were a widely-extended nation, spreading even over Lochlan—that is, the country north and east of the Rhine, including Scandinavia. I venture the suggestion that perhaps Skene misunderstood the passage, and that the word was intended to be "fine," which means clan, tribe, or nation. The two words are much alike in sound and spelling, and the one could easily be taken for the other. The passage, therefore, may mean that the "nations" of Erin, Albin, Britin, and Lochlan were represented at that battle. This suggests another question, namely, Did the Gaidheil first speak of themselves as the "*fine*" or nation *par excellence*? If this be so when, in the course of ages, the meaning of the word was lost, the term which was first the common name for any tribe may have become the proper designation of the Gaelic-speaking race. The people of the Highlands never call themselves Scots. They are known among themselves as Gaidheil or Albanaich. The name of Scotland is Albin, and the part of it north of the Forth and Clyde, Gaidhealtachd, which is likely the name which the Romans attempted to pronounce, getting as near it as the word Caledonia.

As a specimen of this poetry allow me in closing this paper to quote a few lines from a translation to be found in the Highland Society's Report (which in this instance at least is certainly not equal to the Gaelic original) in which the poet describes the terrible impetuosity of Diarmid in battle, and his calmness and gentleness after victory ; the lines being also intended as a contrast between his life and death :—

"Thy strength was like the strength of streams in their foam ; thy speed like the Eagle of Atha, darting on the dun, trembling fawn of the desert. In battle thy path was like the rapid fall of a mountain stream, when it pours its white torrent over the rock, and sends abroad the gray mists on the wings of the winds. The roar of the stream is loud through Mora's rocks. Mountain trees, with all their moss and earth, are swept along between its arms; but when it reaches the calm sea of the vale its strength is lost, and the noise of its course is silent. It moves not the withered leaf, if the eddying wind doth not aid it. On eddying winds let thy spirit be borne, Son of Duino, to thy fathers, but light let the turf lie over thy beauteous form, and calm in the ground be thy slumbers."

MEMORANDUM ON THE MOVEMENT FOR RECKONING TIME ON A SCIENTIFIC BASIS, BY WHICH THE GREATEST POSSIBLE DEGREE OF SIMPLICITY, ACCURACY, AND UNIFORMITY WILL BE OBTAINABLE IN ALL COUNTRIES THROUGHOUT THE WORLD.

BY SANDFORD FLEMING, C.E., C.M.G., LL.D.

(Read 30th November, 1889.)

1. Notwithstanding the great advance which has been made during the present century, in all the Arts and Sciences and their application to the affairs of human life, the reckoning of time is still in a primitive condition in many countries and in an imperfect condition in every country. Difficulties have been developed since the introduction of rapid means of communication, through the twin agencies steam and electricity, which when examined prove that time is computed generally on principles which are untenable. The world's time-reckoning is in fact an exceedingly complicated combination; it is productive of confusion and the confusion is apt to be increased and intensified as population increases and lines of rapid communication are multiplied.

2. During the last ten years efforts have been made to overcome the evils referred to by establishing a remedial system on a sound scientific basis which would be acceptable to all nations and by which perfect accuracy, uniformity, and simplicity would everywhere be obtainable.

3. The subject has been carefully considered by many individuals and by Scientific Societies in Europe and America. It has been discussed at Geographical and Geodetic Congresses at Venice and Rome; and at Conventions of Scientists and practical business men in America. On all these occasions the solution of the problem has been promoted. As an outcome of these various meetings and efforts, the President of the United States, under the authority of an Act of Congress, invited the Governments of all civilized nations to appoint delegates to meet in conference at Washington to consider the whole question and take decisive action in respect thereto.

4. The Washington Conference embraced delegates from twenty-five nations, they had eight sessions, the first was held on 1st October, 1884, the last on 1st November following. After patient deliberation and discussion the object of this International Conference was accomplished by the

passage, with substantial unanimity, of a series of resolutions determining the principles upon which all the nations of the world may unite in the adoption of a universal system of reckoning time.

5. The important results of the Conference are the establishment of (1) a prime meridian for reckoning longitude, (2) a zero for time reckoning, and (3) a unit-measure of time to be common to the whole world.

6. The prime meridian corresponds with the Greenwich meridian.

7. The zero of time may be defined as the moment of mean solar passage on the anti-prime meridian.

8. The unit-measure of time, designated the universal day, may be defined as the interval between two successive mean solar passages on the anti-prime meridian.

9. The Conference determined that the hours of the Universal day shall be counted in a single series from zero to 24.

10. The Universal day, as defined by the Washington Conference, begins and ends at the same moment as the civil day at Greenwich, but it differs from the Greenwich civil day in respect to the numbering of the hours. While the Universal day has a single set of hours numbered from 0 to 24, the Greenwich civil day is divided at noon into halves, the half days before and after noon being subdivided into separate sets of hours, each numbered from 0 to 12 and distinguished as Ante-meridian and Post-meridian. Greenwich time is the local time so-called of the meridian of Greenwich. Universal time, on the other hand, is understood to be common to all localities, and the Universal day is held to be the date of the world.

11. Considerable progress has been made in the adoption of the principles of universal time and the practical success which has attended the application of these principles goes to show that the unification of reckoning by the several civilized nations can best be effected step by step.

RECKONING BY HOUR MERIDIANS.

12. The first important step is the adoption of the "Hour Zone System," commonly designated in America "Standard Time." It may be stated, that in the theory of Universal time the fundamental principle is unity, it is held that there is not more than one time in the whole Universe and that the idea of separate and distinct times in each separate locality is incorrect. While the essential principle of Universal time is indisputable it cannot be denied that a perfectly uniform notation of time throughout the entire globe comes into direct conflict

with our preconceived notions and habits of thought. The Hour Zone system is introduced as an easy means of transition from old to new ideas and it is found that by adopting Hour Meridians as local standards for reckoning, grave difficulties are in a large measure overcome without any violent departure from our inherited usages and prevailing customs. The hour zone system also furnishes the means of applying the correct principles of Universal time in ordinary affairs.

13. In the Hour zone system the circumference of the Globe is divided into twenty-four sections or zones. The central line of each zone is an hour meridian, and the hour meridians are fifteen degrees of longitude apart. The accompanying chart of the world on Mercator's projection shows the geographical position of the twenty-four hour meridians. They are numbered in consecutive order towards the west from zero, the anti-prime meridian.

14. The Hour zones theoretically extend seven and a half degrees of longtitude on each side of the hour meridians, but in practice that is by no means an essential rule. The boundary line of contiguous zones may be governed by national, geographical, or commercial circumstances.

15. As the earth rotates on its axis in twenty-four hours an hour elapses between the solar passage on each successive hour meridian, it is obvious therefore that if the reckoning in each zone be governed by its respective meridian, the reckonings everywhere will be directly related. There will be differences but the differences will in every case be known and they will invariably be multiples of an hour. Throughout the Globe there will be complete identity in the minutes and seconds. For example when the reckoning in the tenth zone is six hours twenty-five minutes, in the eleventh zone it will be five hours twenty-five minutes, in the twelfth zone four hours twenty-five minutes, and so on, each successive zone differing by an exact hour. Thus the only departure from complete uniformity in reckoning around the Globe will be in the numbers of the hours, but the numbers of the hours being governed by the numbers of the hour meridians, the passage to Universal time is simple and direct.

16. As the reckoning in the zone of the twelfth hour meridian corresponds with Universal time, the reckonings in all zones to the East of that meridian will be one or more full hours in advance of Universal time, and in all zones to the West of the twelfth hour meridian the reckonings will be behind Universal time. Universal time will be the mean of all possible reckonings under the hour zone system, and the Universal day the mean of all possible local days.

17. The hour zone system has been adopted for ordinary use in portions of the three Continents of Asia, Europe, and America. In 1887 an Imperial Ordinance was promulgated directing that on and after the first day of January in the year following, time throughout the Japanese Empire would be reckoned by the third hour meridian. The reckoning in England and Scotland is by the twelfth hour meridian, in Sweden the eleventh hour meridian is the standard, and quite recently it has been resolved in Austria-Hungary to be governed by the same meridian. Efforts are now being made to follow the same course in Germany and in other European countries. In North America the hour zone system has been in general use for six years. The reckoning of time being governed as follows, namely :—

By the 16th hour meridian in Nova Scotia and Prince Edward Island.

By the 17th hour meridian in New Brunswick, Quebec, Ontario, Maine, Vermont, Massachusetts, New Hampshire, Connecticut, New York, Pennsylvania, Rhode Island, New Jersey, Maryland, Virginia, North and South Carolina, Georgia, Florida.

By the 18th hour meridian in Manitoba, Keewatin, Minnesota, Wisconsin, Michigan, Iowa, Ohio, Illinois, Indiana, Kentucky, Missouri, Arkansas, Tennessee, Alabama, Mississippi, Louisiana.

By the 19th hour meridian in Assiniboia, Saskatchewan, Alberta, Athabasca, Montana, Dakota, Wyoming, Nebraska, Colorado, Kansas, New Mexico, Texas, Utah, Arizona.

By the 20th hour meridian in British Columbia, Washington, Idaho, Oregon, Nevada, California.

18. The adoption of the hour zone system has been the means of removing the chaos of local times which in many quarters previously caused much friction. Wherever the reckoning is governed by the same standard meridian there is complete uniformity in every division of time. In Japan, Central Europe, Great Britain, United States, Canada, and Mexico, identity of reckoning prevails. In all these countries the hours are struck at the same moment, the only difference is in the numbers by which they are locally known ; with that single exception every division of the day is simultaneous.

THE 24 HOUR NOTATION.

19. The second important step in regulating the reckoning of time throughout the world, is to abandon the division of the day into ante-meridian and post-meridian hours, separately numbered, and to substi-

tute a single series of hours numbered from 0 to 24. This change was resolved upon by the Washington Conference with respect to the Universal day.

20. The old practice of dividing the day into separate sets of twelve hours, however it arose, has not only no advantage to recommend it, but the usage has been found to have positive disadvantages, which have been brought into prominence within the past generation. The division of the day into halves, doubles the chance of error and tends to confusion in connection with the running of railway trains. The mis-print or mistake of a single letter, A.M. for P.M. or *vice versa* will easily arise to cause inconvenience, loss of time, possibly loss of property, or loss of life.

21. The 24 hour notation, so called, removes all doubt and uncertainty and promotes safety. Where it has been adopted in Canada there is no ambiguity, moreover the change has been effected without difficulty and without danger. The hours having a lower number than twelve are known to belong absolutely to the first part of the day, and those having a higher number to the afternoon and evening.

22. The 24 hour notation is strongly recommended by prominent men in Russia, Germany, Italy, Austria, Belgium, France, Spain, Great Britain, indeed, it may be said in every country in Europe. It is brought into daily use on the great lines of telegraph leading from England to Egypt, India, China, Australia, and South Africa. It is received with very great favour in America. It has been in use for nearly four years on 2354 miles of the Canadian Pacific Railway, and for nearly three years on the Canadian Government Railway, the Intercolonial, 986 miles in length. The Managers of these railways and all the employees speak of the 24 hour notation in the highest terms. It is the only system in use at this date north of the 49th parallel and west of the 89th meridian. There is not a Province in Canada where it is not already in use. It has been adopted on the railways in Nova Scotia, New Brunswick, Prince Edward Island, Manitoba, Assiniboia, Alberta, British Columbia, and partly in Quebec and Ontario; so satisfactory are the results of the new notation that it has been determined to extend its application, and it is expected that before long it will be in general use for railway purposes throughout the Dominion.

23. In the United States a strong expression of opinion in favour of the 24 hour notation has been obtained. The American Society of Civil Engineers, deeply concerned in the perfection of the railway system of the Republic, has, since the year 1880, taken an active interest in time reform. This Society led the way in preparing the minds of men for the general acceptance of the Hour Zone system six years ago, and since then it has

vigorously directed attention to the 24 hour notation. It has a special Committee, whose duty under the authority of the Society is to correspond with Railway Managers on the subject, and in every proper way to promote the adoption of the new notation. The communications which have been sent out by the American Society of Civil Engineers to the leading railway men throughout the country have elicited a very large number of replies. They embrace the opinion of, it is believed, a considerable majority of the managers of all the Railway Companies in North America, and of all who have been heard from about 97 per cent. are in favour of the adoption of the 24 hour notation in the railway service of the country at an early date. It is quite obvious that there is a widespread feeling in favour of the change, and it only remains for the General Time Convention, an organized body representing all the railways in the United States, to take decisive action in the matter, so that the new notation may be brought into use simultaneously in every section of the country.

24. Canada, in adopting the hour zone system and in introducing the 24 hour notation, has undoubtedly taken the lead in carrying into effect, in the most practical manner possible, the essential principles of Universal time. The 24 hour notation has likewise been introduced in the Railway service of China, and it is not a little remarkable that one of the oldest Eastern civilizations conjointly with the youngest Western civilization should set an example in breaking through the trammels of custom to inaugurate a reform which every intelligent person believes to be desirable. Universal time will be substantially adopted in North America so soon as the 24 hour notation is brought into use throughout the United States. There is but one step necessary to secure to Great Britain all the advantages of Universal time, that is the adoption of the 24 hour notation; this one reform concerns the railway system and railway travellers especially, and in a country where all travel more or less, I cannot but think that if English Railway Managers were informed as to the ease with which the change has been introduced in Canada and the satisfactory results which have followed, they would very speedily take means to obtain similar advantages. I am confirmed in this view by an examination of the letters which have been received by the Science and Art Department, South Kensington, copies of which I have been favoured with. These letters go to show that the resolutions of the Washington Conference on this subject are cordially favoured by the following important bodies and Departments, viz:

1. Royal Astronomical Society.
2. The Royal Society.
3. The Board of Trade.

4. The General Post Office.
5. The Eastern Telegraph Company.
6. The Eastern Extension Telegraph Company.
7. The Eastern and South African Telegraph Company.
8. The Society of Telegraph Engineers.
9. The Trinity House.
10. The India Office.
11. The Colonial Office.
12. The Admiralty.

To these may be added the Committee of Council on Education, and the Board of Visitors of the Royal Observatory, Greenwich. Indeed, I cannot learn that a single objection has been received from any quarter.

25. As the fundamental objects of the Washington Conference were to remove all doubt and ambiguity in time-reckoning, to prevent discrepancies, to secure simplicity and introduce uniformity, it is manifestly important that the changes proposed, supported as they were at the Conference by the representatives of twenty-five nations, and subsequently looked upon in so many quarters as in themselves intrinsically desirable, should without unnecessary delay be accepted, and, as far as practicable, put in force generally. The first important step is the selection of hour meridians and the adoption of the hour zone system. With these objects in view, the accompanying map has been prepared, it shows the position of the 24 hour meridians and indicates, in a general way, the country or section of country to which any particular hour meridian has greatest proximity. It would greatly advance the unification of time throughout the world, and greatly promote the common good of mankind if every nation with all convenient speed would take means to select the hour meridians on which its reckoning of time may be based. Appended hereto will be found a table indicating the hour meridians, which, in each case, may be found eligible for selection, but in a matter of this kind each nation must judge for itself.

26. I have mentioned what has been done in America, more especially in Canada, in furtherance of this movement. If means be taken to extend the use of the hour zone system to all the British possessions around the Globe they will, individually and collectively, participate in the advantages of a common reckoning of time. I venture to submit, suggestively, the appended list of the principal British Colonies and Dependencies with the hour meridians which appear the most suitable for standards in each case.

BRITISH POSSESSIONS.

Table indicating the Hour Meridians, numbered as on the accompanying Map, which may be selected as local Standards for reckoning time in each of the several British Possessions.

The last column gives the differences between local reckonings and the time of the world—Universal Time. The sign PLUS indicates that local reckonings are in advance of, and MINUS that they are behind, World Time in each case.

COUNTRIES.	Hour Meridians.		Hour Zone Reckonings faster or slower than World Time.
	East or West of Greenwich	Numbered on Map.	
The British Islands (comprising)—			
England and Wales - - -	0	12	0 Hours
Scotland - - - - - -	0	12	0 "
Ireland - - - - - -	0	12	0 "
Canada (comprising) —			
Nova Scotia - - - -	60 West	16	— 4 "
New Brunswick - - - -	75 West	17	— 5 "
Prince Edward Island - - -	60 West	16	— 4 "
Quebec - - - - - -	75 West	17	— 5 "
Ontario - - - - - -	75 West	17	— 5 "
Manitoba - - - - - -	90 West	18	— 6 "
Assiniboia - - - - - -	105 West	19	— 7 "
Saskatchewan - - - - -	105 West	19	— 7 "
Alberta - - - - -	120 West	20	— 8 "
Athabasca - - - - - -	120 West	20	— 8 "
British Columbia - - - -	120 West	20	— 8 "
Australasia (comprising)—			
New South Wales - - -	150 East	2	+10 "
Victoria - - - - - -	150 East	2	+10 "
Queensland - - - - -	150 East	2	+10 "
Tasmania - - - - - -	150 East	2	+10 "
South Australia - - - -	135 East	3	+ 9 "
Western Australia - - -	120 East	4	+ 8 "
New Zealand - - - - -	165 East	1	+11 "
Fiji - - - - - - -	165 East	1	+11 "
New Guinea - - - - -	150 East	2	+10 "
Possessions in Asia (comprising)—			
India - - - - - - -	75 East	7	+ 5 "
Burmah - - - - - -	90 East	6	+ 6 "

BRITISH POSSESSIONS.—(*Continued.*)

COUNTRIES.	Hour Meridians.		Hour Zone Reckonings faster or slower than World Time.
	East or West of Greenwich.	Numbered on Map.	
Ceylon - - - - -	75 East	7	+ 5 Hours
Hong Kong - - - -	120 East	4	+ 8 "
Straits Settlements - - -	105 East	5	+ 7 "
Labuan - - - - -	120 East	4	+ 8 "
West India (comprising)—			
Jamaica - - - - -	75 West	17	— 5 "
Turks Island - - - -	75 West	17	— 5 "
British Guiana - - - -	60 West	16	— 4 "
Bahamas - - - - -	75 West	17	— 5 "
Trinidad - - - - -	60 West	16	— 4 "
Barbadoes - - - - -	60 West	16	— 4 "
Granada - - - - -	60 West	16	— 4 "
British Honduras - - -	90 West	18	— 6 "
St. Vincent - - - - -	60 West	16	— 4 "
St. Lucia - - - - -	60 West	16	— 4 "
Tobago - - - - -	60 West	16	— 4 "
Antigua - - - - -	60 West	16	— 4 "
Montserrat - - - - -	60 West	16	— 4 "
St. Christopher - - - -	60 West	16	— 4 "
Virgin Islands - - - -	60 West	16	— 4 "
Dominica - - - - -	60 West	16	— 4 "
Possessions in Africa (comprising)—			
Cape of Good Hope - - -	30 East	10	+ 2 "
Bechuanaland - - - -	30 East	10	+ 2 "
Basutoland - - - -	30 East	10	+ 2 "
Natal - - - - - -	30 East	10	+ 2 "
Sierra Leone - - - -	15 West	13	— 1 "
Gambia - - - - -	15 West	13	— 1 "
Gold Coast - - - - -	0	12	0 "
Lagos - - - - -	0	12	0 "
Miscellaneous (comprising)—			
St. Helena - - - - -	0	12	0 "
Gibraltar - - - - -	0	12	0 "
Malta - - - - -	15 East	11	+ 1 "
Cyprus - - - - -	30 East	10	+ 2 "
Bermuda - - - - -	60 West	16	— 4 "
Falkland Islands - - - -	60 West	16	— 4 "
Heligoland - - - - -	15 East	11	+ 1 "
Aden - - - - -	45 East	9	+ 3 "
Ascension - - - - -	15 West	13	— 1 "
Fanning Island - - - -	150 West	22	—10 "
Mauritius - - - - -	60 East	8	+ 4 "
Newfoundland - - - -	60 West	16	— 4 "

FOREIGN COUNTRIES.

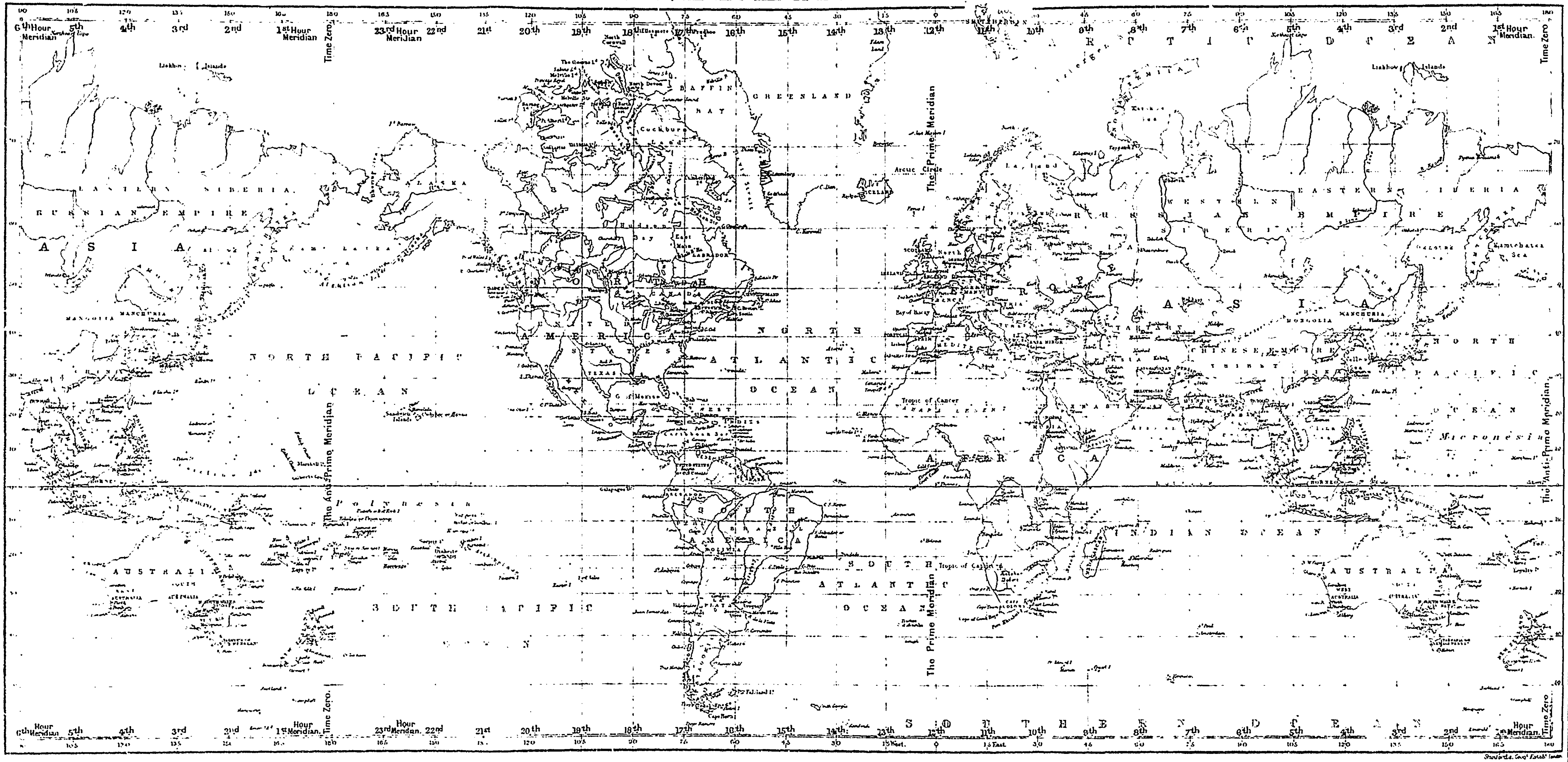
Table showing the Hour Meridians numbered as on the accompany· map and conveniently situated for reckoning time under the Hour Zone system.

The last column gives the differences between local reckonings and the Time of the World—Universal Time.

The sign PLUS indicates that local reckonings are in advance of, and MINUS that they are behind, World Time in each case.

COUNTRIES.	Hour Meridians.		Hour Zone Reckonings faster or slower than World Time.
	East or West of Greenwich.	Numbered on New Map.	
Argentine Republic	60 West	16	— 4 Hours
Austria Hungary	15 East	11	+ 1 "
Belgium	0 —	12	0 "
Bolivia	60 West	16	— 4 "
Brazil	45 West	15	— 3 "
"	60 West	16	— 4 "
Bulgaria	30 East	10	+ 2 "
Costa Rica	90 West	18	— 6 "
Chili	75 West	17	— 5 "
China	120 East	4	+ 8 "
"	105 East	5	+ 7 "
Columbia	75 West	17	— 5 "
Congo	15 East	11	+ 1 "
Denmark	15 East	11	+ 1 "
St. Domingo	75 West	17	— 5 "
Egypt	30 East	10	+ 2 "
France	0 —	12	0 "
Germany	15 East	11	+ 1 "
Greece	30 East	10	+ 2 "
Hawaii	150 West	22	—10 "
Honduras	90 West	18	— 6 "
Hayti	75 West	17	— 5 "
Italy	15 East	11	+ 1 "
Japan	135 East	3	+ 9 "
Mexico	105 West	19	— 7 "
Netherlands	0 —	12	0 "
Nicaragua	90 West	18	— 6 "
Norway	15 East	11	+ 1 "

THE WORLD ON MERCATOR'S PROJECTION, SHEWING THE 24 HOUR MERIDIANS FOR REGULATING STANDARD TIME.



FOREIGN COUNTRIES.—*(Continued.)*

COUNTRIES.	Hour Meridians. East or West of Greenwich.	Hour Meridians. Numbered on Map.	Hour Zone Reckonings faster or slower than World Time.
Paraguay - - - - -	60 West	16	— 4 "
Persia - - - - - -	60 East	8	+ 4 "
Peru - - - - - -	75 West	17	— 5 "
Roumania - - - - -	30 East	10	+ 2 "
Siam - - - - - -	105 East	5	+ 7 "
Servia - - - - - -	30 East	10	+ 2 "
Spain - - - - - -	0 —	12	0 "
Sweden - - - - - -	15 East	11	+ 1 "
Switzerland - - - - -	15 East	11	+ 1 "
Turkey - - - - - -	30 East	10	+ 2 "
Russia in Europe - - - -	45 East	9	+ 3 "
" - - - - -	30 East	10	+ 2 "
Russia in Asia - - - -	165 East	1	+11 "
" - - - -	150 East	2	+10 "
" - - -	135 East	3	+ 9 "
" - - - -	120 East	4	+ 8 "
" - - - -	105 East	5	+ 7 "
" - - - -	90 East	6	+ 6 "
" - - - -	75 East	7	+ 5 "
" - - - -	60 East	8	+ 4 "
Uruguay - - - -	60 West	16	— 4 "
United States - - - -	75 West	17	— 5 "
" - - - -	90 West	18	— 6 "
" - - - -	105 West	19	— 7 "
" - - - -	120 West	20	— 8 "
Alaska - - - - - -	135 West	21	— 9 "
" - - - - - -	150 West	22	—10 "
Venezuela - - - - -	60 West	16	— 4 "

NOTE.

RESPECTING THE HOUR MERIDIANS AS NUMBERED ON THE MAP.

It is obviously desirable that the hour meridians or sub-standards for reckoning time by all nations should be designated in a manner to render them easily distinguishable and readily known throughout the world. A nomenclature based on geographical terms or derived from local names, however appropriate in one country, may in another, or in an opposite hemisphere be quite inapplicable. Moreover, not only would differences of opinion arise as to the appropriateness of such terms, but owing to the diversity of languages among the nations, the difficulty of selecting names universally acceptable would be so increased as to render a common agreement respecting them scarcely attainable.

These objections do not apply to numbers. A nomenclature based on numbers would be common to all nations, and each term would have the same precise meaning in all languages and in both hemispheres. The numbers given to the hour meridians as shown on the map, begin at zero and follow the sun in its apparent motion. The solar passage on the anti-prime meridian being the zero of the "universal" or "world" day, at the end of the first hour the solar passage would be on the first hour meridian, at the end of the second hour it would be on the second hour meridian, and so on for each of the twenty-four hours; the hour in each case agreeing with the number of the hour meridian at the instant of mean solar passage. Then it will be evident that with the hour meridians so numbered the solar passage would be the perpetual index of "world" time.

The notation of time in the zone of the twelfth hour meridian will correspond with the numbers of the hours of the "world's" standard, in all other zones it will differ according to a fixed rule. In zones to the east of the twelfth hour meridian, the notation will be in advance, in zones to the west it will be behind; the following formula gives the number of hours which it will be *faster* or *slower* than the world's standard in each case.

Let H be the number of the hour meridian: then

(1) When H is less than 12, the clocks in (H) zone will be faster than the world's standard $= 12 - H$.

(2) When H is greater than 12, the clocks in (H) zone will be slower than the world's standard $= H - 12$.

The world's standard will be the mean of the notation in all zones.

The principle of this simple means of distinguishing the twenty-four hour meridians constituting the sub-standards for regulating the reckoning of time the world over, and the advantages to accrue from its universal acceptance and application are further explained in the Smithsonian Report for 1886, pages 3[illegible]-2.

THE FORMATION OF TORONTO ISLAND.

BY L. J. CLARK, ESQ.

(Read 26th April, 1890.)

My attention has been somewhat abnormally directed towards the lake, and to lake surroundings, and lake currents during the last two or three years, and, in the course of my investigations, I became aware that there were different theories, particularly as regards lake currents and Island formation. Without very much external aid on the subject, but by a careful process of deductive reasoning, I formed a theory, which, like all young theorists, I considered quite unassailable, and which I still view in the same light, but, alas, my theory is not new.

I have found, since making a more critical study of the subject, that it received a very large share of attention nearly half a century ago, by men who have made a name and fame for themselves, not only in Canada, but in other lands as well, in connection with questions of world-wide interest, in one instance at least, and who are still alive and in a position to compare their past theory of what the future of the Island would be with what it really is. I refer to such men as Mr. Sandford Fleming, Mr. Kivas Tully, Mr. Henry Yule Hind, and Mr. Hugh Richardson.*

I find there is quite a wealth of literature on the subject, which I have read with great interest, and which in the main agrees as to the source whence the material, forming the Island, is derived. I have also placed under contribution that never failing source of information, "the oldest inhabitant," and I now place before you the united results of my cogitations on the subject.

At the outset, I will call attention to two theories that have been put forward, but which on examination, I think, will be found insufficient for the purpose. The *first* is that the Niagara River has been a factor in the Island formation in this way. It is said that the direction of the river at its mouth is in a line with Scarboro' Heights, that the great volume of water makes straight across the lake, strikes the north shore, deflects to the west, and carries along the material from the Heights, of which the Island is formed. I heard a gentleman say that this was the

* Mr. Richardson is dead.

producing cause, and that the portion of the Island around where the lighthouse stands was the first to make its appearance.

To disprove this theory, it is only necessary to say that the velocity of the waters of the Niagara River at its mouth is not sufficient to transport the weighty materials of which the greater part of the Island is formed. To move the heavy shale, which forms a considerable part of the Island, would require a velocity of from five to eight feet per second. So that, if it lost none of its velocity in crossing it would not be able for the work. But that is in the region of the unthinkable. It is pretty well established that the temperature of the water of the Niagara River is raised one or more degrees, by the concussion of the Falls and the rough treatment it receives in coming through the rapids. It would, consequently, be lighter than the water of Lake Ontario, and would spread out, to a certain extent, over the surface, and thus, through increased friction, lose a part of its velocity. This has been well established by the fact that after great freshets that have been sufficient to give turbidity to the water of the river, it has been noticed that five miles out from the shore the discolored water has extended five miles to the east and west. By the time it would get across it would be a mere attenuated film on the surface of the lake, weak in its current and subject to the influence of every "breeze that blows." So that we may hardly look for it to gather up its dissipated energies for the herculean task of building up the Island. But the very fact that the Niagara River deposits its detritus in a bar near its own mouth ought to be sufficient evidence that it will not have strength to load up again when it gets across to this side. Mr. Fleming says "such a theory is wild and incapable of defence, though some are bold enough to venture it."

The other theory is that the material has been brought down by the Don, Humber and other streams to the west. But this theory fails as far as the Humber and Mimico Rivers are concerned, inasmuch as there is a depth of 90 feet of water between the outlet of the Bay and the Lighthouse Point, across which it would be impossible to transport the material of the Island without leaving some traces on its route.

And if the Humber has excavated its huge channel for 30 miles or more in length, and from ¼ to ½ a mile in width, and from 100 to 200 feet in depth, without contributing directly to the formation of the Island, we may naturally suppose the same of the Don.

I say directly, because I believe these streams have contributed to the stratum of clay that underlies the Island and extends out to an unknown distance into the lake.

In this connection, it is interesting to investigate the history of these streams. And, in order to do so, it will be necessary for us to go back to a period anterior to the subsidence of the waters to their present level. All indications point to an ancient lake beach at the foot of the cliff or terrace, which is situated just north of the present limits of Toronto, and which runs parallel with the shore at a distance ranging from nothing at Scarboro' Heights to two or three or more miles in other places. The evidence is pretty strong that the water remained at this level for a somewhat lengthened period. And here I must call attention to a difference of opinion entertained by our two previously mentioned friends, Mr. Fleming and Mr. Hind. Mr. Hind interprets Mr. Fleming to say, that at the time of the subsidence of the water to its present level the Don began to exist. Mr. Hind takes exception to that view, and I think correctly. For we cannot imagine the large section of land, forming nearly the whole of this Province as at present, without any water-courses. But, on the contrary, the first acre that appeared above the surface of the water would have its miniature streams, and, as the continent gradually emerged from the water, these channels would become longer and broader and deeper. And I believe that when the lake stood at its former level, the Don, Humber and other streams existed pretty much as they do now, the only difference being that their mouths were situated at the then existing shore-line. Remember, I do not say that Mr. Fleming says what Mr. Hind says he does.

Now, we can easily discover what became of the immense amount of detritus brought down by those streams. It formed the present site of Toronto, and the stratum of clay that extends out under the Island and to an indefinite distance beyond. The sandy portions we find deposited first near the ancient beach and the clay farther removed, and as we would naturally expect, the Humber being the mightier of the two rivers, the greater was the amount of material brought down, and the more would the bed of the lake be filled up, so we find the land higher in proximity to the Humber, and the descent is from the west to the east. This accounts for the numerous ravines that were washed out in the present site of Toronto after the subsidence of the water, all having a general direction from N.W. to S.E. One word more as to what caused the subsidence of the water to its present level. The writers I have previously referred to, do not throw much light on that part of the subject but, fortunately the President of the American Association for the Advancement of Science, in a lecture delivered in this city last year, showed very conclusively that it was owing to the melting away of an immense glacier or ice-field that extended along our northern shore and cut off the exit of the water by the St. Lawrence. Previous to that time, it is supposed the water of the great chain of lakes found its way to the sea by an outlet in a south-easterly direction, through Rome—this is not the one we hear so much about in politics—and Utica, and down the Hudson River. When this great barrier melted away, the outlet took its present course, and the lake assumed its present level.

On the subsidence of the lake to its present level, all the Don and other streams had to do was to excavate from their former terminus to the new shore line. And I would call the attention of my hearers to the much more ancient appearance of the banks of the Don, for instance, in what I may style the old part than the new. This may be very well seen on some of the C.P.R. bridges that happen to be near or at the terrace.

Now, having told you how the Island was *not* formed, I shall endeavor to tell you briefly how it *was* formed; and, in doing so, I shall keep very close to Mr. Fleming's exposition of the case. The other writers referred to all give Mr. Fleming the credit for first enunciating the true solution of the problem. And I cannot do better than call your attention to a copy of some of the maps and drawings that he has used to explain his theory.

The limited time at my disposal will only allow me to make brief reference to the salient features of the probable solution.

First, the material of which the Island is formed came originally from the Scarboro' Heights;

Second, the mechanical force which transported the material to its present resting place was the storm action of the waves, which is now as active as ever.

In proof of the first premise we find the material on all parts of the Island to be identical in its nature with that composing the Heights: Prof. Pike informed me that he had made an examination of the material from both places and he found them to be of the same geological formation. Then its continuous connection, until recently, with those cliffs to the east, is also evidence to the same effect.

In proof of the second premise, we have the well authenticated fact of the gradual extension of the Island to the westward. Mr. Hind points out that previous to his time it was ascertained that thirty acres had been added to Lighthouse Point from the time of the first surveys. I was credibly informed, a few days since, by an old citizen that he remembered when the Lighthouse was close to the beach.

Wave action on a beach is tolerably well understood. When the direction of the wave or wind is perpendicular to the beach the effect is entirely destructive. The waters, in their agitation, become loaded with sand and other material, which it bears away as the waves recede, and which it deposits at various distances from the shore according to its fineness or coarseness. Some of it will be carried out to such deep water as to be beyond the influence of the waves to bring it back again. This is entirely destructive. But when the waves inpinge on the beach at an angle it causes an onward movement of the material of the beach. This is clearly shown in Figures I. and II. The particles held in suspension are thrown up the incline in the direction of the wave, and when the force is spent it moves back towards the water-line in the most direct course, that is perpendicular. The lighter parts will be carried higher and moved to a greater distance forward as shown in Figure II. Thus we find the fine sand away to westward, while the heavier portions remain along the bar in front of Ashbridge's Bay.

During violent storms, astonishing changes take place in the beach. A summer sojourner at Balmy Beach informed me that, during the great storm of 1885 or 1886, when the Lake Shore Road, near the Humber, was washed away, the whole of the beach from the Heights to the head of Ashbridge's Bay, with the exception of a few hundred feet in front of his own place, was washed away. The same gentleman informed me that large boulders, sometimes weighing hundreds of pounds made their appearance after storms and became permanent landmarks, unless taken by the pleasure-seekers of the locality to form rockeries to adorn their front yards.

This shows the great transporting power of water when in motion. But proof of that need hardly be cited at this day when some of the greatest disasters to life the world has ever known, have been attributable to the uncontrolled fury of water when broken loose from its bounds, as, for instance, the Johnstown disaster.

Mr. Sandford Fleming supposed that when the last subsidence of water took place, instead of there being an abrupt cliff at Scarboro', as at present, the land fell off in easy slopes to the water's edge, as shown in Figures III. and IV. Then, owing to the long reach of 180 miles of lake to the east, the immense waves raised by the easterly winds began to produce their abrading effects on said promontory, and the abraded material was carried and deposited to the west, forming a spur, as in Figure V. The same action continuing produced results as shown in Figures VI., VII., and VIII., until we have our present harbor.

Mr. Hind takes objection slightly to Mr. Fleming's view of the promontory extending such a distance into the lake. He bases his objection on the fact that the depth of water at about one mile from shore is 48 feet,—I verified this fact myself last summer, so that there has been little change in 40 years,—and this he considers to be below the depth at which wave action would be felt, or produce much effect. And this seems reasonable, for at a distance of about 2000 feet from shore we meet with a ridge, the top of which is only about 26 feet below the surface, although on either side it quickly falls away to 33 feet. Now, if the waves had much of an erosive effect at over 26 feet in depth, it would probably remove the top of this ridge, but I found it there last summer just where Mr. Rust found it several years ago when taking soundings of that part of the lake.

But, on the other hand, it occurs to me that if the cliff had formerly extended only a few hundred or even a thousand feet farther south than at present, the bar which now encloses Ashbridge's Bay, would have been driven right on the mainland and have formed a beach, as there appears to have been no stream there sufficient to head it off, as the Don might be capable of doing when it got further west. However, this is not a point of vital importance to the existence of the Island.

It may be claimed that storms from the west would have a counteracting influence. Of course they would, but only in the ratio of 40 : 180, other things being equal. And this, no doubt, accounts for the somewhat peculiar coast-line on the city side of the Island. High and low lake level periods, which have been known to recur at irregular intervals, also had something to do with the irregularity of the said coast-line. According to the American Engineer's Report, between the years 1825 and 1838, Lake Ontario rose nearly 7 feet and Lake Erie nearly the same, which would change the appearance of the Island very much. But it is not necessary to pursue that phase of the subject further.

The phenomena of travelling beaches and deposits, similar to the one under consideration, are by no means rare. One, on a small scale, that came under my own observation, and with which many of you may be familiar, occurs near Grimsby, at what is called the lily pond. The cliffs to the east consist of drift clay containing small fragmentary portions of rock entirely unwater-worn. As the cliff becomes undermined, portions break loose and fall into the water. The clayey portions become dissolved, and are carried out to be deposited on the lake bottom, while the fragmentary rocks become water-worn, and are driven westward where they have formed a ridge six or eight feet in height and fifty feet in width across the mouth of the pond, leaving the opening at the very western side.

Another place I visited last summer, viz.: Irondequoit Bay, near Rochester, presents a similar feature. Mr. Hind calls attention to it in 1854. He says that the opening was then ¼ of a mile farther west than it was formerly, and was becoming shallower.

The mouth of the Aux Sables, in Lake Huron, presents a remarkable illustration of the onward progress of a beach in the direction of the prevailing winds.

Rondeau Harbor, in Lake Erie, is almost a fac simile of Toronto Harbor, and many other examples will occur to you on a little reflection.

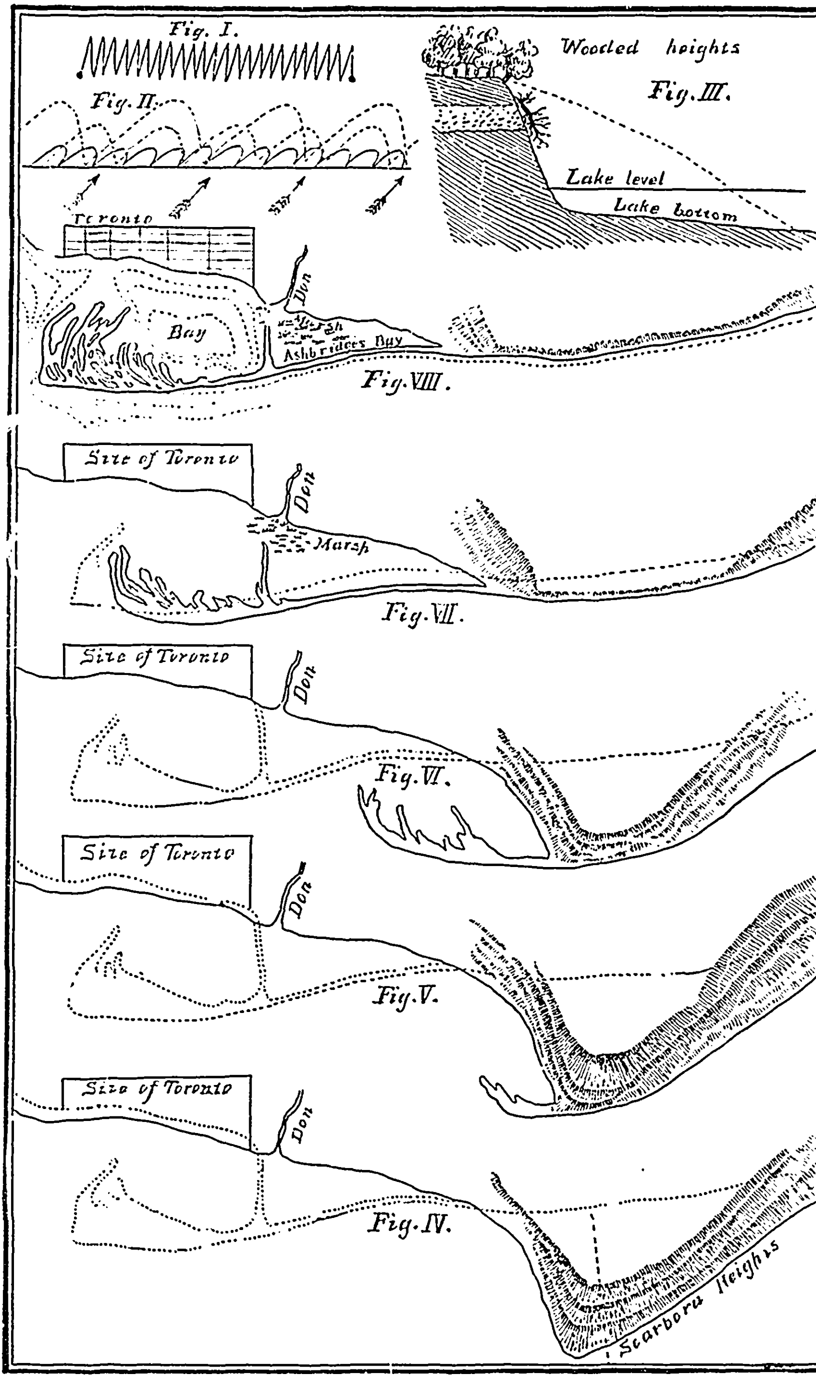
If I had time, I would like to call attention to the formation of the marsh. In the early history of the Don, no doubt, it poured its waters directly into the lake, while the spur, shown in Figure V., was in its infancy, and, at the time it was following Greeley's advice under the powerful influence of the easterly storms, the Don was also trying to obey the same injunction by turning, if not its face, at least its mouth toward the west. But the embryo Island grew more rapidly and soon overhauled the Don, and after a lengthened period of high lake level during which time the young giant was working unseen, came a period of low level, when the Don found its progress menaced by the spit of sand running northward to near the site of the old windmill. I have examined various maps of Toronto for the purpose of obtaining light on this part of my subject. The earliest is Bouchette's, which was made in 1793. This shows that the bar running northward had entirely closed the present mouth of the Don, and that another mouth existed about half way between the mainland and the present gap. At this time, I believe, began the deposits which formed the marsh.

Mr. Lawson, tea merchant, King Street, informs me that he remembers both mouths, the latter being called the big mouth.

Before the Island afforded the protection it does at present these mouths may have been constantly shifting, and at times both may have been closed up. Indeed, some writers tell us distinctly that such has been the case, and that the water of the Don had no visible out-let, but made its way out by filtration through the bar. At such a time sedimentation would go on rapidly.

This is pretty much my own theory—at least I don't saddle it on any one else, though others may have a prior claim to it.

However interesting the subject of the Island formation may be to the scientist, Island preservation is of far greater interest to the financier and business man of Toronto. The reports that reach us of the destruction going on at the east end of the Island are of an alarming character, and it behooves our city guardians to take steps for its preservation before our beautiful Island vanishes from our sight.



Drawing Showing the Development of Toronto Harbor.

CONTRIBUTIONS TO THE MORPHOLOGY AND PHYSIOLOGY OF THE CELL.

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(Read 15th November, 1890.)

In the interior of the epithelial cells of the alimentary canal, and in the glandular cells of the pancreas in amphibia, are usually found structures which are of great interest to both the morphologist and the physiologist. Typical examples of these occurring in the gastric mucosa of the salamander have been described and illustrated by Lukjanow,* and one has but to glance over the figures he has given in order to gain an idea of the number and variety of these bodies. They are much more abundant in the intestinal than in the gastric epithelium of a well-nourished animal, and, so far as my observations go, they present, on the whole, a greater complexity of form than those described by Lukjanow. What is the significance of these bodies? With the exception of some of the intranuclear forms, they can, I believe, be arranged in the three following divisions :

1. Parasites.
2. The remains of broken-down cells and nuclei swallowed by the healthy adjoining cells.
3. Material swallowed by the epithelial cell from the food passing over its free surface (in the case of the intestinal epithelium).
4. Plasmosomata migrated or extruded from the nucleus (only in the glandular cells of the pancreas).

It is, no doubt, impossible, in many cases, to determine to which of these classes this or that particular body belongs since intracellular parasites simulate plasmosomata and kindred structures in some stages of their existence, and I propose, therefore, to treat of the structures in a general way, pointing out, wherever possible, their relationship to one or other of the classes given above excepting, however, those connected

* Beiträge zur Morphologie der Zelle—Arch. fur Anat. und Phys., Suppl. Bd. zur Phys. Abth., 1877, p. 66.

with division 3, the treatment of which I postpone until I have finished my experiments on the methods of the resorption of chromatins (*Nucleins*).

To illustrate the parasitic nature of some of these forms, I will now describe undoubted examples of intracellular parasites from the intestines of the spotted newt and the lake lizard (*Necturus*).

I. A CELLULAR PARASITE FROM THE INTESTINAL EPITHELIUM OF DIEMYCTYLUS VIRIDESCENS.

In April of this year I obtained from the neighborhood of Toronto a number of spotted newts for the purpose of studying the phenomena of secretion in the pancreas and in making preparations of this organ I found it frequently convenient, on account of the small size of the animal and its organs, to include the anterior portion of the intestine. In the intestinal epithelium of one of the newts was found a large number of forms like those shown in Figures 3 and 4, and I immediately endeavored to work out their history. Before detailing the results of this work it may be well to state that the particular object from which the sections studied were made was hardened in Flemming's Fluid and alcohol, stained *in toto* with hæmatoxylin, imbedded by the chloroform process in paraffin, the sections therefrom placed in series on the slide and stained with eosin and safranin, before being permanently mounted in balsam.

The structures in question are so numerous that every second or third epithelial cell, for long stretches of the section, contained one of them. They are always placed in the outer half of the cell between the nucleus and the free border, and have a nearly uniform diameter (9-11μ, averaging 10μ) and an approximately spherical shape. They do not appear to have a definite or distinct membrane, and what takes its place appears to be a zone of homogeneous or faintly granular protoplasm which, in many cases, is denser and thicker at one side of the body than at any other. From this zone trabeculae of granular protoplasm pass inwards to terminate in a more or less centrally placed protoplasmic mass. In a number of these bodies sufficient to render the peculiarity prominent, the bulk of the protoplasm is collected at one side (Fig. 5), while the thicker portion of the protoplasmic rim occupies the opposite side with a large crescentic, oval, or round cavity intervening. The protoplasmic mass stains lightly but readily with eosin and contains a round homogeneous nuclear body, which stains deeply with safranin and measures less than 2μ (1.5μ). Sometimes the nuclear body is placed in a cavity in the protoplasmic mass and connected with the latter by a few fine strands. In a few instances, the nucleus was surrounded at a distance by a distinctly marked membrane which, however, may have been only a thickening of the protoplasm bordering the cavity in which the nucleus was situated.

Not so common, but still quite readily seen, are forms like that represented in Fig. 5, in which, in place of a single nucleus, there are a large number (over twenty) of safranophilous spherules, each surrounded by a small quantity of finely granular protoplasm and marked off from the rest of the mass by a delicate membrane (Fig. 8*d*.) These spherules are homogeneous and measure much less than 1μ. Fig. 6 apparently represents a later stage of the same body, and in this one sees that the homogeneous spherules have become transformed in such a way, that the stained material in each is arranged in a horseshoe or crescentic form, according to the specimen examined (Fig. 6, 7, 8*e*). The comparative scarcity of these forms, the very small size of the objects and the absence of a sharply defined contour to the stained material, render it extremely difficult to determine this arrangement satisfactorily in many cases, but in thin and well stained sections, and ith good objectives (2mm. immersion apochromatic, Zeiss), forms like those figured appear now and then.

There can, I think, be no doubt about the parasitic nature of these intracellular bodies, and we may, therefore, regard the stage described in the last paragraph as that of sporulation.

I endeavored to determine the mode of transition from the stage in which there is a single nucleus to that of sporulation. It was not an easy subject for study, because, for every hundred that one observes belonging to both stages, there are not more than one or two forms that can be ranked as transitional. Two of such are represented in Fig. 8*b* and *c*. I have been led to consider them as stages in the formation of spores, because they present structures which resemble somewhat karyokinetic figures. For example, in the form represented in Fig. 8*b*, the centrally placed stained body may be regarded as belonging to the dyaster stage and seen from one of the poles; in it also structures, bearing a resemblance to individual chromatin loops, can be made out. This arrangement comes out well sometimes in preparations stained with hæmatoxylin and safranin, but oftener the safranophilous substance is collected in a ring form resembling, to a certain extent, the equatorial plate of nuclear division. Probably the explanation of Fig. 8*c* is that it represents a multiple form of karyokinesis. The difficulty of determining the nature of such conditions will be readily understood, when it is remembered that the safranophilous bodies are usually not 2μ in diameter, and that, consequently, its metamorphic elements must be very small.

If the determination of the division of the n .eus is difficult, much more so is that of the full history of the spores. They are so small at first that, apart from the mother organism, they cannot be distinguished from other cellular contents, such as the swallowed portions of the debris of neighboring cells and the spore stages of other parasites. It is only in a few cases that circumstances favor the determination of some of the forms after they have escaped. In Fig. 1, for example, is shown a cavity in the interior of a cell, evidently once occupied by the parasite in question, and in the neighborhood of the cavity is a number of bodies like plasmosomata, of similar, or nearly similar size. These are evidently the spores derived from the organism which occupied the cavity. In a few instances, with the best conditions for observation, forms, like those shown in Fig. 9*a*, are seen. Here the structures are comma-shaped, and their resemblance to other forms in the same Figure, to that of Fig. 10*a* and to those in Fig. 2, is such as to suggest a developmental relationship. The probability, however, that very young forms of Sporozoan parasites are similar to those represented in Fig. 9*a*, is sufficient to invalidate any conclusion that might be drawn from this resemblance.*

There is more certainty in regard to the larger comma-shaped forms, such as are shown in Figs. 2 and 10*a*. These are intensely safranophilous bodies, and measure from 3 to 6μ. Their outlines are sometimes distinct, sometimes not, this depending on the way in which the organism is disposed in the field of the microscope. If the tail should happen to be above or below the head of the comma th. organism may be recognised with difficulty. The connection between these and the spherulating forms can be seen by glancing at Fig. 10 *a–h*. In further development the head of the comma enlarges, the safranophilous substance collects into a small round mass, leaving the protoplasm which contained it more or less coarsely ret: .ulated or finely granular, and with feeble staining capacity. The tail still retains its safranophilous character and remains distinct for several stages. The space between it and the head tends to increase when its point becomes applied to the head (Fig. 10*c*). At the same time it becomes somewhat elongated (*d*), and the safranophilous substance in it condenses into a thin band bounding the convex side of the crescentic cavity. The head also undergoes further changes (*e*). The protoplasm becomes collected at its periphery as a rim to which the small round safranophilous mass, the nucleus, is attached by delicate protoplasmic strands. In the next stage protoplasmic strands may stretch across the crescentic cavity, to the remains of the tail or the point of the

*Compare with Steinhaus' Figures of the intracellular parasites in the pancreas of the Salamander, Ziegler's Beiträge Zur Path. Anat., Bd. VII., Taf. XI.

tail may fuse with the head; in the latter case the crescentic cavity persists (*l*). The safranophilous substance gradually disappears from the thin band representing the remains of the tail, till finally its staining capacity is scarcely marked in some of the forms, although its density is noticeable. This sketch of the organism developed out of the comma-shaped body explains thus the occurrence of a denser, frequently more deeply staining zone at one side, the presence of a crescentic cavity, or of a cavity next the zone, and the frequently excentric position of the nucleus in the adult organism (Figs. 3 and 4). In individual cases, in which these peculiarities are apparently wanting, it may be that they cannot be observed, because the organisms are not favorably placed in the microscopic field.

We can, I think, now account for many of the forms shown in Fig. 9, especially those in which a deeply stained crescent occurs with a sphere in its cavity—they are merely comma-shaped parasites in the process of transformation into that stage in which sporulation takes place. In the same way we may explain some of the forms illustrated by Lukjanow,* especially his Figs. 14, 15, 16, 61*a* and *b*, 66, 72, 74 and 75, and probably also Figs. 7, 11, 13, 68, 69, 77 and 94. His Fig. 48 would seem to indicate that he saw the sporulating phase of the same organism. All his studies were made on the gastric mucosa of the salamander. I have found in the gastric mucosa of *Diemyctulus* very few abnormal structures of this character. If they are parasitic, their comparative absence from the stomach may be attributed to the digestive and resistent action of the gastric mucosa, and it is probable that the irregularity and atypical character of many of the structures drawn by Lukjanow may be due to the physiological action, during life, of the glandular elements in which they occurred.

It is interesting to note the structure of the cytoplasm around the full-sized organisms (Figs. 3–7). It is constituted of very fine rodlets, each with a thick end directed towards the organism and passing in a radiating manner peripherally into a zone of what appears to be finely granular protoplasm, but which is, probably, a portion of the cytoplasmic reticulum condensed. The border of thickened points in many cases closely resembles a membrane. It depends, apparently, on the vitality of the cell whether the radiating arrangement of the cytoplasm occurs or not. It may be absent, as in Fig. 2, when the cell shows signs of degeneration. It is difficult to understand the function of this mechanism, but we may suppose it to act as a filtering apparatus.

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* *Op. cit.*

II. ON CHROMATOPHAGOUS AND OTHER INTRACELLULAR PARASITES IN THE INTESTINE OF NECTURUS LATERALIS.

In the intestinal epithelium of *Necturus* are often found forms which, from their peculiarities, must be regarded as parasitic. When I observed them first, I considered them to belong in a general way to that class of intracellular structures which Lukjanow* has described as occurring in the gastric mucosa of the salamander, and of which there are not a few examples in the intestine of *Necturus*. They are well shown in preparations made from recently captured animals, and their characters are preserved well in the tissues fixed with Flemming's Fluid, or corrosive sublimate, and stained with alum cochineal, or haematoxylin or eosin.

The chromatophagous forms have usually an irregular outline and the protoplasm extended in one or more long pseudopodial processes, which taper often to fine threads In some cases the whole organism is thread-like (Fig. 15 *p*). They are easily distinguishable in alum-cochineal preparations in the unstained, epithelial cytoplasm, in which they may be found, and by their stain being in every respect similar to, and as deep as, that of the chromatin bodies of the epithelial nuclei. With high-powered objectives the stain is seen confined to the fine granules which densely crowd the cytoplasm of these organisms. There is sometimes a quantity of unstained protoplasm at the thicker end (Fig. 14 *p*), or a more or less curiously shaped mass may lie in its neighborhood (Fig. 16 *pr*). Sometimes the bodies are found in the interior of nuclei, but, as a rule, they are not easily recognizable in this position, unless they show amoeboid outlines or are fixed in the act of migrating from the nucleus. One is shown in the latter condition (Fig. 15 *p*). The nucleus is in this case partially deprived of its chromatin by the parasite, which owes its staining capacity to the chromatin it absorbs or invaginates.

An explanation of the relations of such structures as are shown in Fig. 13 (*p*) can be at best only problematical. Here two parasites, each in a separate cavity in the cytoplasm, have their prolongations hooked around one another. This is only one of several instances observed of such a condition, but the preparation drawn shows the process most distinctly. It may be a case of conjugation.

There are a number of forms which are either wholly unstained by the coloring reagent, or which possess one or more stained spherules or granules (Fig. 13 *p*). These may, in some cases at least, represent young stages of the chromatophagous forms.

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* L. c.

In Fig. 12 is shown a cell from the base of the epithelial layer, which has certain peculiarities worthy of note. In one of its two nuclei is a cavity containing an eosinophilous, dumb-bell-shaped structure. The chromatin of this nucleus is very much condensed, but a portion of it is extended into the cavity in the form of doubly-beaded rodlets. The structure here reminds one strongly of that of the cytoplasm about the parasites in the intestine of *Diemyctylus* as described above, and I am inclined, therefore, to regard the dumb-bell structure as a parasite. The elements in the neighborhood of the second nucleus may be parasitic also. Such a case as this illustrates fairly well upon what slender grounds one has to judge of the parasitic or non-parasitic nature of some intracellular bodies.

III. On Certain Structures in the Pancreatic Cells of Amphibia.

In the pancreatic cells of Amphibia are structures which, since their discovery by Nussbaum,* in 1882, have excited attention amongst a number of cytologists, on account of their supposed participation in the processes of secretion. From the fact that they presented resemblances in position and form to structures described by v. la Valette St. George and Bütschli, as occurring in the testicular cells of some invertebrates, Nussbaum gave them for temporary use the name nebenkerne. It will be seen from the description given below that these elements are not normal portions of the gland cell at all, and, therefore, do not merit the title, which has, since Nussbaum's paper was published, maintained its place in nearly all the publications on the subject. I do not intend to discard the term, however, because the full history of the structures have not been worked out, and they may really belong to a stage of a Sporozoan parasite, whose adult form may already be described and named. In that case the continued use of the term nebenkern applied to these elements is preferable to the coining of a new word for temporary service probably, and I will, therefore, not offer any further excuse for adopting it in this work.

If the elements in question were normal, it might be advisable to give them an English name equivalent to the word nebenkern, in which case the words "paranucleus," or "accessory nucleus" might suffice. The word *cytozoon*, on the other hand, is precluded, since it has been adopted by Gaule and his pupils to denote, according to their views, the elements in certain stages of cell metamorphosis or cell rejuvenescence.

According to Nussbaum's description, the nebenkerne are placed in the

* Über den Bau und die Thätigkeit der Drüsen. Arch. für Mikr. Anat., Bd. XXI., p. 296.

protoplasmic portion of the gland cell, between the nucleus and the membrana propria; they are oval in outline, and either solid or more or less spirally twisted. There may be one or more in each cell, and when one only is present it is usually larger than the several taken together, which may happen to be in another cell. On the fourth to the fifth day after feeding the animal (salamander), they are present in every gland cell, while they may be found with difficulty, or not at all, in animals recently fed, and they are rare in animals which have fasted for a long time.

Nussbaum also found solid nebenkerne in the œsophageal glands of the frog, and in the exhausted, unicellular glands in *Argulus*, and thread-like ones in the pancreas of *Triton*.

As to the nature of these bodies, Nussbaum came to no conclusion. Ogata*, on the other hand, put forward a view which connected them with processes of secretion and cell renewal. According to his account, they are the plasmosomata of the nucleus, which have wandered into the cell protoplasm. The small nebenkerne are homogeneous, spherical, or elliptical in outline, often elongated and do not stain with hæmatoxylin, but they readily imbibe eosin, which, consequently, obscures their presence amongst the similarly stained zymogen granules. In the larger nebenkerne the chromatin substance is present, consequently they are either colored homogeneously violet or have one or more corpuscles colored deep violet to pure blue. The large nebenkern can, on the one hand, in old and exhausted cells, develop into a new cell, which, situated immediately adjacent to the membrana propria, pushes the disintegrating nucleus and remains of the old cell towards the lumen, and increases its own cytoplasm, in which zymogen granules appear; on the other hand, it may, in ordinary cells, break up into zymogen granules. It depends on the general condition of the gland, whether the nebenkern breaks up into zymogen granules, or developes into a new cell. The production of zymogen is not, however, limited to the nebenkern, for the granules were seen in the process of formation in the nucleus.

Ogata found in the moderately large, as well as in the full-sized nebenkern, cavities and fissures which gave them various appearances. Sometimes the structures were seen to sit cap-like on the nucleus.

Ogata stimulated the pancreas either by pilocarpin or by electrical irritation of the medulla, and found the number of nebenkerne greatly increased. When two or more doses of pilocarpin were given at intervals of twenty-four hours, the resulting number of nebenkerne was smaller

*Die Veränderung der Pankreaszellen bei der Secretion. Arch. für Anat. and Phys., Phys-Abth., 1883, p. 405.

than when only one dose was given. He explains this on the ground that the first dose has greatly increased the number of nebenkerne, and thereby weakened the cells, which now respond to the second dose less readily.

Ogata also traced a relation between the disappearance of the nebenkerne and the appearance of new nuclei.

Platner's* first published views coincided to a certain extent with those of Ogata. His description substantially is this: The large round nucleolus of the pancreatic cell elongates, and moves towards the periphery of the nucleus, often pushing out its membrane. The long axis of the nucleolus corresponds to the radius of the nucleus. A portion of the nucleus becoming constricted off, this part contains the nucleolus and is separated from the main portion by the formation of a homogeneous, septal wall. The nucleolus and the separated portion of the nucleus constitute together the nebenkern, which, when the main portion of the nucleus regains its usual size, sits on it like a demilune. The nebenkern becomes homogeneous, separates from the nucleus and breaks up into granules which are probably zymogen. These observations were made on the pancreas of *Anguis fragilis*, and were corroborated in that of the frog.

Platner's second study† led to somewhat different results. He used for this purpose the pancreas of a number of Reptilian and Amphibian forms, but he obtained the most decided results from that of the salamander. In the latter the irregularly contoured nuclei of exhausted gland cells stain deeply with safranin, so that the nuclear framework becomes indistinct. Of the many or several prominences on each nucleus one only remains finally. Into this the chromatin, distributed throughout the nucleus, wanders, with the result that the prominence appears as a dark red bud on the remaining portion of the nucleus, which now gradually returns to the normal condition, namely, that in which the nucleus shows an unstainable caryoplasma (Kernsaft). These buds are variously shaped, large or small, round or irregular. The nuclear membrane in most of the cases still covers it. Often it has vanished and the contents, still colored deeply, lie as fibrillar or coiled elements, or as partially granulated material, in the protoplasm of the cell. The constriction between the nucleus and the bud deepens, till finally they separate, the bud now losing its uniformly staining capacity. At the same time the protoplasm of

*Uber die Entstehung der Nebenkerne und seine Beziehung zur Kerntheilung. Arch. für Mikr. Anat. Bd., XXVI., p. 343.

†Beitrage zur Kentniss der Zelle und ihren Theilung. Arch. für Mikr. Anat. Bd. XXXIII., p. 180.

the cell increases, till it attains its normal maximum volume. The retrogressive metamorphosis of the nebenkern, as Platner now terms the separated bud, goes hand in hand with the vigorous formation of zymogen granules in the cell. The nebenkern stains less readily with hæmatoxylin, and its volume decreases gradually, till either only fibrillar remains of the same are visible among the zymogen granules, or it is indistinguishable.

It is seen that these observations raise the question how far "partial" chromatolysis, as Platner terms the formation and degeneration of the nebenkern, thus described, enters into the processes of secretion, but Platner leaves the matter undecided.

Platner accounts for the discrepancies in the two descriptions of the mode of formation of the nebenkern by stating that in the pancreas of Anura, which formed the basis of his earlier observations, the determination of the various points is difficult, because of the small size of the cells in which the nebenkern sits cap-like on the nucleus.

Steinhaus* solves the question of the nature of these bodies differently. He denies their normal occurrence in Amphibia. They were not present in the pancreas of six axolotls which he examined and they were also absent from the pancreas of frogs obtained from one locality, though present in those of another. Even in the pancreas of some salamanders they are absent. He states that they have no connection with the processes of secretion, as the formation of zymogen granules goes on as well in the cells deprived of these bodies, as in those possessing them. They lie unchanged and, so far as the formation of zymogen granules is concerned, inert in the cell protoplasm. He never saw any structures which proved either the origin of these bodies out of the constituents of the cell, or their conversion into zymogen granules, or their connection with cell renewal. Steinhaus studied the condition of the nucleus in all the phases of secretion, but could observe nothing which would be *considered as nuclear budding, according to Platner's description.*

Steinhaus gives no verbal description of the nebenkerne, but in his figures he represents them as varying in size and number in each cell and as thread or worm-like forms more or less coiled, some of the larger ones of which have one end of the thread thickened to resemble a head.

Steinhaus considers these bodies as parasites whose relationship to the Hæmatozoa is unmistakable, but so long as we know only this stage

*Ueber parasitäre Einschlüsse in den Pancreaszellen der Amphibien—Ziegler's Beiträge zur Path. Anat. und zur Allgem. Path., Bd. vii., p. 367.

in their life-history, it is impossible to say anything more definite than that everything at present determined points out their kinship to the Sporozoa.

It is of interest here to note the occurrence of supposed nebenkerne in the pancreas of the dog.* Melissinos and Nicolaides found that these are intra- as well as extranuclear forms, sometimes of curious shape and composition. The intranuclear ones, the plasmosomata, may wander from the nucleus into the cell substance, where, as these observers are led to believe from the results of experiments with pilocarpin, they break up into zymogen granules. They deny the correctness of Platner's view, that the appearances, from which Ogata was led to believe that nuclear plasmosomata migrate into the cell, are artificially produced, and, in support of their position, they mention that in a quarter of an hour after the administration of pilocarpin the plasmosomata show all the stages of migration from the nucleus, the extranuclear forms are numerous and zymogen granules are present, while in half an hour after the administration, neither plasmosomata, extranuclear forms, nor zymogen granules are visible. The extranuclear forms, which arise by migration from the nucleus, of the plasmosomata, they call nebenkerne and these they distinguish from others, which are more or less complicated in their structure and composition and which lie in distinct cavities in the cell protoplasm. These latter they think are: (1) excretions of the cell protoplasm; (2) the remains of leucocytes; (3) chromatolysed nuclei.

METHODS OF STUDY.

I used several methods at the outset of this research but finally gave the preference to one mode of preparation which included either Flemming's Fluid or corrosive sublimate as the hardening reagent. This mode of preparation was as follows:

The animal (*Diemyctylus viridescens*, *Amblystoma punctatum*, *Plethodon glutinosus*) was decapitated, the abdominal cavity opened, the pancreas snipped away and immediately dropped into a saturated solution of corrosive sublimate, where it remained ten to fifteen minutes, or into a quantity of Flemming's Fluid, where it was left from one to twenty-four hours, according to the need. The operation of removal was usually done within twenty seconds, this interval including the decapitation process also. The object of this was to prevent any post-mortem

* Untersuchungen über einige intra- and extranucleare Gebilde im Pankreas der Säugethiere auf ihre Beziehung zu der Secretion. Von C. Melissinos. Mitgetheilt von R. Nicolaides. Arch. für Anat., und Phys., Phys. Abth., 1889, p. 317.

changes in the pancreatic cells and I believe that it was attained in every case. The piece of tissue was after removal from either of these fluids, washed for a few seconds in distilled water, then transferred to 70% alcohol for three hours, in the case of the corrosive sublimate preparation, and for twenty-four hours, when the Flemming's Fluid was used. When the latter was allowed to act longer than one hour, the alcohol was changed as often as it presented a trace of chromic acid coloration. The hardening was completed by a stay of twenty-four hours in 95 per cent alcohol. The organ was now transferred to the staining fluid, alum hæmatoxylin, (a few drops of a saturated solution of hæmatoxylin in absolute alcohol to a saturated solution of pure ammonia alum in distilled water: allowed to stand one month in summer sunlight before using, and kept from deterioration by crystals of thymol), for ten to fifteen hours. In order to prevent overstaining, I found it advisable to dilute the original hæmatoxylin solution with twice its volume of distilled water, in which dilution, after the time allowed, there is only a pure chromatin stain in the nuclei of the pancreatic cells and a faint shade of purplish blue in the nebenkerne. The objects are now washed in distilled water to remove the alum and the excess of the staining fluid, and are then put in a quantity of a 1 per cent solution of eosin in 30 per cent alcohol for from two to three hours. Washed in 95 per cent alcohol, till the latter was but faintly colored with the eosin after one hour's action, the object was placed in absolute alcohol for five minutes, then in pure chloroform for fifteen hours on the average, after which it was kept in a saturated solution of paraffin in chloroform at 35°C. for about eight hours, and finally placed for a like period in melted paraffin (melting point 52°C). The sections were made of a thickness not exceeding 5μ with the Thoma-Yung microtome and fixed by the ribbon method in series to the slide with a diluted Schällibaum's clove oil-collodion mixture, (clove oil 1 volume, collodion 3, equal parts of absolute alcohol and ether 3). I used, sometimes in the case of the corrosive sublimate preparations, the Gaule method of fastening the paraffin sections to slide, but, as the process of staining on the slide was not employed, except when the action of saffranin was required, it did not present any points of advantage over the other, which was the quicker. The paraffin was removed with benzole and the sections mounted in benzole balsam.

The staining of the object as a whole with hæmatoxylin and eosin has the advantages of giving a regular and uniform depth of reaction in the various sections and the different parts of each, and of preventing the loss of important elements entailed by the process of staining on the slide. I found that a little practice enabled one to judge of the length of time necessary to give the tissue its proper depth of stain, and I determined that a stay of eight or ten hours longer than usual in the diluted hematoxylin solution, did not seem to increase the depth of the stain, or to make it more diffuse. Probably the explanation of this is that the equilibrium between the coloring matter in the diluted solution and that deposited in the tissue is reached when the chromatin is saturated. This, of course, is merely an application of the principle, that length of time and degree of concentration are elements in the right employment of staining methods and that these are, roughly speaking, in inverse proportion to one another.

In order to determine if the nebenkerne contribute in any way to the elaboration of the secreted elements of the pancreas I resorted to the use of pilocarpin. I had a large number of *Diemyctyli* at my disposal, and on these I studied the action of the drug, so far as the nebenkerne are concerned. Batches of ten, twenty and thirty were taken, and into the abdominal cavities of each of these less than 2 mgrm. of pilocarpin was injected. Three of these were, at certain periods after the injection, decapitated, the pancreas of each removed, hardened with corrosive sublimate, and treated as described above. These periods were usually: 1, 2, 3, 4, 5, 7, 9, 12, 17, 22, 36, 44, 52 and 60 hours, and these were chosen in some cases for convenience. I took three at each period, because, if I depended on one, misleading results might be obtained. It was found that the averages of the results obtained from each three agreed with each other in presenting an unbroken outline of the history of the nebenkerne.

I treated very young forms of *Amblystoma punctatum* also with pilocarpin, the method of employment of the latter in this case being to dissolve twenty to fifty milligrams in about half a litre of water and placing the animals therein for a period of five to twelve hours. As they measured between thirty and thirty-five millimetres in length, it is obvious that an intra-abdominal injection of a solution of the drug was out of the question.

The specimens of *Necturus* kept in the laboratory aquarium were not used for this investigation, since, owing to their not having been fed for a long time, the pancreas presented a more or less atrophied condition. It was found impossible to stimulate the gland in these to activity, or even to make it secrete at all.

There is a great advantage to be obtained from the concurrent use of the two hardening reagents, corrosive sublimate and Flemming's Fluid. The former fixes thoroughly and quickly the zymogen granules as well as the cellular and nuclear structures in the pancreas, while with Flemming's Fluid, though the cell structure and nucleus are well preserved, the zymogen is dissolved out of all the cells except those at the immediate periphery of the organ. This removal of the zymogen is due to the acetic acid in the fluid, which penetrates where another constituent of the same mixture, osmic acid, is unable to diffuse. The action of acetic acid in this reagent enables us to distinguish between zymogen and other granules which have the same staining capacity with eosin. The osmic acid, furthermore, gives a dark tinge to the nebenkerne and unusual bodies in those cells near the periphery and thus brings them out in clear contrast to the other cytoplasmic structures.

OBSERVATIONS.

In sections made from the pancreas of *Diemyctylus*, which has been hardened with Flemming's Fluid and stained with hæmatoxylin and eosin, one observes in addition to the nucleus and cell protoplasm and, sometimes, zymogen granules, other structures which can be ranged in two groups at least. One of these groups comprise forms whose fundamental structure elements are thick or thin fibrillæ, either in sheaf shape, or wound in a ball fashion (Fig. 1). Sometimes the fibrillæ may be so thick as to merit the designation threads (Fig. 8). These forms are usually but not always, placed between the nucleus and the membrana propria, and they frequently sit, cap-like, on the nucleus, or the latter may be indented by them. In the second group, which are, at the outset, unlike the first, in that they are placed in cavities of the cell, are structures which present a varied form and composition. They are sometimes eosinophilous, sometimes chromophilous, and at times they present both characters, They are numerous in the pancreas of a freshly captured animal, but are not so much so as the members of the first group.

The members of these two groups of intracellular elements have been confused by other observers, and Ogata describes them as derived from the plasmosomata migrated from the nucleus, while Steinhaus appears to believe they are all parasites. In order to show that the views of these observers are hasty generalizations from a limited number of results, I propose to go fully into the description of the structure origin, mode of production, and history of each group. As plasmosomata, migrated, or extruded from the nucleus, are sometimes present, and as they have a different history, they merit special attention as a third group. These three groups may then stand in the order of description as follows:

1. Parasites.
2. The remains of broken down cells and nuclei swallowed by healthy adjoining cells.

3. Plasmosomata, migrated, or extruded from the nucleus into the cell protoplasm.

1. PARASITES.

These are, as already said, usually, but not always, placed between the membrana propria and the nucleus of the cell. They vary in size, measuring in their extreme limits 1μ and 9μ, and their shape, usually oval, may also be oblong, spherical, elongated, club-like, or crescentic in section. They are not very sharply separated from the protoplasm of the cell and if the latter is dense, their outlines are distinguished with difficulty. Their structure varies also, but there are certain features in this respect which are tolerably constant for the great majority of these forms. These are the central cavity and the fibrillated appearance, the fibrillæ, as a rule, appearing as if wound around the central cavity. The central cavity may contain from one to several zymogen-like granules. The fibrillæ do not appear as if wound tightly, but are more or less tortuous in their course and the outermost ones may appear ragged, or project loosely into the surrounding protoplasm. This fibrillated arrangement is best seen in Flemming's Fluid preparations from freshly captured *Diemyctyli*, and, especially, in those on which the reagent has been allowed to act for twenty-four hours. The osmic acid and the hæmatoxylin in such give these bodies a dark brown stain, which deeply contrasts with the lightly or non-stained, surrounding protoplasm. In corrosive sublimate preparations, on the other hand, the fibrillation usually does not appear so distinct except under high powers when it readily becomes manifest, and hrimatoxylin gives it a faint reddish violet stain. Zymogen granules are entangled in the peripheral fibrillæ, often so abundantly, that they obscure the presence of the organism in question.

This stage is the most common, but in order to understand its nature, it will be necessary to consider the characters of the other forms found even in the same sections. These present more the appearance of plasmodia, are usually much smaller, and they take a deeper and more uniform stain with eosin. In the protoplasm of these, one can, at times, see concentric laminated slits, which are apparently an indication of a tendency to form fibrillæ, but which may also indicate that these plasmodia-like masses are derived by the fusion of the protoplasm of a coiled thread. Such coiled threads are rarely seen in ordinary preparations, but very frequently in sections from the pancreas of some *Diemyctyli*, which have fasted for about two months (Fig. 8). These coils have been, now and again, found to be dense in sections from the pancreas removed fifty to sixty hours from the animal after the injection of p locarpin. When these bodies are very small, the number of turns in the coil is not more than two or three, whereas in the largest forms the number of turns cannot usually be made out.

All the forms, then, are either plasmodia-like masses, or are composed of fibrillæ or threads. Whether the plasmodia are elements of a separate stage in the metamorphosis of the bodies, or whether they are merely formed by the fusion of the protoplasm of the threads, cannot be decided definitely. It can certainly be determined that the fibrillated stage is one of degeneration, for one can find the fibrillated forms in all conditions up to disappearance. Figs. 1, 2, 3, 4, and *6nb* show this. The first step in this consists in a more or less parallel straightening of the fibrillæ and a consequent flattening of the whole mass, then the cell protoplasm pushes it towards the periphery where it lies, usually, directly under the cell membrane (Figs. 2, 3, and *4nb*). Here the fibrillæ disintegrate one by one, till finally, owing to their fineness and small number, they can not be distinguished from the cell protoplasm. Platner has described the occurrence of such fibrillated remains in the cell protoplasm, and he considers them derived from the nebenkerne.

I am inclined to believe that the coiled thread is the intact form of the parasite, and that the plasmodium-like mass may be either an earlier or a subsequent stage in the life history of the parasite. In the case of the latter form, the fact, that it is usually smaller than those in which the fibrous or fibrillated structure is manifest, tends to show that it is a younger stage, but not conclusively, since even small fibrillated masses occur sometimes.

I have withheld the proofs that these forms are parasitic till now. Of course each fact adduced is not of itself sufficient to prove the correctness of my view, but all taken together are conclusive in this respect. These facts may be summarized in the following items :—

They are not present in the pancreas of the great majority of young forms of *Amblystoma punctatum*. I sectioned the whole of the pancreas of seven of these and found these bodies in only two of them. Of these two, one contained only eleven of the structures, while the rest possessed hundreds, and in both these cases, as well as in the other five, the cells exhibited all stages in secretion. I treated five other larvæ with pilocarpin, and examined the pancreas at intervals of four, seven, eleven, thirteen, and twenty-two hours after, without finding a single specimen of this nebenkern. The larva, in which the greatest number of such were found, measured in total length a little over thirty millimetres, while the others were of the same length or some what longer, and we may conclude, therefore, that the occurrence of these bodies does not depend on the stage of development, although it may depend on the change in the food, or habitat, which the increased development entails.

2. They are present in all the cells of the actively secreting pancreas of *Diemyctylus*, as well as in that of an animal fasting for two months or more. When two or more are present in a cell, they are, usually, but not always, small. I have found them present in the cells apparently without diminution in number at every indicated interval, after the injection of pilocarpin. In corrosive sublimate preparations of the gland cells distended with zymogen granules, these bodies are, in many cases, not seen. If one relied wholly on corrosive sublimate as a hardening reagent, one might conclude that this is a stage in which the nebenkerne are absent, having been used up in the formation of zymogen, and such a conclusion has been advanced by Ogata. That the bodies are not absent, but merely obscured by the granules, is shown in preparations made with Flemming's Fluid from a pancreas in the same condition. This reagent dissolves out the zymogen in the centrally placed tubules, and, if allowed to act for twenty-four hours, blackens the structures in question, thereby showing them to be as numerous in this phase of cellular activity as in any other. I have, however, found that they, as a rule, stain somewhat more readily with eosin at certain intervals after injections of pilocarpin, and this condition is concurrent with the filling up of the exhausted cell with zymogen, and with a subsequent exhaustion of the same. The deeper stain during the formation of zymogen is due to absorption of the latter diffused from the nucleus, its seat of formation, while, in the other case, the cells, having their energy exhausted, cannot destroy or disintegrate the organisms, which absorb the cell juices and thereby attain a greater readiness for eosin. I think this latter condition is in some way connected with the vitality of the animal, for it is less apt to appear in vigorous animals, and I found it best exemplified in sluggish ones, while in some cases, again, it appeared in forty-five to fifty-five hours after the administration of one dose of pilocarpin.

3. They are not derived from the nucleus by constriction and partial chromatolysis, as Platner describes, although other structures described farther on, with which these have been confused, may be so derived. I have examined series of sections made from the pancreas of over seventy *Diemyctyli*, exhibiting all the phases of glandular activity and yet I have never in a single instance seen the bodies in question, in any way, derived from the nucleus, nor are they plasmosomata which have migrated from the nucleus and have undergone a certain amount of extranuclear development, a thesis which Ogata adopts and defends. I have found extranuclear plasmosomata, and, as will be seen from the description

further on, traced their history, which is totally unlike that of the structures in question. Given, then, that they are derived neither from the cell protoplasm nor from the nucleus, the only remaining conclusion possible is that they come from without—in other words, they are parasitic.

4. The parasitic nature of these bodies is best shown by their form in the two young *Amblystomata* referred to above. Fig. 10 *a*, *b*, *c*, *e*, *f (nb)*, represent the commoner types of these and a resemblance to a "wurmchen" type is readily seen in these.

5. The fibrillation and gradual disappearance of these bodies occur without any participation whatever in the processes of cell activity and secretion. There can be no doubt about the correctness of this, and moreover, Platner's description practically admits it, although he thinks that the desintegration of these bodies furnishes material for an increase in the amount of the cell protoplasm and, possibly, of its zymogen. It is not to be denied that the desintegration and possible assimilation of these bodies increase the cell protoplasm and may, therefore, very indirectly assist in the formation of zymogen.

The statements made by Steinhaus that these structures are not derived from the cell or nucleus, that they have no functional relation to secretion, nor have anything to do with cell renewal, I can, therefore, fully confirm. His observation that they are inconstant even in the same species, agrees with mine as to the young *Amblystomata.* His figures, however, of these bodies resemble but few of mine, and show the "würmchen" form to be more common than I have been permitted to see in my preparations. If Platner's statement is correct, that the fibrillar remains of these bodies can be observed in the pancreas of the salamander, it is evident that Steinhaus has overlooked the full history of the structures. Steinhaus is also in error in concluding that the parasites alone are the nebenkerne of Ogata or Platner, for bodies have evidently been included in this class by the two observers, which are not parasitic at all.

What are these parasites? Steinhaus believes that they are similar to, not to say identical with, those described under the names Hæmatozoa and Cytozoa. There are several facts which speak for the correctness of this view. The forms of some of them correspond with that found in the blood cells of the frog, the "würmchen" of Gaule and known as *Drepanidium ranarum* of Lankester. The latter is also to be found in the blood of *Diemyctylus.* Kruse* states, however, that it is not present in the blood of the tadpole and this fact is to be taken in connection with the absence,

* Virchow's Arch., Bd. 120, p. 553.

generally, of the pancreatic parasites in young *Amblystomata*, if an explanation is desired of the latter phenomenon. Furthermore, the degeneration and disintegration of the pancreatic parasites and the complete absence of the reproductive processes show that some other tissue is the breeding ground of the parasite, and their presence in every pancreatic cell points to the blood as their source.

The destruction of such large numbers of the parasites in the pancreatic cells seems to indicate that the pancreas of Amphibia is a protective as well as a secretive organ, and that it plays this part specially, since the parasites have not been found in any other organ after the most careful search.

2. Karyolytic and Cytolytic Products.

These elements are few in some *Diemyctyli*, abundant in others, the latter especially in freshly captured animals. They are found only in groups of the cells at certain spots in the sections and they present characters which definitely distinguish them from the elements described in the foregoing section. Probably the best representation of these forms is given by a glance at Figs. 6 *chm*, 4 *rchc*, *pmeg*, 5 *pm*.

Their form is usually spherical or approximately so, and their size, as well as their structure, varies. They often consist of chromatin and eosinophilous substance, or simply of protoplasm which has a special affinity for staining reagents. Less commonly, they may contain eosinophilous granules like the zymogen granules, or these may be present with the chromatin masses. Apart from the occurrence of eosinophilous granules and the slightly stained protoplasm, the structure of these bodies is mostly varied by the quantity of chromatin present and the form which it takes. Sometimes the whole of the structure seems composed of chromatin (Figs. 3 and 6 *chm*), but more frequently the latter forms a small oddly shaped mass irregularly placed in the structure. One may see rings, rods, crescents, hooks, and spirals formed of this substance and variously disposed in the protoplasmic mass carrying them. These bodies usually lie in the cavities in the protoplasm of the containing cell, a peculiarity which readily brings them to view when their affinity for staining reagents is very slight. These elements are sharply distinguished from the parasitic bodies in that they never fibrillate and they, moreover, have a different fate. The latter can only be studied in the pancreas of freshly caught animals, and in those in which the various phases of the resting cells are being developed. In the active gland they may be numerous but as the resting phase of the gland cell is step by step being established they are found to become correspondingly smaller, the staining with hæmatoxylin less vivid, while the larger bodies disintegrate and the fragments become scattered through the cell. The disappearance of these elements, the concurrent increase in the cell protoplasm and the appearance of zymogen granules are not matters of physiological relation. The removal, or rather the disappearance of chromatin, is on the other hand in some way connected with the abundance of chromatin in the greatly enlarged nucleus of the containing cell (Figs. 3, 4, 5, and 6). The nucleus may be somewhat distorted in its shape, and this is without doubt due to the abundance of the chromatin which it has absorbed from the elements in the cell. The processes of disintegration and absorption go on till finally in the resting gland cell a few protoplasmic masses, scarcely larger than zymogen granules, may remain.

The origin of these bodies is to be sought for in the broken down gland cell. Indeed one can see them so derived in the sections. In Figs. 3 and 5 are some of the remains (*cm* and *rohe*) of such disintegrated cells lying in the intercellular spaces, while the surrounding cells contain masses, which, from their position, are evidently swallowed portions of the same. The farther a cell is removed from these intercellular masses the freer it is from the intracellular elements in question and at a distance not greater than the diameter of a cell these may be absent altogether. In other words, wherever one finds the intracellular bodies numerous one can also in the same or in the next section find intercellular elements to indicate the place of origin of the former. It is quite possible that disintegrated leucocytes may give rise to the same, but I have seen no evidence of such, except, perhaps, in such forms as that represented in Fig. 6*a*.

These bodies are also present more or less in the pancreas of all the young *Amblystomata* examined and they exhibit here also the same varying composition and structure.

These bodies do not participate in the processes of secretion. The presence of eosinophilous granules, like those constituting the zymogen, led Ogata to consider them as breaking up into zymogen and from the fact that the parasites may appear to contain zymogen granules more or less imbedded in them, he concluded that the latter are earlier phases in this formation of zymogen. These eosinophilous granules are not formed of zymogen, however, because in the more centrally placed cells in a section of the pancreas prepared with Flemming's Fluid, the zymogen granules are dissolved out by the acetic acid in this reagent, but the eosinophilous granules are not affected. This phenomenon has a bearing on the mode of secretion and I will, therefore, forego an explanation of it till I come to this subject farther on.

Nothing can probably demonstrate more effectually the non-secretory nature of these elements than the fact that they are present in the cubical cells lining the ducts and ductlets of the gland (Figs. 11 *b, clm* and 12 *rclc*). Nor are these bodies confined to the pancreas, for I have found them in the ephithelial cells of the intestine, in the liver, the kidney and cutaneous epithelium of *Diemyctylus* and *Necturus*. They indicate, however, how little of a tissue is normally lost to itself and how it husbands its waste material. It is, of course, on first view, surprising that the pancreatic cells should exhibit amœboid properties, but it is less so when we remember that the hepatic cells, which in sections have a definite and apparently fixed form, manifest in the teased out scrapings from the cut surface of the fresh liver amœboid movements.

3. Migrated or Extruded Plasmosomata.

Platner denies that the nuclear plasmosomata migrate, and, at first, I was inclined to this view. It is easy to see in well hardened sections of the pancreas plasmosomata driven by the knife from the periphery of the nucleus into the cell, the nuclear membrane torn, and the cavity previously occupied by the plasmosoma empty. This occurs chiefly when the plasmosomata are large and placed next to the nuclear membrane. The apparent protrusion of the nuclear membrane, in some cases, is really due to a shrinking of the same at every part, except opposite the plasmosoma, which offers a resistance. I found, however, as the investigation proceeded that there were phenomena which could not be so explained. For example, in the pancreas of a young *Amblystoma*, about one-fourth of the nuclei showed plasmosomata which were fixed in the act of passing from the nucleus to the cell. I saw plasmosomata of dumb-bell form half outside and half within the nucleus and some were embedded in the cell protoplasm. I saw this condition, moreover, but less marked, in the pancreas of a specimen of *Diemyctylus* removed twenty hours after the injection of pilocarpin. Though the evidence was unmistakeable, I cannot but think that if the phenomena are constant or normal, they should be observed oftener. In any case the migration or extrusion has, from all that I see, no connection with the processes of secretion. If it is a case of extrusion, one might imagine it to occur readily in the pancreas of any specimen of *Diemyctylus*, unless one were to suppose that in certain stages of cell activity the nucleus is more contractile. My attempts to establish the correctness of such a supposition resulted unsuccessfully.

That the extrusion or migration is not a normal phenomenon appears to be borne out in the history of the extranuclear plasmosomata. They either disintegrate and form granules like that of zymogen in size and staining reaction, or persist for a time in a cavity of the cell protoplasm and gradually loose their eosinophilous character. Forms of the latter are rare but they can be distinguished from the cytolysed products of other cells by the fact that they are more or less eosinophilous, and by the fact further, that one only is to be found in a cell, while similar bodies, protoplasmic or otherwise, are absent from the adjoining cells. For the purposes of the diagnosis of course serial sections are necessary. But with these aids even, the process of determining whether a slightly eosinophilous, extranuclear mass is a plasmosoma derived from the nucleus is a difficult one. The disintegration into zymogen-like granules is easily distinguishable on account of the fact that the resulting granules are collected at one spot in the cell (not near the border) and from their resisting the action of acetic acid. It is possible, on the other hand, that a plasmosoma may neither disintegrate into zymogen-like granules, nor persist with the gradual loss of the eosinophilous character in the cell protoplasm. I observed in the pancreas removed from an animal one and a half hours after the injection of pilocarpin, the ductlets filled with zymogen in a granular condition and containing here and there a large plasmosoma-like mass. In this case no intra-cellular plasmosomata were observed, althou zymogen was still present in the cells. I think this phenomenon indicates that the pancreatic cell can, under such a strong stimulus as pilocarpin furnishes, throw out of itself all material not part of its own mechanical structure, and that the extranuclear plasmosomata may, in some cases, be disposed of in this way.

That Ogata made the mistake he did in assuming that the extranuclear plasmosomata become converted into nebenkerne and the latter again into zymogen granules is very natural in view of what is described above. The passage of plasmosomata from the nucleus to the cell, the mingling of zymogen granules, either with the substance of the plasmodium-like mass or with the fibrillæ of the degenerated parasite and the occurrence of protoplasmic masses loaded with eosinophilous granules are demonstrable facts which Ogata seems to have observed, and he built up from these the theory outlined, a feat and a mistake which any cytologist, who had paid as careful attention to the subject as Ogata did, might have committed at that time. What was less excusable was the construction of a theory of cell rejuvenescence, for although chromatolysis was then unknown, or at least undescribed, and, therefore, the occurrence in pancreatic cells of protoplasmic masses possessing chromatin unexplained, yet the knowledge concerning the indirect process of cell division had then made a great advance and it was hardly necessary to postulate the existence of another process. All things considered, however, Ogata's work has been of great service in calling special attention to structures, the further study of which may definitely establish a new function for the pancreas in cold-blooded animals, viz., a protective one against the Hæmatozoic parasites.

In connection with these remarks on Ogata's views, I may mention that I have frequently observed in some sections of the pancreas of *Diemyctylus* examples of karyokinesis and that in the cells in this condition there were neither nebenkerne, protoplasmic masses, nor plasmosomata. Steinhaus gives an illustration of a pancreatic cell exhibiting karyokinesis in which, apparently also, nebenkerne (parasitic) are present. I have also frequently observed cell and nuclear division in the pancreatic cells of the young *Amblystomata* and it was apparent that the nuclear division might go on with the cell more or less filled with zymogen granules.

4. ZYMOGENESIS.

It has been known from the researches of Haidenhain and others that changes in the shape and staining power of the nucleus accompany the change from the resting to the active phase of the secreting cell. What the relations are which these changes bear to one another, were not divined, but it was generally supposed that they were the results of increased or decreased nutrition. The observations of Platner and Steinhaus embrace one aspect of these changes *i. e.*, the staining power of the nucleus, and it is to this that I propose to devote this section.

A summary of Platner's views as to the changes in the staining power of the nucleus of the pancreatic cell has been given above in the historical sketch of the literature on the pancreatic nebenkerne. Steinhaus'* observations, bearing more directly on the staining power, are of greater interest to us and may be abstracted as follows :

The exhausted gland cells are small, indistinctly contoured, and deficient in protoplasm and their arrangement in the form of alveoli is lost. Their nuclei which are angular and crenated are, when a double stain of hæmatoxylin and safranin is employed, colored red, and their nucleoli are safranophilous. When the active phase of the cells begins, the cytoplasm increases, the contour of the cell becomes distinct, the arrangement in alveoli with central lumen is attained, while the form of the cell becomes bluntly conical. At the same time the nucleus becomes oval and stains readily with hæmatoxylin. This dye stains one sort of nucleoli, the karyosomata, while the safranin colors the other and larger kind, the plasmo-

* *op. cit. p. 371.*

somata. At this point the formation of zymogen granules begins in the part of the cell next the lumen and it proceeds till the cell is filled with them. As to the origin and mode of production of the zymogen granules nothing is known. When secretion begins these granules disappear and the nucleus now tends to return to the condition found in the exhausted cell.

My own observations coincide with those of Steinhaus. I may emphasize here one or two points. The nucleus of the exhausted gland cell stains readily and deeply with safranin, that of the cell in which the formation of zymogen is going on vigorously, is colored deeply with hæmatoxylin, while its plasmosoma takes readily the safranin.

My explanation of this phenomenon is drawn from the results of my observations on the formation of yolk in the ovarian ova of *Necturus* and *Rana*, and a summary of these may therefore not be out of place here.

In the nuclei of the developing ova at a certain stage the chromatin is principally collected in the form of nucleoli at the periphery immediately under the nuclear membrane. These nucleoli are usually spherical and they may, though not usually, or very much, vary in size. All the chromatin of the nucleus is not so situated, for there are long threads which at certain points in the granular karyoplasma unite at angles with one another. *At this stage yolk spherules are absent from the cell.* If now sections of such an ovary are stained with the indigo-carmine stain of Shakespeare and Norris, the significance of the peripheral nucleoli is determined. Such sections show here and there an ovum in which the peripheral nucleoli are stained deep blue, while the remainder of the nucleus and cell is stained red. In other ova, again, the peripheral nucleoli and the karyoplasma are stained blue, the cell red, while in others again the peripheral nucleoli are smaller, the whole ovum, with its yolk spherules which now begin to be formed, is stained blue, or blue green.

The origin of the substance which stains indigo-blue in this process is certainly derived from the peripheral nucleoli, for it is possible to meet with an ovum once in a while in which a portion of the karyoplasma in the immediate neighborhood of and around each nucleolus is, like the latter, stained indigo-blue, while the remainder of the karyoplasma is red. The peripheral nucleoli generate a substance, therefore, which diffuses gradually through the nucleus, then into the cell protoplasm, the point in time of the latter occurrence corresponding with the formation of the yolk spherules. The mode of origin is through a process of deposition from the nucleus of a substance allied to chromatin in the cytoplasm.

The diffusion of a substance produced from the nucleoli through the nucleus and into the cell protoplasm, can also be determined by other staining reagents, *e.g.*, alum cochineal, but the different stages in this phenomena cannot be thereby so readily determined as with the other method.

I regard the yolk spherules as formed by the union of a derivative of the nuclear chromatin with a constituent of the cell protoplasm. This derivative of the nuclear chromatin is, possibly, the same as the hæmatogen which Bunge discovered in the fowl's egg united with an albumin. The formation of yolk spherules in the cell protoplasm is analogous to the the formation of zymogen granules in the pancreatic cells and both are accompanied by changes in the nucleus and an increase in the cell protoplasm. It is most natural to conclude that the processes underlying the formation both of the yolk spherules and of the zymogen granules are in a general way alike. We see many facts supporting this view. In the developing ovum there are phases in the elaboration of the chromatin and the formation of nucleoli (plasmosomata) comparable to the production of chromatin in the nucleus of the resting pancreatic cell, and to the apparent conversion of this chromatin into safranophilous substance which diffuses through the nucleus in the exhausted cell. We see a further parallel to the formation of yoke spherules in that as the nucleus loses its safranophilous substance the cell protoplasm acquires safranophilous granules. If we accept the parallel so far as correct, we may then assume that the chromatin of the nucleus of the pancreatic cell gives rise to a substance which we may call "prozymogen," sometimes dissolved in the nuclear substance, sometimes collected in masses (plasmosomata), and finally diffused into the cell protoplasm, uniting with a constituent of the latter as zymogen. This is, I think, the true explanation of the phenomena of secretion.

With the help of this theory we can explain why it is that in certain pancreatic cells the protoplasmic masses contain, as described above, eosinophilous granules of exactly the same size as those of zymogen, but unlike the latter in that they are not dissolved out by solutions containing acetic acid. The protoplasmic masses swallowed by a pancreatic cell, cannot be of the same composition as the cell protoplasm, and are not amenable to the laws which govern the nutrition of the cell as a whole. *When the prozymogen diffuses from the nucleus to the cell it invades* the protoplasmic masses enclosed, and it becomes united with a constituent of the latter, thereby forming a compound similar to zymogen in some respects: the capacity for forming spherules, the eosinophilous and safranophilous reaction, but differing from it, as already said, by being insoluble in solutions of acetic acid.

That the nucleus is the seat of formative energy is shown by a number of observations*, especially those which bear on the vegetable cell. In the latter the first stages, at least of starch formation, are carried out in the nucleus and this secretes a compound which is finally converted by the the cytoplasm into starch. Korschelt† has also determined that in the formation of the chitinous processes on the eggs of *Nepa* and *Ranatra* the chitin necessary for each process is elaborated in a cavity between and surrounded by two epithelial nuclei, and the only legitimate conclusion from such a circumstance is that the chitin is derived from a nuclear substance. I may also here refer to the fact that my own observations have definitely shown that the hæmaglobin of the red corpuscles in *Necturus* and *Amblystoma* is derived from the chromatin of the nucleus both of the fully formed as well as of the developing red cell, and that the hæmaglobin so formed diffuses through the nuclear membrane and becomes fixed in the cytoplasm. All these facts point definitely to the prominent part played by the nucleus and if everything in connection therewith is carefully studied, it will be admitted, I believe, that the interpretation which I have given of the changes occurring in the nuclei of the pancreatic cell during the various phases of glandular activity, is not a strained or a far-fetched one.

APPENDIX.

After the foregoing was written, a paper containing the observations of Eberth‡ on the pancreatic nebenkerne in salamander came into my hands. In this is advanced a new view of the relations of these bodies, or pseudo-nuclei, as Eberth prefers to call them. He states that they are developed out of the reticular fibrillæ of the cytoplasm, the latter at spots apparently becoming swollen, or thickened by fusion with their neighbors, and at the same time altered in composition, whereby their

* See a resumé of such researches in Strasburger: "Ueber Kern-und Zelltheilung im Pflanzenreiche nebst einem Anhang über Be fruchtung," Jena, 1888, pp. 194-204.

† "Ueber einige interessante Vorgänge bei der Bildung der Insecteneier." Zeit. für wess. Zool. Bd. 45.

‡ Neber Einschlüsse in Epithelzellen. Fortschritte der Medicin, Sept. 1., 1890.

capacity for absorbing staining reagents is increased. Later several of such bent fibrillæ approach one another and acquire the shape of a sickle, semicircle, or circle. The latter show all possible stages of transformation into the laminated bodies and spherules, which possess a very irregular fibrillation appearing to consist of loose threads, while they may at times resemble laminated colloid bodies. The pseudo-nuclei disappear during hunger, while becoming gradually paler and less easily stainable. As to the process and manner of disintegration Eberth could offer no explanation. He compares these bodies with structures described by Czermak as occurring in the ethmoid cartilage of the calf, and with those found by Solger in the cartilage cells of the shoulder-girdle of the pike. Eberth believes these structures to be normal, and, in a sense, comparable to the nodules of the nuclear network.

Eberth states that the employment of corrosive sublimate as a hardening reagent and of paraffin for imbedding produces contraction and shrinkage in these objects, and that then one obtains the peculiar shapes which possess a certain resemblance to Cytozoa. He accordingly recommends Rabl's Fluid or Flemming's Fluid for hardening and celloidin for imbedding.

Now I have carefully gone over the whole of my preparations since last October, and have during this winter made a number of new preparations from *Diemyctyli* and young *Amblystomata*, using for this purpose each of the three hardening reagents mentioned, frequently on pieces of the pancreas from the small animal. I have found that Rabl's Fluid often gives the appearance of coarse, parallel fibrillation in the pancreatic cells, when neither Flemming's Fluid nor corrosive sublimate demonstrated the presence of a single nebenkern in the parts of the pancreas hardened with either of these reagents. Such a parallel arrangement of coarse fibrillæ is probably artificially produced. It appears also to cause a swelling of the cytoplasmic fibrillæ, whereby these are rendered more distinct, and I think that to this property is due the advantage obtained by the employment of Rabl's Fluid in demonstrating the elements of the achromatic spindles in dividing nuclei.

My later observations strongly confirm my view that the nebenkerne are parasitic elements. In eight *Amblystomata*, killed during January and February, there were nebenkerne in only one, and here very abundantly. There could be no doubt about the sharply outlined form, as Steinhaus has figured it, often homogeneous but as often fibrillated. I have seen quite distinctly the thickened portion of the organism which simulates a head. As the *Amblystomata* kept in the laboratory tank were not regularly fed, I attribute the intact form possessed by many of the parasites to the lowered vitality of the host produced by want of food.

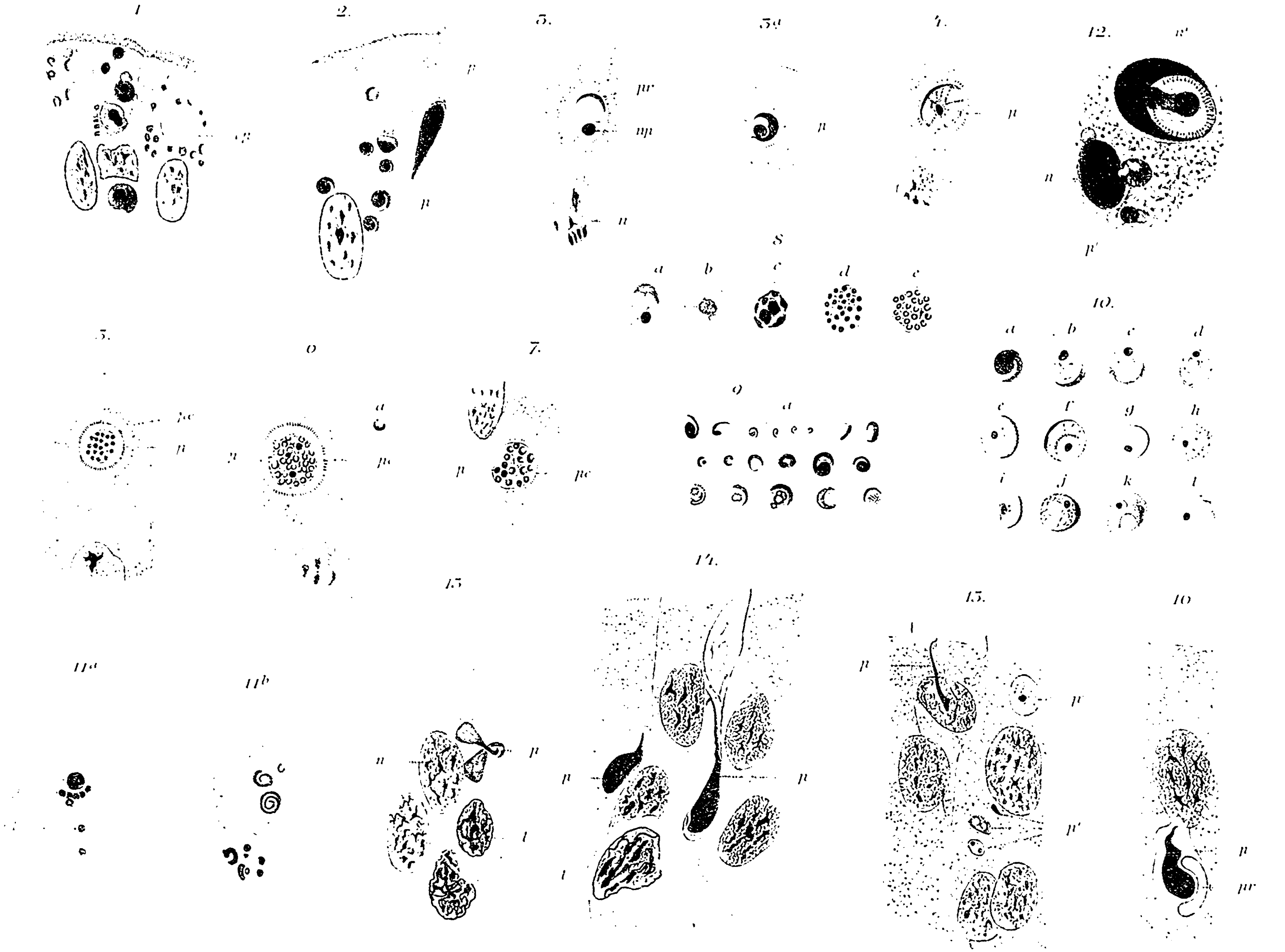
Eberth's views are directly opposed to mine. He considers the fibrillation of the structures in question not as an evidence of their degeneration, but as a stage in their formation. His observations, confined as they were to one form, cannot, I think, be held as conclusive by any one who has studied the changes in the pancreas of Amphibia as exhibited throughout the year. I cannot share Eberth's views as to the action of corrosive sublimate on the form of these bodies and that it does not produce a contraction or shrinkage, as he maintains, is shown by Figs. 1, 2, 9, and 10*d*, *nb*, which were drawn from preparations made with this reagent. I would call attention to Fig. 10*b*, *nb*, which shows a form not at all uncommon in the specimen of *Amblystoma* referred to in the last paragraph and which is very like some of the specimens of *Drepanidium* figured by Gaule.

I have, in this connection, made further observations on the elaboration of the pancreatic ferment. The results of these are confirmatory of the views already advanced by me and may be summarized as follows :—

1. In the gland cell filling up with zymogen granules, the latter are largest at the border of lumen of the gland tubule, while the smallest are found at that edge of the granular area nearest the nucleus. This serves to show that the granules are increased in volume by the deposition of a substance from the "protoplasmic" area of the gland cell.

2. While the eosinophilous substance disappears from the nucleus, the "protoplasmic" zone becomes eosinophilous at a time nearly coinciding with the commencement of the deposit of granules in the cell. In other words, the eosinophilous (or safranophilous) substance diffuses out the nucleus to the protoplasmic zone of the cell, from which it is apparently removed to be fixed in some way in the zymogen granules.

3. In the gland cell after exhaustion and when a restoration of its active condition commences there is an absorption, apparently from without, of chromatin, or of a chromatin-like substance, by the protoplasmic zone, and it would seem that the nucleus increases its quantity of chromatin from this source.



EXPLANATION OF PLATE I.

The illustrations are drawn with the Abbe camera lucida, combined with the 3mm. or the 2mm. apochromatic objectives (Zeiss), and compensation ocular 4 or 8.

Figs. 1-11 are from the intestine of *Diemyctylus viridescens.*

Fig. 1. Three epithelial cells in each of which there are unusual structures—*cp* represents the cavity in which, apparently, a parasitic element matured and whose spores are seen in the adjacent cytoplasm. In the central cell are probably both spores and invaginated, cytolysed material, while in the cell to the left there are structures which from their shape appear to be parasitic. ×720.

Fig. 2. Two epithelial cells in one of which the nucleus is degenerated. In both cells are seen structures exemplifying two stages in the development of the same parasite. In the degenerated cell the parasite, *p*, is matured, but in the cytoplasm of the other cell, they are, apparently, all comma-shaped. ×1000.

Fig. 3. A single epithelial cell containing a fairly typical specimen of the parasite, *n*, the cellular nucleus, *np*, the nucleus of the parasitic organism. There is present a cavity and a rim of thickened protoplasm, *pr*.

Fig. 3*a*. An epithelial cell in which the parasite, *p*, is in the stage of transition from the comma to the adult form. ×1000.

Fig. 4. In this the parasite, *p*, possesses a central mass of protoplasm in which is imbedded the nucleus and which sends processes toward the periphery. The remains of the tail of the comma are still recognisable in the denser portion of the periphery. ×1000.

Figs. 5, 6, and 7. The sporulation stages of the parasite with the trabecular arrangement of the cell protoplasm *pc*, well marked The horseshoe form of the spore is clearly shown in 6*a*. ×1000. 6*a*. ×2250.

Fig. 8. Represents five stages in the development of the sporulation phase of the parasite. In *a* the thickened band of protoplasm at one side represents the remains of the tail of the comma stage; in *b* the two central rings probably represent a stage of mitosis which is further advanced in *c*; in *d* the spores are formed each in a cavity of the ptoor plasm and these are further developed in *e*. ×1000.

Fig. 9. Represents illustrations of comma forms met with in the epithelial cells. In *a* coiled form is shown. ×1000.

Fig. 10 *a-d.* are illustrations showing the way in which the comma is transformed into the adult parasite; *e-l* represent forms which show the various ways in which the nucleus, cavity and tail are disposed in the adult or developing form. ×1000.

Fig. 11*a.* Represents a section of an epithelial cell in a cavity of which are enigmatical structures, the larger one probably being parasitic, the others may be either parasitic or protoplasmic masses with chromatin spherules. ×1000.

Fig. 11*b.* In this cell are a number of structures all of which are evidently parasites. ×1000.

Fig. 12. A cell found in the epithelial layer of the intestine of *Necturus*, *n*, the nucleus, *p*, plasmosomata-like masses which may be parasitic, n^1, a nucleus in which the chromatin is principally massed at one side and continued into the cavity in the form of doubly beaded rodlets; a dumb-bell shaped body, deeply eosinophilous, is shown in the act of migration from the cavity. ×660.

Fig. 13. Epithelial cells of the intestine of *Necturus; n*, the epithelial nuclei; *l*, the nuclei of leucocytes; *p*, two intracellular parasites lying in cavities of the cell. ×660.

Fig. 14. Intestinal epithelial cells of *Necturus; p*, parasitic elements; *l*, the nucleus of a leucocyte. ×660.

Fig. 15. Intestinal cells of *Necturus; p*, parasites migrating from from nucleus; p^1, either invaginated, cytolysed material or stages in the development of the parasite. ×500.

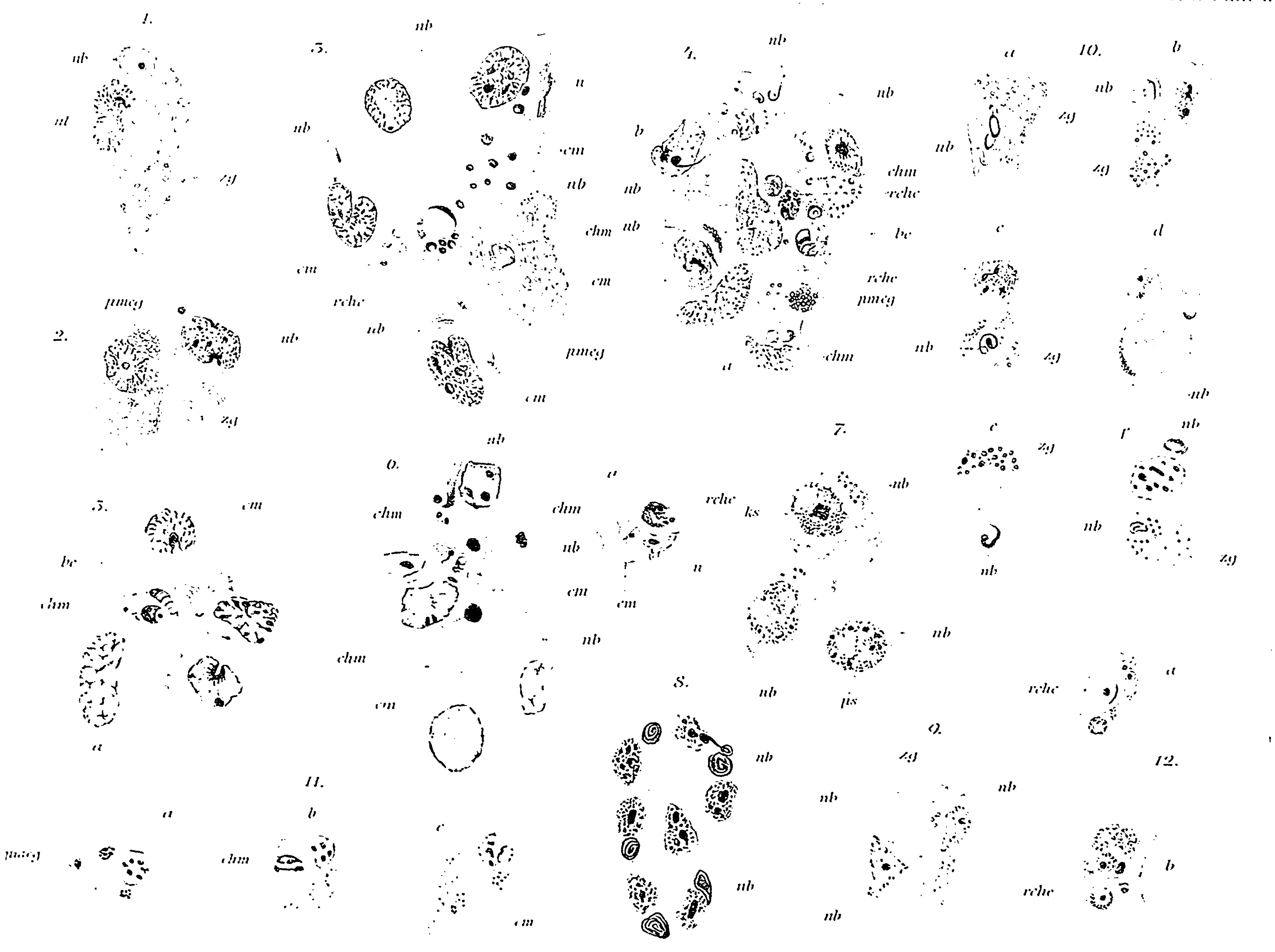
Fig. 16. A single epithelial cell of the intestine of *Necturus*, showing a large cavity in its proximal part occupied by a parasite *p*, and protoplasmic remains, *pr.* ×600.

EXPLANATION OF PLATE II.

The outlines of all the figures were made with Abbe's camera lucida in combination with 2mm. apochromatic objective and compensation ocular, 4 or 8. In the case of Fig. 8 the drawing was made at the foot instead of at the level of the stage of the microscope, hence the difference in the magnification.

bc, blood corpuscle.

cm, cytolysed masses.



chm, chromatin masses or bodies derived from chromatolysed nuclei.

pmeg, protoplasmic bodies loaded with eosinophilous granules like zymogen, but insoluble in acetic acid.

nb, nebenkern.

rchc, remains of chromatolysed nuclei and cells.

zg, zymogen granules.

Fig. 1 A resting pancreatic cell from *Diemyctylus; nl*, a large irregular plasmosoma; the chromatin is very abundant. Corrosive sublimate. Hæm., eosin. ×1000.

Fig. 2. Two resting pancreatic cells from the same preparation as the last. In the right hand cell the elasticity of the fibrils of the degenerated nebenkern has sprung out the cell wall. ×1000.

Fig. 3. From the active pancreas of *Diemyctylus*. Illustrates the invagination by normal cells of cytolysed material. The cavity in the centre occupied by the round mass, *rchc*, was probably the site of the cytolysed cell, and from this the cytolysed products have passed to the surrounding cells. The part represented occupied the centre of the section and the meshes of the cytoplasmic network were filled with zymogen granules which were dissolved out by the acid hardening reagents. It is to be noted that the nuclei here are large and rich in chromatin. Flemming's Fluid. Hæm., eosin. ×1000.

Fig. 4. Taken from near the margin of a similarly prepared section and therefore showing zymogen granules; *a*, enlarged nuclei; *b*, a nucleus with a sickle-shaped element, half within and half without the cell. ×1000.

Fig. 5. From the resting pancreas of *Diemyctylus*. The part drawn was from near the margin of the section. In the centre of the illustration is shown a cavity or intercellular space partially occupied by cytolysed material and the chromatin derived from it is found in the adjacent cell *(chm)*, whose nucleus is greatly enlarged. The other nuclei are somewhat irregular and rich in chromatin. Flemming's Fluid. Hæm., eosin, safranin. ×1000.

Fig. 6. From the central part of a section from the pancreas of a freshly captured specimen of *Diemyctylus*. Here also are shown free intercellular masses, and in the adjacent cells spherules of chromatin and cytoplasm; *a* represents a single cell from the same preparation. Flemmings Fluid. Hæm., eosin. ×1000.

Fig. 7. Three pancreatic cells from *Diemyctylus*. The formation of zymogen has advanced somewhat, the chromatin is abundant and the

karyosomata numerous and sometimes large *(ks)*. The plasmosomata of which there are two to each nucleus are usually large and irregular in shape. Corrosive sublimate. Hæm., eosin. ×1000.

Fig. 8. From the pancreas of a specimen of *Diemyctylus* deprived of food for five weeks. Corrosive sublimate. Hæm., eosin.

Fig. 9. From the pancreas of a specimen of *Diemyctylus* removed forty-five hours after an intra-abdominal injection of 0.4mgrm of pilocarpin. Corrosive sublimate. Hæm., eosin. ×1000.

Figs. 10 and 11. From the pancreas of specimens of *Amblystoma punctatum* (developing into adult condition). Fig. 10, *a-f*, drawn from the same pancreas. Corrosive sublimate. Hæm., eosin. ×1000.

Fig. 12. Cells lining the pancreatic ductlets of *Diemyctylus*, showing in their interior cytolysed and chromatolysed products *a* and *b*, from the pancreas 24 hours and one hour respectively after the intra-abdominal injection of pilocarpin. Corrosive sublimate. Hæm., eosin. ×1000

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(2.)—UNITED STATES.

Smithsonian Institution .... Washington, D.C.
Bureau of Ethnology .... "
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Surgeon-General, War Department .... "
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American Monthly Microscopical Journal	"
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Lick Observatory	"
Colorado Scientific Society	Denver.
Bridgeport Scientific Society	Bridgeport, Conn.
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American Journal of Science	New Haven, Conn.
Connecticut Academy of Arts and Sciences	"
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Georgia Historical Society	Savannah, Ga.
Chicago Historical Society	Chicago, Ill.
American Antiquarian and Oriental Journal	"
Illinois State Laboratory of Natural History	Champaign, Ill.
Brookville Society of Natural History	Brookville, Ind.
Indiana Historical Society	Indiana.
Academy of Natural Sciences	Davenport, Iowa.
State Historical Society of Iowa	Iowa City.
Kansas Historical Society	Topeka.
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Hemenway South-western Archæological Expedition	Salem, Mass.
American Antiquarian Society	Worcester, Mass.
Worcester Society of Antiquity	"
Agricultural College	near Lansing, Mich.
Academy of Natural Sciences	Minneapolis.
Geological and Natural History Survey of Minnesota	"
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Academy of Sciences	St. Louis, Mo.
Missouri Historical Society	"
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E. M. Museum of Geology and Archæology, Princeton College	Princeton, N.J.
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American Catholic Quarterly Review	"
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State Historical Society of Wisconsin .... "
Society of Alaskan Natural History and Ethnology .... Sitka, Alaska.
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(3.)—MEXICO.

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(4.)—SOUTH AMERICA AND WEST INDIES.

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Royal Agricultural and Commercial Society of British Guiana .... Demerara.
Institute of Jamaica .... Kingston, Jamaica.
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II.—EUROPE.

(1.)—GREAT BRITAIN AND IRELAND.

ENGLAND.

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Journal of Microscopy and Natural Science .... Bath.
Scientific Enquirer .... "

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SCOTLAND.

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IRELAND.

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Belfast Natural History and Philosophical Society	"	—6

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(3.)—BELGIUM.

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(4.)—DENMARK.

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(6.)—GERMANY.

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R. Friedländer und Sohn	"
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Geographische Gesellschaft	"
Naturforschende Gesellschaft	Danzig.
Naturwissenschaftlicher Verein "Isis"	Dresden.
Verein für Erdkunde	"
Senckenbergische Naturforschende Gesellschaft	Frankfurt-am-Main.
Naturwissenschaftlicher Verein des Regierungs-Bezirkes	Frankfurt-an-der-Oder.
Dr. Ernst Huth	"
Oberhessische Gesellschaft für Natur-und Heilkunde	Giessen.
Oberlausitzische Gesellschaft der Wissenschaften	Görlitz.
Königliche Gesellschaft der Wissenschaften	Göttingen.
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Anthropologischer Verein in Schleswig-Holstein	Kiel.
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Ostpreussische Physikalisch-Ökonomische Gesellschaft	Königsberg.
Naturforschende Gesellschaft zu Leipzig	Leipzig.
Königlich-Sächsische Gesellschaft der Wissenschaften	"
Verein für Erdkunde zu Leipzig	"
Museum für Völkerkunde	"
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Deutsche Gesellschaft für Anthropologie, Ethnologie und Urgeschichte	"
Görres-Gesellschaft (Historisches Jahrbuch)	"
Geographische Gesellschaft	"
Société Botanique Bavaroise	"
Westfälischer Provinzial-Verein für Wissenschaft und Kunst	Münster.
Naturhistorische Gesellschaft zu Nürnberg	Nürnberg.

Germanisches Nationalmuseum ....Nürnberg.
Verein für Naturkunde ....Offenbach-am-Mair
Historische Gesellschaft für die Provinz Posen.. .. ..Posen.
Zeitschrift für Physiologische Chemie ....Strassburg.
Kaiserliche Universitäts- und Landes-Bibliothek.................... "
Verein für Vaterländische Naturkunde in Würtemberg ....Stuttgart.
Nassauischer Verein für Naturkunde ....Wiesbaden. —52.

(7.)—ICELAND.

Islenzka Fornleifafélags ....Reykjavik. —1.

(8.)—ITALY.

Società Italiana dei Microscopisti ....Acireale.
R. Accademia Petrarca di Scienze, Lettere ed Arti ....Arezzo.
R. Accademia delle Scienze dell' Istituto di.......... .. . .Bologna.
Ateneo di Brescia ....Brescia.
Società Storica per la Provincia e Antica Diocesi di Como ....Como
R. Istituto di Studi Superiori in Firenze.............................Firenze.
Società Italiana di Antropologia, Etnologia, e Psicologia Comparata.... "
Sezione Fiorentina della Società Africana d'Italia.................. .. "
Società Entomologica Italiana .... "
Società di Lettura e Conversazione Scientifiche................ .. ...Genova.
Società Ligustica di Scienze Naturali e Geografiche......... ... . "
Società Ligure di Storia Patri...................... . .. . "
R. Accademia Lucchese di Scienze, Lettere ed Arti.. . .. . .Lucca.
R. Accademia di Belle Arti...... .... .Milano.
R. Istituto Lombardo di Scienze e Lettere .... "
Società Italiana di Scienze Naturali .... "
Società Veneto-Trentina di Scienze Naturali ....Padova.
Nuova Notarisia .... "
Società Toscana di Scienze Naturali...... . .. .Pisa.
Gazzeta Chimica Italiana .. ..Palermo.
Circolo Matematico di Palermo .... "
Società Siciliana per la Storia Patria.................... .... "
R. Accademia di Scienze, Lettere, e Belle Arti di Palermo............. "
Direzione del Giornale del Genio Civile .... .Roma.
Società Geografica Italiana.............. . ... "
R. Comitato Geologico d'Italia .... "
R. Accademia dei Lincei.............. .... "
Accademia Pontificia de' Nuovi Lincei .... "
Bullettino di Bibliografia e di Storia delle Scienze Matematiche e Fisiche.. "
Specula Vaticana .... "
"Cosmos" di Guido Cora.......... .... Torino.
Archivio di Letteratura Biblica ed Orientale .. .. "
R. Accademia delle Scienze......... .... "
Notarisia, Commentarium Phycologicum.............. ....Venezia.
R. Istituto Veneto di Scienze, Lettere ed Arti .... " —35

(9.)—NETHERLANDS.

Koninklijke Akademie van Wetenschappen ....Amsterdam.
Kon. Zoologisch Genootschap "Natura Artis Magistra" .... "
Kon. Nederlandsch Aardrijkskundig Genootschap .... "

École Polytechnique de Delft .... Delft.
Koninklijk Instituut voor de Taal-, Land- en Volkenkunde van Nederlandsch-Indië .... 'S Gravenhage.
Société Hollandaise des Sciences .... Harlem.
Fondation de P. Teyler van der Hulst .... "
Nederlandsche Botanische Vereeniging .... Leiden.
Nederlandsche Dierkundige Vereeniging .... "
Recueil des Travaux Chimiques des Pays-Bas .... "
Koninklijk Nederlandsch Meteorologisch Instituut .... Utrecht. —11

(10.)—NORWAY.

Musée de Bergen .... Bergen.
Polytekniske Forening .... Kristiania.
Forening til Norske Fortidsmindersmerkers Bevaring .... "
Videnskabs Selskabet .... "
Kongelige Norske Frederiks Universitet .... "
Nyt Magazin for Naturvidenskaberne .... "
Norwegische Commission der Europæischen Gradmessung .... "
Tromsö Museum .... Tromsö. —8

(11.)—PORTUGAL.

Sociedade de Geographia de Lisboa .... Lisboa.
Académie Royale des Sciences de Lisbonne .... "
"Gazette du Portugal" .... " —3

(12.)—ROUMANIA.

Institut Météorologique de Roumanie .... Bucarest. —1

(13.)—RUSSIA.

Société des Naturalistes à l'Université Impériale de .... Kharkow.
Société des Naturalistes à l'Université de St. Wladimir .... Kiew.
Societas Scientiarum Fennica .... Helsingfors.
Société de Géographie de Finlande .... "
Tifliser Observatorium .... Tiflis.
La Section Caucasienne de la Société Impériale Russe de Géographie .... "
Société Impériale des Naturalistes de Moscou .... Moscou.
Société Physico-chimique Russe à l'Université de .... S. Pétersbourg.
Comité Géologique .... "
La Société Impériale Russe de Géographie .... " —10.

(14.)—SPAIN.

"Crónica Cientifica" .... Barcelona.
"Revista Tecnologico Industrial" .... "
Real Academia de Ciencias Naturales y Artes .... "
Real Academia de Ciencias Morales y Politicas .... Madrid.
Real Academia de la Historia .... "
Sociedad Geográfica de Madrid .... " —6.

(15.)—SWEDEN.

Kongliga Universitetet .... Lund.
Kongliga Fysiografiska Sällskapet .... "

Kongliga Svenska Vetenskaps-Akademien .... Stockholm.
Kongliga Bibliotheket .... "
Stockholms Hogskola .... "
Svenska Sällskapet för Antropologi och Geografi .... "
Geologiska Förening i Stockholm .... "
"Acta Mathematica" .... "
Kongliga Universitetet .... Upsala. —9.

(16.)—SWITZERLAND.

Geografische Gesellschaft von Bern .... Bern.
Naturforschende Gesellschaft in Bern .... "
Schweizerische Naturforschende Gesellschaft .... Frauenfeld.
Société de Physique et d'Histoire Naturelle .... Genève.
Société de Géographie de Genève .... "
Institut National Génevois .... "
Société Vaudoise des Sciences Naturelles .... Lausanne.
Société Neuchâteloise de Géographie .... Neuchâtel.
Naturforschende Gesellschaft in Zürich .... Zürich. —9.

III.—ASIA.

(1.)—INDIA.

Asiatic Society of Bengal .... Calcutta.
Geological Survey of India .... "
Editor of the "Record" .... "
Survey of India Department .... "
"Indian Antiquary" .... Bombay.
Government Central Museum and Library .... Madras.
"Orientalist" .... Kandy, Ceylon.—7

(2.)—STRAITS SETTLEMENTS.

Journal of the Straits Branch of the Royal Asiatic Society .... Singapore. —1

(3.)—JAPAN.

University of Tōkyō .... Tōkyō.
Asiatic Society of Japan .... "
Deutsche Gesellschaft für Natur- und Völkerkunde Ostasiens .... "
Literature College of Imperial University of Japan .... "
College of Science, Imperial University of Japan .... "
Tōkyō Anthropological Society .... " —6

(4.)—JAVA.

Bataviaasch Genootschap van Kunsten en Wetenschappen .... Batavia.
Nederlandsch-Indische Maatschappij van Nijverheid en Landbouw .... " —2

(5.)—CHINA.

China Branch of the Royal Asiatic Society .... Shanghai.
Observatory of Hong Kong, and Government Publications .... Hong Kong.
His Excellency the Governor of Hong Kong .... " —3

(6.)—COCHIN-CHINA.

Société des Études Indo-Chinoises .... Saigon. —1

IV.—AFRICA.

(1.)—ALGERIA.

Société Archéologique du Départment de Constantine....... . . Constantine.
Société de Géographie et d'Archéologie de la Province d'Oran .. ..Oran.
Académie d'Hippone.. ... . Bône. —3

(2.)—CAPE COLONY.

South African Philosophical Society. .. ..Cape Town. —1

(3.)—EGYPT.

Institut Égyptien . . .. .Le Caire. — 1

V.—AUSTRALASIA.

(1.)—AUSTRALIA.

Royal Society of New South Wales .... Sydney.
Royal Geographical Society of Australasia .... "
Department of Mines, New South Wales ... . "
Linnean Society of New South Wales....... . ... "
Board of Technical Education .... "
Australasian Association for the Advancement of Science ... . "
Royal Society of Queensland . ...Brisbane.
Royal Society of Victoria ....Melbourne.
Public Library of Victoria .... "
Government Statist . ... " —10.

(2.)—NEW ZEALAND.

New Zealand Institute. .... Wellington. — 1.

(3).—TASMANIA.

Royal Society of Tasmania...... .. ..Hobarton. —1.

TOTAL ....516.