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THE

CANADIAN RECORD

OF SCIENCE.

VOL. VII. JULY, 1897. No. 7.

Postscript to a "Description of a New Genus and Species of Cystideans from the Trenton limestone at Ottawa."

By J. F. Whiteaves.

In the January number of this journal for the current year the writer endeavoured to describe a new genus and species of blastoid-like cystideans from the Trenton limestone at Ottawa, under the name *Astrocystites Canadensis*. Since this description was published, the writer has been informed by Mr. F. A. Bather, M.A., of the Natural History Department of the British Museum, that Haeckel in 1896 separated *Asteroblastus tuberculatus*, Schmidt, from the typical *A. stellatus* of Eichwald, under the new generic name *Asterocystis*. Mr. Bather thinks that there is not sufficient difference between the words *Astrocystites* and *Astrocystis*, and it would obviously be inconvenient to use such essentially similar names for two such closely related genera. The writer, therefore, desires to be allowed to substitute the generic name *Steganoblastus* (from στεγᾱνος, closely covered, with reference to the large covering plates and covered mouth, as kindly suggested by Mr. Bather) for that of *Astrocystites*,

which is practically preoccupied, and to retain the original specific name. In other words it is desired that the genus and species in future be called *Steganoblastus Canadensis* instead of *Astrocystites Canadensis.*

OTTAWA. Sept. 14th, 1897.

ADDENDUM TO NOTE ON NOVA SCOTIA CARBONIFEROUS ENTOMOSTRACA IN NUMBER FOR JANUARY, 1897.

Since the above note was printed, I have learned from Prof. T. Rupert Jones that he and his colleague, Mr. Kirkby, have recognized in specimens sent by me from Smelt Brook, north of New Glasgow, on the East River of Pictou, in addition to *Carbonia Bairdiodes*, two additional species, viz., *C. fabulina*, Jones and Kirkby, which is very common in most parts of the Coal Formation of Nova Scotia and Cape Breton, and *C. Rankiniana*, Fig. 10, a British Coal Formation species, not previously recognized in Nova Scotia, where it may have been overlooked owing to its strong resemblance to some forms of *C. fabulina.*

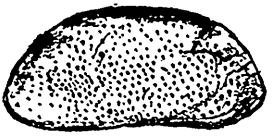

FIG. 10.
C. Rankiniana.

I mentioned with some doubt the specimens of *Estheria Dawsoni* from the supposed Lower Carboniferous Red Shales of the East Branch of the East River, but Prof. Jones confirms my identification of them, so that we may now hold this species as characteristic of the Lower Carboniferous of Nova Scotia; as it occurs in that formation in localities so widely separated as Lower Horton, Five Islands in Colchester, and Pictou County. The Pictou specimens are, however, of small size, and in the form of casts.

J. WM. DAWSON.

Sept. 30th, 1897.

The Meeting of the British Association for the Advancement of Science.

A few years ago our cousins to the south celebrated the four hundredth anniversary of the discovery of America by the Spaniards. Since that time the continent has been rediscovered by various nations, one of these discoveries, that of Canada, having occurred in 1884 when the British Association met in Montreal. The intrepid explorers found that instead of a howling wilderness of Arctic climate, peopled by pioneers living in log cabins and constantly armed against marauding Indians, the fair Dominion could boast of many of the advantages of a high state of civilization, including educational institutions that compared favorably with those of the mother country. The travellers on returning disseminated the knowledge thus obtained, and did much to convert Canada into one of the (Britishally) known parts of the globe. However, judging from many remarks made by various members of two expeditions which came here during the last summer to rediscover us again (the expression is used advisedly), a thorough knowledge of our country had not, up to the time of the sailing of these expeditions, percolated through all the strata of the population of the British Isles. We must not, however, be too ready to lay all the blame upon the old-country folk; we are far too prone in descanting upon the beauties of the Dominion to lay stress upon our winter scenery, our snow-shoeing, our boundless prairies, stupendous mountains, mighty lakes and rivers, etc., etc., and are we not fond of sending across the seas samples of Indian work, purporting to have come from the wigwam of the feathered and untutored savage, but probably manufactured in a very modern style of dwelling by the light of the sun coming through glass windows or the soft effulgence of an up-to-date kerosene lamp!

Be this all as it may, Canada, as a whole, and Toronto and Montreal in particular, were delighted to welcome the members of the British Association for the Advancement of Science and the British Medical Association who had travelled so far to hold their meetings here. We were glad of an opportunity of returning the hearty welcome accorded our representatives to the Jubilee celebrations, and we modestly think that the opportunity was not lost.

It is with the work of the British Association for the Advancement of Science that the readers of the RECORD are more particularly interested, and elsewhere we publish some of the principal addresses. The splendid arrangements made for the meetings by the people of Toronto, the programme of the meetings themselves, the excursions so well planned and carried out—these we cannot here dwell upon. Suffice it to say that the Queen City's reception was regal and was appreciated; it has all been exhaustively reported in the daily press.

On the way to Toronto the Association was not allowed to pass unrecognized. The steamer "Parisian," of the Allan Line, had been chartered to convey the members across the ocean, and was boarded at Rimouski by Dr. Harrington, of McGill University, who welcomed the travellers to Montreal, and explained what plans had been made there for their reception. On Saturday afternoon the steamer arrived in Montreal, and the landing of the passengers was much facilitated by an arrangement made with the Customs authorities by which luggage was passed without examination upon production of certificate of membership. Some of the "Colonials" were rather amused at the appearance at dinner in the Windsor Hotel that evening of one or two members in flannels, but a slight delay in the conveyance of some of the luggage to the hotel may have accounted for this.

Sunday was spent in a restful way, and on Monday morning a reception was tendered the Association by the

Governors, Principal and Fellows of McGill University in the Peter Redpath Library. After addresses of welcome had been made, the visitors were conducted in parties through the various buildings of the University, and, gathering at one o'clock in the William Molson Hall, sat down to a cold collation. After lunch carriages were in waiting to convey the party to Mount Royal Park, and on their return five o'clock tea was served in the Library. Some of the members went on to Ottawa that night, others leaving Montreal for Toronto direct on Tuesday, and on Wednesday morning the regular meetings began in Toronto.

During the last few years Montreal and Toronto have been the meeting places of many associations, conventions, etc., and the country cannot but benefit by such gatherings of intellectual men and women. Canadians become acquainted with the learned people of other countries, and these people learn much of Canada that they did not know before. We are always glad to receive such friends, but it was with peculiar pleasure that we welcomed the members of the two British Associations during the last summer. May it not be long till we do so again!

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Address

By Sir John Evans, K.C.B., D.C.L., LL.D., Sc.D., Treas.R.S., V.P.S.A., For.Sec.G.S., Correspondant de l'institut de France, etc., etc., etc., President.

Once more has the Dominion of Canada invited the British Association for the Advancement of Science to hold one of the annual meetings of its members within the Canadian territory; and for a second time has the Association had the honour and pleasure of accepting the proffered hospitality.

In doing so, the Association has felt that if by any

possibility the scientific welfare of a locality is promoted by its being the scene of such a meeting, the claims should be fully recognised of those who, though not dwelling in the British Isles, are still inhabitants of that Greater Britain whose prosperity is so intimately connected with the fortunes of the Mother Country.

Here, especially, as loyal subjects of one beloved Sovereign, the sixtieth year of whose beneficent reign has just been celebrated with equal rejoicing in all parts of her Empire; as speaking the same tongue, and as in most instances connected by the ties of one common parentage, we are bound together in all that can promote our common interests.

There is, in all probability, nothing that will tend more to advance those interests than the diffusion of science in all parts of the British Empire, and it is towards this end that the aspirations of the British Association are ever directed, even if in many instances the aim may not be attained.

We are, as already mentioned, indebted to Canada for previous hospitality, but we must also remember that, since the time when we last assembled on this side of the Atlantic, the Dominion has provided the Association with a President, Sir William Dawson, whose name is alike well known in Britain and America, and whose reputation is indeed world wide. We rejoice that we have still among us the pioneer of American geology, who among other discoveries first made us acquainted with the "Air-breathers of the Coal," the terrestrial or more properly arboreal Saurians of the New Brunswick and Nova Scotia Coal-measures.

On our last visit to Canada, in 1884, our place of assembly was Montreal, a city which is justly proud of her McGill University; to-day we meet within the buildings of another of the Universities of this vast Dominion—and in a city, the absolute fitness of which for

such a purpose must have been foreseen by the native Indian tribes when they gave to a small aggregation of huts upon this spot the name of Toronto—"the place of meetings."

Our gathering this year presents a feature of entire novelty and extreme interest, inasmuch as the sister Association of the United States of America,—still mourning the loss of her illustrious President, Professor Cope,—and some other learned societies, have made special arrangements to allow of their members coming here to join us. I need hardly say how welcome their presence is, nor how gladly we look forward to their taking part in our discussions, and aiding us by interchange of thought. To such a meeting the term international seems almost misapplied. It may rather be described as a family gathering, in which our relatives more or less distant in blood, but still intimately connected with us by language, literature, and habits of thought, have spontaneously arranged to take part.

The domain of science is no doubt one in which the various nations of the civilized world meet upon equal terms, and for which no other passport is required than some evidence of having striven towards the advancement of natural knowledge. Here, on the frontier between the two great English-speaking nations of the world, who is there that does not inwardly feel that anything which conduces to an intimacy between the representatives of two countries, both of them actively engaged in the pursuit of science, may also, through such an intimacy, react on the affairs of daily life, and aid in preserving those cordial relations that have now for so many years existed between the great American Republic and the British Islands, with which her early foundations are indissolubly connected? The present year has witnessed an interchange of courtesies which has excited the warmest feelings of approbation on both sides of the Atlantic. I

mean the return to its proper custodians of one of the most interesting of the relics of the Pilgrim Fathers, the Log of the May Flower. May this return, trifling in itself, be of happy augury as testifying to the feelings of mutual regard and esteem which animate the hearts both of the donors and of the recipients!

At our meeting in Montreal the President was an investigator who had already attained to a foremost place in the domains of Physics and Mathematics, Lord Rayleigh. In his address he dealt mainly with topics such as Light, Heat, Sound and Electricity, on which he is one of our principal authorities. His name and that of his fellow-worker, Professor Ramsay, are now and will in all future ages be associated with the discovery of the new element, Argon. Of the ingenious methods by which that discovery was made, and the existence of Argon established, this is not the place to speak. One can only hope that the element will not always continue to justify its name by its continued inertness.

The claims of such a leader in physical science as Lord Rayleigh to occupy the Presidential chair are self-evident, but possibly those of his successor on this side of the Atlantic are not so immediately apparent. I cannot for a moment pretend to place myself on the same purely scientific level as my distinguished friend and for many years colleague, Lord Rayleigh, and my claims, such as they are, seem to me to rest on entirely different grounds.

Whatever little I may have indirectly been able to do in assisting to promote the advancement of science, my principal efforts have now for many years been directed towards attempting to forge those links in the history of the world, and especially of humanity, that connect the past with the present, and towards tracing that course of evolution which plays as important a part in the physical and moral development of man as it does in that of the animal and vegetable creation.

It appears to me, therefore, that my election to this important post may, in the main, be regarded as a recognition by this Association of the value of Archæology as a science.

Leaving all personal considerations out of question, I gladly hail this recognition, which is, indeed, in full accordance with the attitude already for many years adopted by the Association towards Anthropology, one of the most important branches of true Archæology.

It is no doubt hard to define the exact limits which are to be assigned to Archæology as a science, and Archæology as a branch of History and Belles Lettres. A distinction is frequently drawn between science on the one hand and knowledge or learning on the other; but translate the terms into Latin, and the distinction at once disappears. In illustration of this I need only cite Bacon's great work on the "Advancement of Learning," which was, with his own aid, translated into Latin under the title *De Augmentis Scientiarum*.

It must, however, be acknowledged that a distinction does exist between Archæology proper, and what, for want of a better word, may be termed Antiquarianism. It may be interesting to know the internal arrangements of a Dominican convent in the middle ages; to distinguish between the different mouldings characteristic of the principal styles of Gothic architecture; to determine whether an English coin bearing the name of Henry was struck under Henry II., Richard, John, or Henry III., or to decide whether some given edifice was erected in Roman, Saxon, or Norman times. But the power to do this, though involving no small degree of detailed knowledge and some acquaintance with scientific methods, can hardly entitle its possessors to be enrolled among the votaries of science.

A familiarity with all the details of Greek and Roman mythology and culture must be regarded as a literary

rather than a scientific qualification; and yet when among the records of classical times we come upon traces of manners and customs which have survived for generations, and which seem to throw some rays of light upon the dim past, when history and writing were unknown, we are, I think, approaching the boundaries of scientific Archæology.

Every reader of Virgil knows that the Greeks were not merely orators, but that with a pair of compasses they could describe the movements of the heavens and fix the rising of the stars; but when by modern Astronomy we can determine the heliacal rising of some well-known star, with which the worship in some given ancient temple is known to have been connected, and can fix its position on the horizon at some particular spot, say, 3,000 years ago, and then find that the axis of the temple is directed exactly towards that spot, we have some trustworthy scientific evidence that the temple in question must have been erected at a date approximately 1,100 years B.C. If on or close to the same site we find that more than one temple was erected, each having a different orientation, these variations, following as they may fairly be presumed to do the changing position of the rising of the dominant star, will also afford a guide as to the chronological order of the different foundations. The researches of Mr. Penrose seem to show that in certain Greek temples, of which the date of foundation is known from history, the actual orientation corresponds with that theoretically deduced from astronomical data.

Sir J. Norman Lockyer has shown that what holds good for Greek temples applies to many of far earlier date in Egypt, though up to the present time hardly a sufficient number of accurate observations have been made to justify us in foreseeing all the instructive results that may be expected to arise from Astronomy coming to the aid of Archæology.

The intimate connection of Archæology with other sciences is in no case so evident as with respect to Geology, for when considering subjects such as those which I shall presently discuss, it is almost impossible to say where the one science ends and the other begins.

By the application of geological methods many archæological questions relating even to subjects on the borders of the historical period have been satisfactorily solved. A careful examination of the limits of the area over which its smaller coins are found has led to the position of many an ancient Greek city being accurately ascertained; while in England it has only been by treating the coins of the Ancient Britons, belonging to a period before the Roman occupation, as if they were actual fossils, that the territories under the dominion of the various kings and princes who struck them have been approximately determined. In arranging the chronological sequence of these coins, the evolution of their types—a process almost as remarkable, and certainly as well defined, as any to be found in nature—has served as an efficient guide. I may venture to add that the results obtained from the study of the morphology of this series of coins were published ten years before the appearance of Darwin's great work on the "Origin of Species."

When we come to the consideration of the relics of the Early Iron and Bronze Ages, the aid of Chemistry has of necessity to be invoked. By its means we are able to determine whether the iron of a tool or weapon is of meteoritic or volcanic origin, or has been reduced from iron-ore, in which case considerable knowledge of metallurgy would be involved on the part of those who made it. With bronze antiquities the nature and extent of the alloys combined with the copper may throw light not only on their chronological position, but on the sources whence the copper, tin, and other metals of which they consist were originally derived. I am not aware of

there being sufficient differences in the analysis of the native copper from different localities in the region in which we are assembled, for Canadian Archæologists to fix the sources from which the metal was obtained which was used in the manufacture of the ancient tools and weapons of copper that are occasionally discovered in this part of the globe.

Like Chemistry, Mineralogy and Petrology may be called to the assistance of Archæology in determining the nature and source of the rocks of which ancient stone implements are made; and, thanks to researches of the followers of those sciences, the old view that all such implements formed of jade and found in Europe must of necessity have been fashioned from material imported from Asia can no longer be maintained. In one respect the Archæologist differs in opinion from the Mineralogist, namely, as to the propriety of chipping off fragments from perfect and highly-finished specimens for the purpose of submitting them to microscopic examination.

I have hitherto been speaking of the aid that other sciences can afford to Archæology when dealing with questions that come almost, if not quite, within the fringe of history, and belong to times when the surface of our earth presented much the same configuration as regards the distribution of land and water, and hill and valley, as it does at present, and when, in all probability, the climate was much the same as it now is. When, however, we come to discuss that remote age in which we find the earliest traces that are at present known of man's appearance upon earth, the aid of Geology and Palæontology becomes absolutely imperative.

The changes in the surface configuration and in the extent of the land, especially in a country like Britain, as well as the modifications of the fauna and flora since those days, have been such that the Archæologist pure and simple is incompetent to deal with them, and he must

either himself undertake the study of these other sciences or call experts in them to his assistance. The evidence that man had already appeared upon the earth is afforded by stone implements wrought by his hands, and it falls strictly within the province of the Archæologist to judge whether given specimens were so wrought or not; it rests with the geologist to determine their stratigraphical or chronological position, while the Palæontologist can pronounce upon the age and character of the associated fauna and flora.

If left to himself the Archæologist seems too prone to build up theories founded upon form alone, irrespective of geological conditions. The Geologist, unaccustomed to archæological details, may readily fail to see the difference between the results of the operations of Nature and those of Art, and may be liable to trace the effects of man's handiwork in the chipping, bruising and wearing which in all ages result from natural forces; but the united labors of the two, checked by those of the Palæontologist, cannot do otherwise than lead towards sound conclusions.

It will perhaps be expected of me that I should on the present occasion bring under review the state of our present knowledge with regard to the Antiquity of Man; and probably no fitter place could be found for the discussion of such a topic than the adopted home of my venerated friend, the late Sir Daniel Wilson, who first introduced the word "prehistoric" into the English language.

Some among us may be able to call to mind the excitement, not only among men of science, but among the general public, when, in 1859, the discoveries of M. Boucher de Perthes and Dr. Rigollot in the gravels of the valley of the Somme, at Abbeville and Amiens, were confirmed by the investigations of the late Sir Joseph Prestwich, myself, and others, and the co-existence of man with the extinct animals of the Quaternary fauna, such as the mammoth

and woolly-haired rhinoceros, was first virtually established. It was at the same time pointed out that these relics belonged to a far earlier date than the ordinary stone weapons found upon the surface, which usually showed signs of grinding or polishing, and that in fact there were two Stone Ages in Britain. To these the terms Neolithic and Palæolithic were subsequently applied by Sir John Lubbock.

The excitement was not less when, at the meeting of this Association at Aberdeen in the autumn of that year, Sir Charles Lyell, in the presence of the Prince Consort, called attention to the discoveries in the valley of the Somme, the site of which he had himself visited, and to the vast lapse of time indicated by the position of the implements in drift-deposits a hundred feet above the existing river.

The conclusions forced upon those who examined the facts on the spot did not receive immediate acceptance by all who were interested in Geology and Archæology, and fierce were the controversies on the subject that were carried on both in the newspapers and before various learned societies.

It is at the same time instructive and amusing to look back on the discussions of those days. While one class of objectors accounted for the configuration of the flint implements from the gravels by some unknown chemical agency, by the violent and continued gyratory action of water, by fracture resulting from pressure, by rapid cooling when hot or by rapid heating when cold, or even regarded them as aberrant forms of fossil fishes, there were others who, when compelled to acknowledge that the implements were the work of men's hands, attempted to impugn and set aside the evidence as to the circumstances under which they had been discovered. In doing this they adopted the view that the worked flints had either been introduced into the containing beds at a

comparatively recent date, or if they actually formed constituent parts of the gravel, then that this was a mere modern alluvium resulting from floods at no very remote period.

In the course of a few years the main stream of scientific thought left this controversy behind, though a tendency to cut down the lapse of time necessary for all the changes that have taken place in the configuration of the surface of the earth and in the character of its occupants since the time of the Palæolithic gravels, still survives in the inmost recesses of the hearts of not a few observers.

In his address to this Association at the Bath meeting of 1864, Sir Charles Lyell struck so true a note that I am tempted to reproduce the paragraph to which I refer:—

"When speculations on the long series of events which occurred in the glacial and post-glacial periods are indulged in, the imagination is apt to take alarm at the immensity of the time required to interpret the monuments of these ages, all referable to the era of existing species. In order to abridge the number of centuries which would otherwise be indispensable, a disposition is shown by many to magnify the rate of change in prehistoric times by investing the causes which have modified the animate and inanimate world with extraordinary and excessive energy. It is related of a great Irish orator of our day that when he was about to contribute somewhat parsimoniously towards a public charity, he was persuaded by a friend to make a more liberal donation. In doing so he apologised for his first apparent want of generosity by saying that his early life had been a constant struggle with scanty means, and that 'they who are born to affluence cannot easily imagine how long a time it takes to get the chill of poverty out of one's bones.' In like manner we of the living generation when called upon to make grants of thousands of centuries

in order to explain the events of what is called the modern period, shrink naturally at first from making what seems so lavish an expenditure of past time. Throughout our early education we have been accustomed to such strict economy in all that relates to the chronology of the earth and its inhabitants in remote ages, so fettered have we been by old traditional beliefs, that even when our reason is convinced, and we are persuaded that we ought to make more liberal grants of time to the geologist, we feel how hard it is to get the chill of poverty out of our bones."

Many, however, have at the present day got over this feeling, and of late years the general tendency of those engaged upon the question of the antiquity of the human race has been in the direction of seeking for evidence by which the existence of man upon the earth could be carried back to a date earlier than that of the Quaternary gravels.

There is little doubt that such evidence will eventually be forthcoming, but, judging from all probability, it is not in Northern Europe that the cradle of the human race will eventually be discovered, but in some part of the world more favoured by a tropical climate, where abundant means of subsistence could be procured, and where the necessity for warm clothing did not exist.

Before entering into speculations on this subject, or attempting to lay down the limits within which we may safely accept recent discoveries as firmly established, it will be well to glance at some of the cases in which implements are stated to have been found under circumstances which raise a presumption of the existence of man in pre-Glacial, Pliocene, or even Miocene times.

Flint implements of ordinary Palæolithic type have, for instance, been recorded as found in the Eastern Counties of England, in beds beneath the Chalky Boulder Clay; but on careful examination the geological evidence has

not to my mind proved satisfactory, nor has it, I believe, been generally accepted. Moreover, the archæological difficulty that man, at two such remote epochs as the pre-Glacial and the post-Glacial, even if the term Glacial be limited to the Chalky Boulder Clay, should have manufactured implements so identical in character that they cannot be distinguished apart, seems to have been entirely ignored.

Within the last few months we have had the report of worked flints having been discovered in the late Pliocence Forest Bed of Norfolk, but in that instance the signs of human workmanship upon the flints are by no means apparent to all observers.

But such an antiquity as that of the Forest Bed is as nothing when compared with that which would be implied by the discoveries of the work of men's hands in the Pliocene and Miocence beds of England, France, Italy and Portugal, which have been accepted by some Geologists. There is one feature in these cases which has hardly received due attention, and that is the isolated character of the reputed discoveries. Had man, for instance, been present in Britain during the Crag Period, it would be strange indeed if the sole traces of his existence that he left were a perforated tooth of a large shark, the sawn rib of a manatee, and a beaming full face, carved on the shell of a pectunculus!

In an address to the Anthropological Section at the Leeds meeting of this Association in 1890 I dealt somewhat fully with these supposed discoveries of the remains of human art in beds of Tertiary date; and I need not here go further into the question. Suffice it to say that I see no reason why the verdict of "not proven" at which I then arrived should be reversed.

In the case of a more recent discovery in Upper Burma in beds at first pronounced to be Upper Miocene, but subsequently "definitely ascertained to be Pliocene," some

of the flints are of purely natural and not artificial origin, so that two questions arise: First, Were the fossil remains associated with the worked flints or with those of natural forms? and second, Were they actually found in the bed to which they have been assigned or did they merely lie together on the surface?

Even the *Pithecanthropus erectus* of Dr. Eugène Dubois from Java meets with some incredulous objectors from both the physiological and the geological sides. From the point of view of the latter the difficulty lies in determining the exact age of what are apparently alluvial beds in the bottom of a river valley.

When we return to Palæolithic man, it is satisfactory to feel that we are treading on comparatively secure ground, and that the discoveries of the last forty years in Britain alone enable us to a great extent to reconstitute his history. We may not know the exact geological period when first he settled in the British area, but we have good evidence that he occupied it at a time when the configuration of the surface was entirely different from what it is at present: when the river valleys had not been cut down to anything like their existing depth, when the fauna of the country was of a totally different character from that of the present day, when the extension of the southern part of the island seaward was in places such that the land was continuous with that of the continent, and when in all probability a far more rainy climate prevailed. We have proofs of the occupation of the country by man during the long lapse of time that was necessary for the excavation of the river valleys. We have found the old floors on which his habitations were fixed, we have been able to trace him at work on the manufacture of flint instruments, and by building up the one upon the other the flakes struck off by the primæval workman in those remote times we have been able to reconstruct the blocks of flint which served as his material,

That the duration of the Palæolithic Period must have extended over an almost incredible length of time is sufficiently proved by the fact that valleys, some miles in width and of a depth of from 100 to 150 feet, have been eroded since the deposit of the earliest implement-bearing beds. Nor is the apparent duration of this period diminished by the consideration that the floods which hollowed out the valleys were not in all probability of such frequent occurrence as to teach Palæolithic man by experience the danger of settling too near to the streams, for had he kept to the higher slopes of the valley there would have been but little chance of his implements having so constantly formed constituent parts of the gravels deposited by the floods.

The examination of British cave-deposits affords corroborative evidence of this extended duration of the Palæolithic Period. In Kent's Cavern at Torquay, for instance, we find in the lowest deposit, the breccia below the red-cave earth, implements of flint and chert corresponding in all respects with those of the high level and most ancient river gravels. In the cave-earth these are scarcer, though implements occur which also have their analogues in the river deposits; but, what is more remarkable, harpoons of reindeer's horn and needles of bone are present, identical in form and character with those of the caverns of the Reindeer Period in the south of France, and suggestive of some bond of union or identity of descent between the early troglodytes, whose habitations were geographically so widely separated the one from the other.

In a cavern at Creswell Crags, on the confines of Derbyshire and Nottinghamshire, a bone has moreover been found engraved with a representation of parts of a horse in precisely the same style as the engraved bones of the French caves.

It is uncertain whether any of the River-drift specimens

belong to so late a date as these artistic cavern-remains; but the greatly superior antiquity of even these to any Neolithic relics is testified by the thick layer of stalagmite, which had been deposited in Kent's Cavern before its occupation by men of the Neolithic and Bronze Periods.

Towards the close of the period covered by the human occupation of the French caves, there seems to have been a dwindling in the number of the larger animals constituting the Quaternary fauna, whereas their remains are at present in abundance in the lower and therefore more recent of the gravel levels. This circumstance may afford an argument in favor of regarding the period represented by the later French caves as a continuation of that during which the old river gravels were deposited, and yet the great change in the fauna that has taken place since the latest of the cave-deposits included in the Palæolithic Period is indicative of an immense lapse of time.

How much greater must have been the time required for the more conspicuous change between the old Quaternary fauna of the river gravels and that characteristic of the Neolithic Period!

As has been pointed out by Prof. Boyd Dawkins, only thirty-one out of the forty-eight well-ascertained species living in the post-Glacial or River-drift Period survived into pre-historic or Neolithic times. We have not, indeed, any means at command for estimating the number of centuries which such an important change indicates; but when we remember that the date of the commencement of the Neolithic or Surface Stone Period is still shrouded in the midst of a dim antiquity, and that prior to that commencement the River-drift Period had long come to an end; and when we further take into account the almost inconceivable ages that even under the most favorable conditions the excavation of wide and deep valleys by river action implies, the remoteness of the date at which the Palæolithic Period had its beginning almost transcends our powers of imagination.

We find distinct traces of river action from 100 to 200 feet above the level of existing streams and rivers, and sometimes at a great distance from them; we observe old fresh-water deposits on the slopes of valleys several miles in width; we find that long and lofty escarpments of rock have receded unknown distances since their summits were first occupied by Palæolithic man; we see that the whole side of a wide river valley has been carried away by an invasion of the sea, which attacked and removed a barrier of chalk cliffs from 400 to 600 feet in height; we find that what was formerly an inland river has been widened out into an arm of the sea, now the highway of our fleets, and that gravels which were originally deposited in the bed of some ancient river now cap isolated and lofty hills.

And yet, remote as the date of the first known occupation of Britain by man may be, it belongs to what, geologically speaking, must be regarded as a quite recent period, for we are now in a position to fix with some degree of accuracy its place on the geological scale. Thanks to investigations ably carried out at Hoxne in Suffolk, and at Hitchin in Hertfordshire, by Mr. Clement Reid, under the auspices of this Association and of the Royal Society, we know that the implement-bearing beds at those places undoubtedly belong to a time subsequent to the deposit of the Great Chalky Boulder Clay of the Eastern Counties of England. It is, of course, self-evident that this vast deposit, in whatever manner it may have been formed, could not for centuries after its deposition was complete have presented a surface inhabitable by man. Moreover, at a distance but little farther north, beds exist which also, though at a somewhat later date, were apparently formed under glacial conditions. At Hoxne the interval between the deposit of the Boulder Clay and of the implement-bearing beds is distinctly proved to have witnessed at least two noteworthy

changes in climate. The beds immediately reposing on the clay are characterized by the presence of alder in abundance, of hazel, and yew, as well as by that of numerous flowering plants indicative of a temperate climate very different from that under which the Boulder Clay itself was formed. Above these beds characterized by temperate plants comes a thick and more recent series of strata, in which leaves of the dwarf Arctic willow and birch abound, and which were in all probability deposited under conditions like those of the cold regions of Siberia and North America.

At a higher level and of more recent date than these—from which they are entirely distinct—are the beds containing Palæolithic implements formed in all probability under conditions not essentially different from those of the present day. However this may be, we have now conclusive evidence that the Palæolithic implements are, in the Eastern Counties of England, of a date long posterior to that of the Great Chalky Boulder Clay.

It may be said, and said truly, that the implements at Hoxne cannot be shown to belong to the beginning rather than to some later stage of the Palæolithic Period. The changes, however, that have taken place at Hoxne in the surface configuration of the country prove that the beds containing the implements cannot belong to the close of that period.

It must, moreover, be remembered that in what are probably the earliest of the Palæolithic deposits of the Eastern Counties, those at the highest level, near Brandon in Norfolk, where the gravels contain the largest proportion of pebbles derived from the Glacial beds, some of the implements themselves have been manufactured from materials not native to the spot but brought from a distance, and derived in all probability either from the Boulder Clay, or from some of the beds associated with it.

We must, however, take a wider view of the whole question, for it must not for a moment be supposed that there are the slightest grounds for believing that the civilisation, such as it was, of the Palæolithic Period originated in the British Isles. We find in other countries implements so identical in form and character with British specimens that they might have been manufactured by the same hands. These occur over large areas in France under similar conditions to those that prevail in England. The same forms have been discovered in the ancient river gravels of Italy, Spain and Portugal. Some few have been recorded from the north of Africa, and analogous types occur in considerable numbers in the south of that continent. On the banks of the Nile, many hundreds of feet above its present level, implements of the European times have been discovered; while in Somaliland, in an ancient river valley at a great elevation above the sea, Mr. Seton-Karr has collected a large number of implements formed of flint and quartzite, which, judging from their form and character, might have been dug out of the drift deposits of the Somme or the Seine, the Thames or the ancient Solent.

In the valley of the Euphrates implements of the same kind have also been found, and again farther east in the lateritic deposits of Southern India they have been obtained in considerable numbers. It is not a little remarkable, and is at the same time highly suggestive, that a form of implement almost peculiar to Madras reappears among implements from the very ancient gravels of the Manzanares at Madrid. In the case of the African discoveries we have as yet no definite Palæontological evidence by which to fix their antiquity, but in the Narbadà Valley of Western India Palæolithic implements of quartzite seem to be associated with a local fáuna of Pleistocene age, comprising, like that of Europe, the elephant, hippopotamus, ox, and other mammals of

species now extinct. A correlation of the two faunas with a view of ascertaining their chronological relations is beset with many difficulties, but there seems reason for accepting this Indian Pleistocene fauna as in some degree more ancient than the European.

Is this not a case in which the imagination may be fairly invoked in aid of science? May we not from these data attempt in some degree to build up and reconstruct the early history of the human family? There, in Eastern Asia, in a tropical climate, with the means of subsistence readily at hand, may we not picture to ourselves our earliest ancestors gradually developing from a lowly origin, acquiring a taste for hunting, if not indeed being driven to protect themselves from the beasts around them, and evolving the more complicated forms of tools or weapons from the simpler flakes which had previously served them as knives? May we not imagine that, when once the stage of civilisation denoted by these Palæolithic implements had been reached, the game for the hunter became scarcer, and that his life in consequence assumed a more nomad character? Then, and possibly not till then, may a series of migrations to "fresh woods and pastures new" not unnaturally have ensued, and these following the usual course of "westward towards the setting sun" might eventually lead to a Palæolithic population finding its way to the extreme borders of Western Europe, where we find such numerous traces of its presence.

How long a term of years may be involved in such a migration it is impossible to say, but that such a migration took place the phenomena seems to justify us in believing. It can hardly be supposed that the process that I have shadowed forth was reversed, and that man, having originated in North-Western Europe, in a cold climate where clothing was necessary and food scarce, subsequently migrated eastward to India and

southward to the Cape of Good Hope! As yet, our records of discoveries in India and Eastern Asia are but scanty; but it is there that the traces of the cradle of the human race are, in my opinion, to be sought, and possibly future discoveries may place upon a more solid foundation the visionary structure that I have ventured to erect.

It may be thought that my hypothesis does not do justice to what Sir Thomas Browne has so happily termed "that great antiquity, America." I am, however, not here immediately concerned with the important Neolithic remains of all kinds with which this great continent abounds. I am now confining myself to the question of Palæolithic man and his origin, and in considering it I am not unmindful of the Trenton implements, though I must content myself by saying that the "turtle-back" form is essentially different from the majority of those on the wide dissemination of which I have been speculating, and, moreover, as many here present are aware, the circumstances of the finding of these American implements are still under careful discussion.

Leaving them out of the question for the present, it may be thought worth while to carry our speculations rather further and to consider the relations in time between the Palæolithic and the Neolithic Periods. We have seen that the stage in human civilisation denoted by the use of the ordinary forms of Palæolithic implements must have extended over a vast period of time if we have to allow for the migration of the primæval hunters from their original home, wherever it may have been in Asia or Africa, to the west of Europe, including Britain. We have seen that, during this migration, the forms of the weapons and tools made from silicious stones had become, as it were, stereotyped, and further, that, during the subsequent extended period implied by the erosion of the valleys, the modifications in the form of the imple-

ments and the changes in the fauna associated with the men who used them were but slight.

At the close of the period during which the valleys were being eroded comes that represented by the latest occupation of the caves by Palæolithic man, when both in Britain and in the south of France the reindeer was abundant; but among the stone weapons and implements of that long troglodytic phase of man's history not a single example with the edge sharpened by grinding has as yet been found. All that can safely be said is that the larger implements as well as the larger mammals had become scarcer, that greater power in chipping flint had been attained, that the arts of the engraver and the sculptor had considerably developed, and that the use of the bow had probably been discovered.

Directly we encounter the relics of the Neolithic Period, often, in the case of the caves lately mentioned, separated from the earlier remains by a thick layer of underlying stalagmite, we find flint hatchets polished at the edge and on the surface, cutting at the broad and not at the narrow end, and other forms of implements associated with a fauna in all essential respects identical with that of the present day.

Were the makers of these polished weapons the direct descendants of Palæolithic ancestors whose occupation of the country was continuous from the days of the old river gravels? or had these long since died out, so that after Western Europe had for ages remained uninhabited, it was re-peopled in Neolithic times by the immigration of some new race of men? Was there, in fact, "a great gulf fixed" between the two occupations? or was there in Europe a gradual transition from the one stage of culture to the other?

It has been said that "what song the Syrens sang, or what name Achilles assumed when he hid himself among women, though puzzling questions, are not beyond

all conjecture"; and though the questions now proposed may come under the same category, and must await the discovery of many more essential facts before they receive definite and satisfactory answers, we may, I think, throw some light upon them if we venture to take a few steps upon the seductive if insecure paths of conjecture. So far as I know we have as yet no trustworthy evidence of any transition from the one age to the other, and the gulf between them remains practically unbridged. We can, indeed, hardly name the part of the world in which to seek for the cradle of Neolithic civilisation, though we know that traces of what appear to have been a stone-using people have been discovered in Egypt, and that what must be among the latest of the relics of their industry have been assigned to a date some 3,500 to 4,000 years before our era. The men of that time had attained to the highest degree of skill in working flint that has ever been reached. Their beautifully made knives and spear-heads seem indicative of a culminating point reached after long ages of experience; but whence these artists in flints came or who they were is at present absolutely unknown, and their handiworks afford no clue to help us in tracing their origin.

Taking a wider survey, we may say that, generally speaking, not only the fauna but the surface configuration of the country were, in Western Europe at all events, much the same at the commencement of the Neolithic Period as they are at the present day. We have, too, no geological indications to aid us in forming any chronological scale.

The occupation of some of the caves in the south of France seems to have been carried on after the erosion of the neighboring river valleys had ceased, and so far as our knowledge goes these caves offer evidence of being the latest in time of those occupied by man during the Palæolithic Period. It seems barely possible that, though in the north of Europe there are no distinct signs of such

late occupation, yet that, in the south, man may have lived on, though in diminished numbers; and that in some of the caves, such, for instance, as those in the neighborhood of Mentone, there may be traces of his existence during the transitional period that connects the Palæolithic and Neolithic Ages. If this were really the case we might expect to find some traces of a dissemination of Neolithic culture from a North Italian centre, but I much doubt whether any such traces actually exist.

If it had been in that part of the world that the transition took place, how are we to account for the abundance of polished stone hatchets found in Central India? Did Neolithic man return eastward by the same route as that by which in remote ages his Palæolithic predecessor had migrated westward? Would is not be in defiance of all probability to answer such a question in the affirmative? We have, it must be confessed, nothing of a substantial character to guide us in these speculations; but, pending the advent of evidence to the contrary, we may, I think, provisionally adopt the view that owing to failure of food, climatal changes, or other causes, the occupation of Western Europe by Palæolithic man absolutely ceased, and that it was not until after an interval of long duration that Europe was re-peopled by a race of men immigrating from some other part of the globe where the human race had survived, and in course of ages had developed a higher stage of culture than that of Palæolithic man.

I have been carried away by the liberty allowed for conjecture into the regions of pure imagination, and must now return to the realms of fact, and one fact on which I desire for a short time to insist is that of the existence at the present day in close juxtaposition with our own civilisation, of races of men who, at all events but a few generations ago, lived under much the same conditions as did our own Neolithic predecessors in Europe.

The manners and customs of these primitive tribes and peoples are changing day by day, their languages are becoming obsolete, their myths and traditions are dying out, their ancient processes of manufacture are falling into oblivion, and their numbers are rapidly diminishing, so that it seems inevitable that ere long many of these interesting populations will become absolutely extinct. The admirable Bureau of Ethnology instituted by our neighbors in the United States of America has done much towards preserving a knowledge of the various native races in this vast continent; and here in Canada the annual Archæological reports presented to the Minister of Education are rendering good service in the same cause.

Moreover, the Committee of this Association appointed to investigate the physical characters, languages and industrial and social conditions of the North-Western tribes of the Dominion of Canada is about to present its twelfth and final report, which in conjunction with those already presented will do much towards preserving a knowledge of the habits and languages of those tribes. It is sad to think that Mr. Horatio Hale, whose comprehensive grasp of the bearings of ethnological questions, and whose unremitting labors have so materially conduced to the success of the Committee, should be no longer among us. Although this report is said to be final, it is to be hoped that the Committee may be able to indicate lines upon which future work in the direction of ethnological and archæological research may be profitably carried on in this part of Her Majesty's dominions.

It is, however, lamentable to notice how little is being or has been officially done towards preserving a full record of the habits, beliefs, arts, myths, languages and physical characteristics of the countless other tribes and nations more or less uncivilised which are comprised within the limits of the British Empire. At the meeting of this Association held last year at Liverpool it was

resolved by the General Committee "that it is of urgent importance to press upon the Government the necessity of establishing a Bureau of Ethnology for Greater Britain, which by collecting information with regard to the native races within and on the borders of the Empire will prove of immense value to science and to the Government itself." It has been suggested that such a bureau might with the greatest advantage and with the least outlay and permanent expense be connected either with the British Museum or with the Imperial Institute, and the project has already been submitted for the consideration of the trustees of the former establishment.

The existence of an almost unrivalled ethnological collection in the Museum, and the presence there of officers already well versed in ethnological research, seem to afford an argument in favor of the proposed bureau being connected with it. On the other hand, the Imperial Institute was founded with an especial view to its being a centre around which every interest connected with the dependencies of the Empire might gather for information and support. The establishment within the last twelve months of a Scientific Department within the Institute, with well-appointed laboratories and a highly trained staff, shows how ready are those concerned in its management to undertake any duties that may conduce to the welfare of the outlying parts of the British Empire: a fact of which I believe that Canada is fully aware. The Institute is therefore likely to develop, so far as its scientific department is concerned, into a Bureau of Advice in all matters scientific and technical, and certainly a Bureau of Ethnology such as that suggested would not be out of place within its walls.

Wherever such an institution is to be established, the question of its existence must of necessity rest with Her Majesty's Government and Treasury, inasmuch as without funds, however moderate, the undertaking cannot

be carried on. I trust that in considering the question it will always be borne in mind that in the relations between civilised and uncivilised nations and races it is of the first importance that the prejudices and especially the religious or semi-religious and caste prejudices of the latter should be thoroughly well known to the former. If but a single "little war" could be avoided in consequence of the knowledge acquired and stored up by the Bureau of Ethnology preventing such a misunderstanding as might culminate in warfare, the cost of such an institution would quickly be saved.

I fear that it will be thought that I have dwelt too long on primæval man and his modern representatives, and that I should have taken this opportunity to discuss some more general subject, such as the advances made in the various departments of science since last this Association met in Canada. Such a subject would no doubt have afforded an infinity of interesting topics on which to dilate. Spectrum analysis, the origin and nature of celestial bodies, photography, the connection between heat, light and electricity, the practical applications of the latter, terrestrial magnetism, the liquefaction and solidification of gases, the behavior of elements and compounds under the influence of extreme cold, the nature and uses of the Röntgen rays, the advances in bacteriology and in prophylactic medicine, might all have been passed under review, and to many of my audience would have seemed to possess greater claims to attention than the subject that I have chosen.

It must, however, be borne in mind that most, if not indeed all, of these topics will be discussed by more competent authorities in the various Sections of the Association by means of the Presidential addresses or otherwise. Nor must it be forgotten that I occupy this position as a representative of Archæology, and am therefore justified in bringing before you a subject in

which every member of every race of mankind ought to be interested—the antiquity of the human family and the scenes of its infancy.

Others will direct our thoughts in other directions, but the farther we proceed the more clearly shall we realise the connection and interdependence of all departments of science. Year after year, as meetings of this Association take place, we also may foresee that "many shall run to and fro and knowledge shall be increased." Year after year advances will be made in science, and in reading that Book of Nature that lies ever open before our eyes; successive stones will be brought for building up that Temple of Knowledge of which our fathers and we have labored to lay the foundations. May we not well exclaim with old Robert Recorde ?—

"Oh woorthy temple of Goddes magnificence: Oh throne of glorye and seate of the lorde: thy substance most pure what tonge can describe ? thy signes are so wonderous, surmountinge mannes witte, the effects of thy motions so diuers in kinde: so harde for to searche, and worse for to fynde—Thy woorkes are all wonderous, thy cunning unknowen: yet seedes of all knowledge in that booke are sowen—And yet in that boke who rightly can reade, to all secrete knowledge it will him straighte leade."[1]

REPORT OF EXPLORATIONS IN THE LABRADOR PENINSULA ALONG THE EAST MAIN, KOKSOAK, HAMILTON, MANICUAGAN AND PORTIONS OF OTHER RIVERS IN 1892–93–94–95. BY A. P. LOW, B. AP. SC.[2]

One of the most interesting and valuable reports which has been issued by the Geological Survey of Canada

1 Preface to Robert Recorde's "Castle of Knowledge," 1556.

2 Annual Report of Progress, Geological Survey of Canada. Vol. VIII., p. 385.

in recent years is that which has just appeared on the Peninsula of Labrador, by Mr. A. P. Low.

The report embodies the results of four years' exploration, during which time Mr. Low has traversed Labrador from north to south and from east to west, and it presents in readable form a summary of our knowledge not only of the geography and geology, but also of the climatology, botany, zoology and natural resources of this remotest part of the Dominion, the interior of which, prior to Mr. Low's exploration, was practically unknown. Mr. Low's work, the results of portions of which have been previously published in preliminary reports to the Geological Survey, and as papers presented to various scientific societies, has attracted much attention, and its value has received especial recognition by the Royal Geographical Society.

The report is accompanied by a fine map of Labrador in four sheets on a scale of 25 miles to the inch, which is colored geologically along the lines of traverse, and it is illustrated by a number of views showing the character of the country, among them one of the Grand Falls of the Hamilton River, concerning which there was so much discussion a few years since.

The peninsula may be described as a high rolling plateau, having a general elevation of from 1,600 to 1,800 feet, the surface sloping rapidly down towards the Atlantic and Gulf of St. Lawrence, but much more gently toward James's Bay. To the north of Nain the high land of the coast rises in ranges of sharp unglaciated mountains to the height of from 2,500 to probably 6,000 feet.

One of the most remarkable physical features of the country are the deep canons or fjords, followed by all the rivers draining the interior where they cut through the margin of the peninsula and run out to sea. These have rock walls from 1,000 to 4,000 feet in height, while the river channels are from 10 to 100 fathoms deep. They

appear to be valleys of denudation and are of very ancient origin, antedating the Cambrian; undisturbed, horizontal beds of Cambrian age being found deposited upon their lower levels. The gorges of the Hamilton, Sandwich and Kaipokok might be cited as examples as well as those of the Moisie and Saguenay discharging into the Gulf of St. Lawrence.

About nine-tenths of Labrador is underlain by rocks of Laurentian age, and like all the rest of the glaciated Laurentian country, the plateau is studded with myriads of lakes great and small, which are estimated to occupy at least one-fourth of the total surface, and which are drained by a network of streams discharging into the deep fjords above referred to. The Peninsula is underlain exclusively by the oldest rock systems of the earth's crust, the Laurentian, Huronian and Cambrian, together with certain rocks of intrusive origin. The Laurentian rocks differ in no essential particular from those found elsewhere in Canada. Both the Fundamental Gneiss and the Grenville Series are largely represented, the latter running in wide and persistent bands across the country and consisting of micaceous gneisses and schists, quartzites, crystalline limestones, etc., often holding graphite. Great anorthosite intrusions cut these rocks, from certain of which is derived the precious labradorite.

The Huronian is represented by several widely separated areas of clastic and volcanic rocks, together with many basic eruptives. They consist of schists of various kinds, with conglomerates, breccias, diorites and other rocks. The Laurentian and Huronian are intensely folded, the folding having taken place at a time long prior to the deposition of the sedimentary beds of Cambrian age, and a sufficiently long time had elapsed, as has been mentioned, between this period of folding and the Cambrian submergence to permit of enormous denudation and erosion.

The Cambrian strata, which rest unconformably upon the Laurentian and Huronian, consist of bedded sand-

stones, argillites, shales and limestones along with bedded traps and other volcanic rocks and enormous deposits of excellent iron ore, whose mode of occurrence is closely analogous to that of the iron ores of Michigan and Wisconsin.

The surface of the country is mantled with drift, and there is distinct evidence that the whole Labrador Peninsula, except a narrow strip of very high land along the North Atlantic coast, was completely buried in ice, during a portion, at least, of the glacial period. The movement of this ice was outward in all directions from a central gathering ground. The position of this Névé field was about midway between the east and west coast of the peninsula and between latitudes 53° and 55°, and the area is now characterized by the presence of partially rounded boulders and angular blocks of rocks scattered over hill and hollow. Most of these repose on rocks of the same character as themselves, and have evidently been transported but very short distances from their original positions. They probably represent boulders of decomposition, but slightly modified by subsequent ice action.

The various sorts of drift and the forms assumed by the drift are described, although a detailed study of these was impossible owing to the dense forest growth which covers the greater part of the area.

There is distinct evidence of a post glacial uplift which, however, it is believed was not equal all around the coast, being about three times as great on the south and west margins as along the north and east coast, where two hundred feet appears to be the limit of raised marine terraces and beaches.

Appended to the report are lists of the Mammalia, Birds, Food Fishes and Plants found in Labrador, as well as an appendix by Mr. Ferrier on the microscopical structure of some of the rocks collected, and one by Mr. Eaton on the meteorology of the Peninsula.

FRANK D. ADAMS.

The Great Unmapped Areas on the Earth's Surface Awaiting the Explorer and Geographer.[1]

By J. Scott Keltie, LL.D., Secretary to the Royal Geographical Society, Editor of the Geographical Journal and of the Statesman's Year-Book, etc., etc.

We meet this year in exceptional circumstances. Thirteen years ago the British Association met for the first time in a portion of the empire beyond the limits of the British islands. During these thirteen years much has happened of the greatest interest to geographers, and if I attempted to review the progress which has been made during these years—progress in the exploration of the globe, progress in geographical research, progress in geographical education—I could not hope to do it to any purpose in the short time during which it would be right for a president to monopolize the attention of the Section.

But we have, at the same time, reached another stage in our history which naturally leads us to take stock of our progress in the past. We have all of us been celebrating the sixtieth year of the glorious reign of the Sovereign of whose vast dominions Canada and the United Kingdom form integral parts. The progress made during that period in our own department of science has been immense; it would take volumes to tell what has been done for the exploration of the globe.

The great continent of Africa has practically been discovered, for sixty years ago almost all but its rim was a blank. In 1837 enormous areas in North America were unexplored and much of the interior of South America was unknown. In all parts of Asia vast additions have been made to our knowledge; the maps of the interior of that continent were sixty years ago of the most diagrammatic character. The Australian interior was nearly as great a blank as that of Africa; New

[1] Presidential address delivered before the Geographical Section of the British Association for the Advancement of Science, at Toronto, August 19th, 1897.

Zealand had not even been annexed. Need I remind you of the great progress which has been made during the period both in the North and South Polar areas, culminating in the magnificent achievement of Dr. Nansen? It was just sixty years ago that the great Antartic expedition under Sir James Ross was being organized; since that, alas! little or nothing has been done to follow up his work. Sixty years ago the science of oceanography, even the term, did not exist. It is the creation of the Victorian era, and may be said almost to have had its origin in the voyage of the "Challenger," which added a new domain to our science and opened up inexhaustible fields of research.

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I have thought, then, that the most useful and most manageable thing to do on the present occasion will be to indicate briefly what, in my estimation, are some of the problems which geography has to attack in the future, only taking such glances at the past as will enable us to do this intelligibly.

ASIA.

Turning to the continent of Asia, we find that immense progress has been made during the past sixty years. In the presidential address given sixty years ago Mr. Hamilton says of Asia: "We have only a general knowledge of the geographical character of the Burman, Chinese and Japan empires; the innumerable islands of the latter are still, except occasionally, inaccessible to European navigators. Geographers hardly venture on the most loose description of Tibet, Mongolia, or Chinese Tartary, Siam and Cochin China." Since then the survey of India, one of the greatest enterprises undertaken by any State, has been completed, and is being rapidly extended over Burma. But I need not remind you in detail of the vast changes that have taken place in Asia

during these years and the immense additions that have been made to our knowledge of its geography. Exploring activity in Asia is not likely to cease, though it is not to be expected that its inhospitable centre will ever be so carefully mapped as have been the mountains of Switzerland.

The most important desiderata, so far as pioneer exploration in Asia is concerned, may be said to be confined to two regions. In southern and central Arabia there are tracts which are entirely unexplored. It is probable that this unexplored region is in main a sandy desert. At the same time it is, in the south at least, fringed by a border of mountains whose slopes are capable of rich cultivation and whose summits the late Mr. Theodore Bent found, on his last and fatal journey, to be covered with snow. In exploration, as in other directions, it is the unexpected that happens; and if any traveller cared to face the difficulties—physical, political and religious—which might be met with in southern and central Arabia, he might be able to tell the world a surprising story.

The other region in Asia where real pioneer work still remains to be done is Tibet and the mountainous districts bordering it on the north and east. Lines of exploration have in recent years been run across Tibet by Russian explorers like Prjevalsky, by Rockhill, Prince Henry of Orleans, and Bonvalot, by Bower, Littledale, Wellby and Malcolm. From the results obtained by these explorers we have formed a fair idea of this, the most extensive, the highest, and the most inhospitable plateau in the world. A few more lines run in well selected directions would probably supply geography with nearly all she wants to learn about such a region, though more minute exploration would probably furnish interesting details as to its geological history.

THE FORBIDDEN CITY.

The region lying to the north of the Himalayan range and to the south of the parallel of Lhasa is almost a blank on the map, and there is ample room here for the enterprising pioneer. The forbidden city of Lhasa is at present the goal of several adventurers, though as a matter of fact we cannot have much to learn in addition to what has been revealed in the interesting narrative of the native Indian traveller, Chandra Das. The magnificent mountain region on the north and east of Tibet furnishes a splendid field for the enterprising explorer. Mrs. Bishop recently approached it from the east, through Sze-chuen, and her description of the romantic scenery and the interesting non-Mongolian inhabitant leaves us with a strong desire to learn more. On the south-east of Tibet is the remarkable mountainous region, consisting of a series of lofty parallel chains, through which run the upper waters of the Yangtse, the Mekong, the Salwin, and the Irrawaddy. This last-named river, recent exploration has shown, probably does not reach far into the range. But it will be seen by a glance at a map that the upper waters of the other rivers are carried far into the heart of the mountains. But these upper-river courses are entirely conjectural and have given rise to much controversy. There is plenty of work here for the explorer, though the difficulties, physical and political, are great.

But besides these great unexplored regions there are many blanks to be filled up in other parts of Asia, and regions which, though known in a general way, would well repay careful examination. There is the mountain track between the Zarafshan river and the middle course of the Sarkhab, tributary of the Oxus, and the country lying between that and the Oxus. There is the great Takla-Makan desert in Chinese or Eastern Turkistan, part of which has recently been explored by Russian expeditions and by that young and indefatigable Swedish

traveller, Dr. Sven Hedin. It is now one of the most forbidding deserts to be found anywhere, but it deserves careful examination, as there are evidences of its once having been inhabited, and that at no very remote period. It is almost surrounded by the Tarim, and on its eastern edge lies Lob-nor, the remarkable changes in which have been the subject of recent investigation. As readers of Dr. Nansen's Voyage of the "Fram" will remember, the Siberian coast is most imperfectly mapped. Of course it is a difficult task, but it is one to which the Russian government ought to be equal. China has on paper the appearance of being fairly well mapped; but as a matter of fact our knowledge of its mountain ranges and of its great river courses is to a large extent extremely vague. All this awaits careful survey. In north-eastern Manchuria and in many parts of Mongolia there are still blanks to be filled up and mountain and river systems to be surveyed. In the Malay peninsula and in the great array of islands in the east and south-east of Asia—Sumatra, Borneo, the Philippines—much work still remains to be done. Thus for the coming century there will be abundance of work for explorers in Asia and plenty of material to occupy the attention of our geographical societies.

DARKEST AFRICA.

Coming to the map of Africa, we find the most marvellous transformation during the last sixty years, and mainly during the last forty years, dating from Livingstone's memorable journey across the continent. Though the north of Africa was the home of one of the oldest civilizations, and though on the shores of the Mediterranean Phœnicians, Carthaginians, Greeks and Romans were at work for centuries, it has only been within the memory of many of us that the centre of the continent, from the Sahara to the confines of Cape Colony, has ceased to be an unexplored blank. This

blank has been filled up with bewildering rapidity. Great rivers and lakes and mountains have been laid down in their main features, and the whole continent, with a few unimportant exceptions, has been parcelled out among the powers of Europe; but much still remains to be done ere we can form an adequate conception of what is in some respects the most interesting and the most intractable of the continents. Many curious problems still remain to be solved. The pioneer work of exploration has to a large extent been accomplished; lines have been run in all directions; the main features have been blocked out; but between these lines the broad meshes remain to be filled in, and to do this will require many years of careful exploration. However, there still remain one or two regions that afford scope for the adventurous pioneer.

To the south of Abyssinia and to the west and north-west of Lake Rudolf, on to the Upper Nile, is a region of considerable extent, which is still practically unknown. Again, in the western Sahara there is an extensive area, inhabited mainly by the intractable Tuaregs, into which no one has been able to penetrate, and of which our knowledge is extremely scanty. Even in the central Sahara there are great areas which have not been traversed, while in the Libyan desert much remains to be done. These regions are of interest almost solely from the geographical and geological standpoints; but they deserve careful investigation, not only that we may ascertain their actual present condition, but in order, also, that we may try to discover some clues to the past history of this interesting continent. Still, it must be said that the great features of the continent have been so fully mapped during the last half century that what is required now is mainly the filling-in of the details. This is a process that requires many hands and special qualifications. All over the continent there are regions which

will repay special investigation. Quite recently an English traveller, Mr. Cowper, found not far from the Tripoli coast miles of magnificent ruins and much to correct on our maps. If only the obstructiveness of the Turkish officials could be overcome, there is a rich harvest for any one who will go to work with patience and intelligence. Even the interior of Morocco, and especially the Atlas mountains, are but little known. The French, in both Tunis and Algeria, are extending our knowledge southward.

EFFECTS OF THE POWERS.

All the powers who have taken part in the scramble for Africa are doing much to acquire a knowledge of their territories. Germany especially deserves praise for the persistent zeal with which she has carried out the exploration of her immense territories in East and West Africa. The men she sends out are unusually well qualified for the work, capable not simply of making a running survey as they proceed and taking notes on country and people, but of rendering a substantial account of the geology, the fauna, the flora, and the economic conditions. Both in the French and British spheres good work is also being done, and the map of Africa is being gradually filled up. But what we especially want now are men of the type of Dr. J. W. Gregory, whose book on the Great Rift valley is one of the most valuable contributions to African geography ever made. If men of this stamp would settle down in regions like that of Mount Ruwenzori or Lake Rudolf or the region about lakes Bangweolo and Tanganyika, or in the Atlas or in many other regions that could be named, the gains to scientific geography, as well as to the economic interests of Africa, would be great. An example of work of this kind is seen in the discoveries made by a young biologist trained in geographical observation, Mr. Moore, on Lake Tanganyika. There he

found a fauna which seems to afford a key to the past history of the centre of the continent, a fauna which, Mr. Moore maintains, is essentially of a salt-water type. Mr. Moore, I believe, is inclined to maintain that the ancient connection of this part of Africa with the ocean was not by the west, as Joseph Thomson surmised, but by the north, through the Great Rift valley of Dr. Gregory, and he strongly advocates the careful examination of Lake Rudolf as the crucial test of his theory. It is to be hoped that he or some one equally competent will have an opportunity of carrying out an investigation likely to provide results of the highest importance.

CLIMATE OF THE COUNTRY.

But there are other special problems connected with this, the most backward and the most repellent of continents, which demand serious investigation—problems essentially geographical. One of the most important of these, from the point of view of the development of Africa, is the problem of acclimatization. The matter is of such prime importance that a committee of the Association has been at work for some years collecting data as to the climate of tropical Africa. In a general way we know that that climate is hot and the rainfall scanty; indeed, even the geographers of the ancient world believed that Central Africa was uninhabitable on account of its heat; but science requires more than generalities, and therefore we look forward to the exact results which are being collected by the committee referred to with much hope. We can only go to work experimentally until we know precisely what we have to deal with. It will help us greatly to solve the problem of acclimatization when we have the exact factors that go to constitute the climate of tropical Africa. At present there is no doubt that the weight of competent opinion—that is, opinion of those who have had actual experience of African climate and of

those who have made a special study of the effects of that climate on the human constitution—is that, though white men, if they take due precautions, may live and do certain kinds of work in tropical Africa, it will never be possible to colonize that part of the world with people from the temperate zone. This is the lesson taught by generations of experience of Europeans in India.

So far, also, sad experience has shown that white people cannot hope to settle in Central Africa as they have settled in Canada and the United States and in Australia, and make it a nursery and a home for new generations. Even in such favorable situations as Blantyre, a lofty region on the south of Lake Nyasa, children cannot be reared beyond a certain age; they must be sent home to England, otherwise they will degenerate physically and morally. No country can ever become the true home of a people if the children have to be sent away to be reared. Still, it is true our experience in Africa is limited. It has been maintained that it might be possible to adapt Europeans to tropical Africa by a gradual process of migration: Transplant southern Europeans to North Africa; after a generation or two remove their progeny further south, and so on, edging the succeeding generation further and further into the heart of the continent. The experiment—a long one it would be—might be tried; but it is to be feared that the ultimate result would be a race deprived of all those characteristics which have made Europe what it is.

HIDDEN ENEMIES.

An able young Italian physician, Dr. Sambon, has recently faced this important problem, and has not hesitated to come to conclusions quite opposed to those generally accepted. His position is that it has taken us centuries in Europe to discover our hidden enemies, the microbes of the various diseases to which northern

humanity is a prey, and to meet them and conquer them. In Africa we have a totally different set of enemies to meet, from lions and snakes down to the invisible organisms that produce those forms of malaria, anæmia, and other diseases characteristic of tropical countries. He admits that these are more or less due to heat, to the nature of the soil, and other tropical conditions, but that if once we knew their precise nature and modes of working we should be in a position to meet them and conquer them. It may be so, but this is a result that could only be reached after generations of experience and investigation, and even Dr. Sambon admits that the ultimate product of European acclimatization in Africa would be something quite different from the European progenitors. What is wanted is a series of carefully conducted experiments.

I have referred to the Blantyre highlands. In British East Africa there are plateaus of much greater altitude, and in other parts of Central Africa there are large areas of 4,000 feet and over above sea level. The world may become so full that we may be forced to try to utilize these lofty tropical regions as homes for white people when Canada and Australia and the United States become over populated. As one of my predecessors in this chair (Mr. Ravenstein) tried to show at the Leeds meeting some years ago, the population of the world will have more than doubled in a century, and about 180 years hence will have quadrupled. At any rate, here is a problem of prime importance for the geographer of the coming century to attack. With so many energetic and intelligent white men all over Africa; it should not be difficult to obtain the data which might help toward its solution.

NORTH AMERICA.

I have dwelt thus long on Africa, because it will really be one of the great geographical problems of the coming

century. Had it been as suitable as America or Australia, we may be sure it would not have remained so long neglected and despised by the European peoples as it has done. Unfortunately for Africa, just as it had been circumnavigated, and just as Europeans were beginning to settle upon its central portion and trying to make their way into the interior, Columbus and Cabot discovered a new world—a world as well adapted as Europe for the energies of the white races. The discovery postponed the legitimate development of Africa for four centuries. Nothing could be more marked than the progress which America has made since its rediscovery 400 years ago, and the stagnation of Africa, which has been known to Europe since long before the beginning of history. During these 400 years North America at least has been very thoroughly explored. The two great nations which divide North America between them have their Government surveys, which are rapidly mapping the whole continent and investigating its geology, physical geography, and natural resources.

I need hardly tell an audience like this of the admirable work done by the survey of Canada under Sir William Logan, Dr. Selwyn, and his successor, Dr. George Dawson; nor should it be forgotten that under the lands department such excellent topographical work has been carried out by Captain Deville and his predecessors. Still, though much has been done, much remains to be done. There are large areas which have not as yet been roughly mapped. Within quite recent years we have had new regions opened up to us by the work of Dawson and Ogilvie on the Yukon, Dr. Bell in the region to the south of Hudson bay, by the brothers Tyrrell in the barren lands on the west of the same bay, by O'Sullivan beyond the sources of the Ottawa, and by Low in Labrador.

But it is not so long since that Dr. Dawson, in reviewing what remains to be done in the Dominion in the way

of even pioneer exploration, pointed out that something like a million square miles remained to be mapped. Apart from the uninhabitable regions in the north, there are, as Dr. Dawson pointed out, considerable areas which might be turned to profitable agricultural and mining account of which we know little, such areas as these which have been recently mapped out on the south of Hudson bay by Dr. Bell and beyond the Ottawa by Mr. O'Sullivan. Although the eastern and western provinces have been very fully surveyed, there is a considerable area between the two lying between Lake Superior and Hudson bay which seems to have been so far almost untouched. A very great deal has been done for the survey of the rivers and lakes of Canada. I need hardly say that in Canada, as elsewhere in America, there is ample scope for the study of many problems in physical geography—past and present glaciation and the work of glaciers, the origin and régime of lake basins, the erosion of river beds, the oscillation of coast lines. Happily, both in Canada and the United States there are many men competent and eager to work out problems of this class, and in the reports of the various surveys, in the transactions of American learned societies, in scientific periodicals, and in separate publications, a wealth of data has already been accumulated of immense value to the geographer.

UNITED STATES.

Every geologist and geographer knows the important work which has been accomplished by the various surveys of the United States, as well as by the various State surveys. The United States Coast Survey has been at work for more than half a century, mapping not only the coast but all the navigable rivers. The Lake Survey has been doing a similar service for the shores of the Great Lakes of North America. But it is the work of the Geological Survey which is best known to geographers—a

survey which is really topographical as well as geological, and which, under such men as Hayden, King and Powell, has produced a series of magnificent maps, diagrams and memoirs of the highest scientific value and interest. Recently this survey has been placed on a more systematic basis, so that now a scheme for the topographical survey of the whole of the territory of the United States is being carried out. Extensive areas in various parts of the States have been already surveyed on different scales. It is to be hoped that in the future, as in the past, the able men who are employed on this survey work will have opportunities of working out the physiography of particular districts, the past and present geography of which is of advancing scientific interest. Of the complete exploration and mapping of the North American continent we need have no apprehension; it is only a question of time, and it is to be hoped that neither of the governments responsible will allow political exigencies to interfere with what is really a work of national importance.

CENTRAL AND SOUTH AMERICA.

It is when we come to Central and South America that we find ample room for the unofficial explorer. In Mexico and the Central American States there are considerable areas of which we have little or only the vaguest knowledge. In South America there is really more room now for the pioneer explorer than there is in Central Africa. In recent years the Argentine Republic has shown laudable zeal in exploring and mapping its immense territories, while a certain amount of good work has also been done by Brazil and Chili. Most of our knowledge of South America is due to the enterprise of Europeans and of North American explorers. Along the great river courses our knowledge is fairly satisfactory, but the immense areas, often densely clad with forests, lying between the rivers are almost unknown. In Pata-

gonia, though a good deal has recently been done by the Argentine government, still in the country between Punta Arenas and the Rio Negro we have much to learn, while on the West Coast range, with its innumerable fjord-like inlets, its islands and peninsulas. there is a fine field for the geologist and physical geographer. Indeed, throughout the whole range of the Andes systematic exploration is wanted, exploration of the character of the excellent work accomplished by Whymper in the region around Chimborazo.

There is an enormous area lying to the east of the northern Andes and including their eastern slopes, embracing the eastern half of Ecuador and Colombia, Southern Venezuela, and much of the country lying between that and Northern Bolivia, including many of the upper tributaries of the Amazon and Orinoco, of which our knowledge is of the scantiest. Even the country lying between the Rio Negro and the Atlantic is but little known. There are other areas in Brazil and in the northern Chaco which have only been partially described, such as the region whence the streams forming the Tapajos and the Paraquay take their rise, in Mato Grosso. A survey and detailed geographical and topographical description of the whole basin of Lake Titicaca is a desideratum.

In short, in South America there is a wider and richer field for exploration than in any other continent. But no mere rush through these little-known regions will suffice. The explorer must be able not only to use his sextant and his theodolite, his compass, and his chronometer. Any expeditions entering these regions ought to be able to bring back satisfactory information on the geology of the country traversed, and of its fauna and flora, past and present. Already the revelations which have been made of the past geography of South America and of the life that flourished there in former epochs are of the

highest interest. Moreover, we have here the reinains of extinct civilizations to deal with, and although much has been done in this direction, much remains to be done, and in the extensive region already referred to the physique, the traditions, and the customs of the natives will repay careful investigation.

AUSTRALIA.

The southern continent of Australia is in the hands of men of the same origin as those who have developed to such a wonderful extent the resources of Canada and the United States, and therefore we look for equally satisfactory results so far as the characteristics of that continent permit. The five colonies which divide among them the three million square miles of the continent have each of them efficient government surveys, which are rapidly mapping their features and investigating their geology; but Australia has a trying economic problem to solve. In none of the colonies is the water supply quite adequate; in all are stretches of desert country of greater or less extent. The centre and western half of the continent are covered by a desert more waterless and more repellent than even the Sahara; so far as our present knowledge goes, one-third of the continent is uninhabitable. This desert area has been crossed by explorers, at the expense of great sufferings, in various directions, each with the same dreary tale of almost featureless sandy desert, covered here and there with spinifex and scrub, worse than useless. There are hundreds of thousands of square miles still unknown, but there is no reason to believe that these areas possess any features that differ essentially from those which have been found along the routes that have been explored.

There have been one or two well-equipped scientific expeditions in recent years that have collected valuable data with regard to the physical characteristics, the

geology and biology of the continent; and it is in this direction that geography should look for the richest results in the future. There remains much to be done before we can arrive at satisfactory conclusions as to the physical history of what is in some respects the most remarkable land area on the globe. Though the surface water supply is so scanty, there is reason to believe that underneath the surface there is an immense store of water. In one or two places in Australia, especially in Western Queensland and in New South Wales, this supply has been tapped with satisfactory results; millions of gallons a day have been obtained by sinking wells. Whether irrigation can ever be introduced on an extensive scale into Australia depends upon the extent and accessibility of the underground water supply, and that is one of the geographical problems of the future in Australia. New Zealand has been fairly well surveyed, though a good deal remains to be done before its magnificent mountain and glacier system is completely known. In the great island of New Guinea both the British and the Germans are opening up the interiors of their territories to our knowledge, but the western and much larger portion of the island presents a large field for any explorer who cares to venture into its interior.

POLAR EXPLORATION.

The marvellous success which has attended Dr. Nansen's daring adventure into the Arctic seas has revived a widespread interest in polar exploration. Nansen may be said to have almost solved the North Pole problem—so far, at least, as the Old World side of the Pole is concerned. That some one will reach the Pole at no distant date is certain; Nansen has shown the way, and the legitimate curiosity of humanity will not rest satisfied till the goal be reached. But Arctic exploration does not end with the attainment of the Pole. Europe has done

her share on her own side of the Pole; what about the side which forms the hinterland of North America, and especially of Canada? To the north of Europe and Asia we have the scattered groups of islands, Spitsbergen, Franz Josef Land, Nova Zembla, and the New Siberian islands. To the north of America we have an immense archipelago, the actual extent of which is unknown. Nansen and other Arctic authorities maintain that the next thing to be done is to complete exploration on the American side—to attempt to do for that half of the North Pole region what Nansen has done for the other half. It may be that the islands which fringe the northern shores of the new world are continued far to the north; if so, they would form convenient stages for the work of a well-equipped expedition. It may be that they do not go much farther than we find them on our maps. Whatever be the case, it is important, in the interests of science, that this section of the polar area be examined; that as high a latitude as possible be attained; that soundings be made to discover whether the deep ocean extends all round the Pole.

It is stated that the gallant Lieutenant Peary has organized a scheme of exploring this area which would take several years to accomplish. Let us hope that he will be able to carry out his scheme. Meantime, should Canada look on with indifference? She has attained the standing of a great and prosperous nation. She has shown the most commendable zeal in the exploration of her own immense territory. She has her educational, scientific and literary institutions which will compare favorably with those of other countries; her press is of a high order, and she has made the beginnings of a literature and an art of her own. In these respects she is walking in the steps of the mother country. But has Canada not reached a stage when she is in a position to follow the maternal example still further? What has more

contributed to render the name of Great Britain illustrious than those enterprises which for centuries she has sent out from her own shores, not a few of them solely in the interests of science? Such enterprises elevate a nation and form its glory and its pride. Surely Canada has ambitions beyond mere material prosperity; and what better beginning could be made than the equipment of an expedition for the exploration of the seas that lie between her and the Pole? I venture to throw out these suggestions for the consideration of those who have at heart the honor and glory of the great Canadian Dominion.

THE ANTARCTIC REGIONS.

Not only has an interest in Arctic exploration been revived, but in Europe at least an even greater interest has grown up in the exploration of the region around the opposite Pole of the earth of which our knowledge is so scanty. Since Sir James C. Ross' expedition, which was sent out in the year 1839, almost nothing has been done for Antarctic research. We have here to deal with conditions different from those which surround the North Pole. Instead of an almost landless ocean, it is believed by those who have given special attention to the subject that a continent about the size of Australia covers the South Polar region. But we do not know for certain, and surely, in the interests of our science, it is time we had a fairly adequate idea of what are the real conditions. We want to know what is the extent of that land, what are its glacial conditions, what is the character of its geology, what evidence exists as to its physical and biological conditions in past ages? We know there is one lofty, active volcano. Are there any others? Moreover, the science of terrestrial magnetism is seriously impeded in its progress because the data in this department from the Antarctic are so scanty. The seas around this continent require to be investigated both as to their depth, their

temperature, and their life. We have here, in short, the most extensive unexplored area on the surface of the globe.

For the last three or four years the Royal Geographical Society, backed by other British societies, has been attempting to move the home government to equip an adequate expedition to complete the work begun by Ross sixty years ago, and to supplement the great work of the 'Challenger"; but though sympathy has been expressed for Antarctic exploration, and though vague promises have been given of support, the government is afraid to enter upon an enterprise which might involve the services of a few naval officers and men. We need not criticise this attitude; but the Royal Geographical Society has determined not to let the matter rest here. It is now seeking to obtain the support of public-spirited men for an Antarctic expedition under its own auspices. It is felt that Antarctic exploration is peculiarly the work of England, and that if an expedition is undertaken it will receive substantial support from the great Australasian colonies, which have so much to gain from a knowledge of the physical condition of a region lying at their own doors and probably having a serious influence on their climatological conditions. Here, then, is one of the greatest geographical problems of the future, the solution of which should be entered upon without further delay. It may be mentioned that a small and well-equipped Belgian expedition has already started, mainly to carry out deep-sea search around the South Pole area, and that strenuous efforts are being made in Germany to obtain the funds for an expedition on a much larger scale.

OCEANOGRAPHY.

But our science has to deal not only with the lands of the globe; its sphere is the whole of the surface of the earth and all that is thereon, so far at least as

distribution is concerned. The department of oceanography is a comparatively new creation; indeed, it may be said to have come definitely into being with the famous voyage of the "Challenger." There had been expeditions for ocean investigation before that, but on a very limited scale. It has been through the results obtained by the "Challenger," supplemented by those of expeditions that have examined more limited areas, that we have been able to obtain an approximate conception of the conditions which prevail throughout the various ocean depths—conditions of movement, of temperature, of salinity, of life. We have only a general idea of the contours of the ocean bed, and of the composition of the sediment which covers that bed. The extent of the knowledge thus acquired may be gauged from the fact that it occupies a considerable space in the fifty quarto volume—the "Challenger" publications—which it took Dr. John Murray twenty years to bring out.

What islands are to the ocean, lakes are to the land. It is only recently that these interesting geographical features have received the attention they deserve.

Rivers are of not less geographical interest than lakes, and these have also recently been the subject of special investigation by physical geographers. I have already referred to Professor Davis' study of a special English river system. The work in the English lake district by Mr. Marr, spoken of in connection with Dr. Mill's investigations, was mainly on the hydrology of the region. Both in Germany and in Russia special attention is being given to this subject, while in America there is an enormous literature on the Mississippi alone, mainly, no doubt, from the practical standpoint, while the result of much valuable work on the St. Lawrence is buried in Canadian official publications.

Book Notices.

The Mineral Wealth of Canada: A Guide for Students of Economic Geology.—By Arthur B. Willmott, M.A., B.Sc. Toronto: William Briggs, 1897.

This little book of some 200 pages represents in a somewhat extended form Professor Willmott's lectures on the Mineral Resources of Canada to the students of McMaster University. "While it is not customary to treat this subject so fully in an elementary class, the author has felt that in a young and undeveloped country like our own it was highly desirable that all university students should know something of our latent mineral wealth. So at the expense of Palæontology, much of which is more suitable for an advanced course, time was found for economic geology in an elementary one. To save labor of dictation and to make them useful to a larger number, these lecture notes are now published."

It is the only work we have giving a systematic account of the mineral resources of the whole Dominion, but it does not lay claim to originality, except in method of treatment, the work being a compilation chiefly from the Reports of the Geological Survey of Canada.

After a short introduction dealing with the nature, origin and mutual relations of the various rocks composing the earth's crust, the main subject is taken up and dealt with under three heads: (1) Minerals yielding metals. (2) Minerals yielding non-metallic products. (3) Rocks and their products. Each of these sections comprises several chapters treating of groups of allied metallic or non-metallic products.

Thus one chapter deals with our Ores of Iron, Manganese and Chromium; another with those of Nickel and Cobalt, and a third with the Granites and Sandstones of the Dominion, and so on.

In the case of each mineral, its physical characters and properties are first described, and then brief notes are given of the chief occurrences in the Dominion, with statistics of its production in recent years.

While, therefore, it is impossible in so small a space to deal exhaustively with so vast a subject, Professor Willmott's book will be of great value to those who desire to obtain some general knowledge of our Mineral Resources, and the references to the literature of the subject, given at the close of each chapter, will point out to the reader the sources of further information, if this be desired.

The volume is well printed and of convenient size.

If the attitude of the critic is to be preserved, however, it must be noted that the book contains many minor inaccuracies of statement.

A mineral, for instance, is defined as "an inorganic homogeneous substance of definite chemical composition," a definition which would

embrace all artificial salts of inorganic origin. On page 25 it is stated that the Ores of Iron and Manganese are practically the only ores formed by precipitation from aqueous solution, while on page 27 we are told that Lead Sulphide and Gold may "under certain conditions" be carried in solution by subterranean waters, and that it is from such waters that they have been deposited in the fissures in which we find them. Again, on page 29 it is stated that veins, "from their mode of formation, are believed to extend indefinitely in depth," while it is generally recognized that they must be confined to a comparatively superficial portion of the earth's crust above the limit of plastic flow, while the statement (page 31) that "depth has no known influence on the character of the vein," is only true of that portion below the limit of surface influences. No Gypsum deposits of any importance occur in the Lower Silurian of the Province of Quebec (page 105), nor are the Clay deposits near St. John, P. Q., "extensively used for the production of porcelain," unless crockery, drain pipes, etc., can be so classed.

The statement (p. 42) that the Iron Ores of the Archæan (which in the Chart of Geological Time on page 19 is made to include all pre-Cambrian deposits) are "doubtless metamorphosed bog ores," is rather sweeping, in view of the results of the work of Van Hise and others in the immense deposits of Iron Ore of their age, immediately to the south of Lake Superior.

That "when a fault is vertical there is no horizontal displacement" (p. 24) also is certainly not true in all cases, while the statement that "the Potsdam Sandstone of Quebec occurs on the south of the Ottawa River in Ontario (p. 168)" has a somewhat Hibernian flavor.

A number of other little inaccuracies will be noticed in looking over the book, which will undoubtedly be corrected when the second edition is called for, which, judging by the increased attention which is now being directed to our Mineral Resources, will probably be before very long. F. D. A.

REPORT OF THE GEOLOGY OF A PORTION OF THE LAURENTIAN AREA, LYING NORTH OF THE ISLAND OF MONTREAL.

The last Annual Report of the Geological Survey of Canada (Vol. VIII.) contains a report and map of a portion of the Laurentian area, lying north of Montreal. It is of especial scientific interest, inasmuch as it is the first publication which describes in a complete form all the different rock structures which are found in a typical area of the Canadian Archæan, with the purpose of ascertaining their true origin. The report is written by Dr. F. D. Adams, of McGill University. The first appendix contains a list of the different publications referring to the Canadian anorthosites, while the second is an abridge-

ment of a paper by Mr. A. J. Rossi, of New York, on the smelting of Titaniferous Iron Ores. The latter is very important, as the areas occupied by the anorthosites contain enormous masses of iron ore of this character.

The map which accompanies the report comprises an area of 3,258 square miles, including parts of the Counties of Argenteuil, Terrebonne, Montcalm and Joliette, in the Province of Quebec.

The coloring of the map is very distinct, the areas of the several rocks being easily distinguished; this is also aided by letters and abbreviated words. The strike and dip of the rocks, as well as the localities which contain deposits of economic minerals, are indicated by the usual geological signs. The influence of the strike of the rock on the natural features of a country is important, and especially well shown in the course taken by the River L'Assomption, and in the formation of Lac des Iles, the forks of Lac Ouareau, and others.

The topographical features are as minutely shown as the scale of four miles to the inch would permit; also the roads and railway lines, so that to anyone interested in this district, especially those who have enjoyed the Natural History Society's field days, in this section of the country, the possession of such a map would be extremely useful.

On examining the map it is seen that occupying the south-east corner are the Palæozoic Rocks of the Cambrian age, under which the Archæan dips. One small area of Cambrian which has escaped the destructive agency of erosion is situated in the township of Abercrombie. The country surrounding it affords this interesting fact of scientific value, namely, that where the Cambrian has been but lately removed from the Archæan hills, they have the same characteristics as other and longer exposed hills, so showing that it must have been a pre-Cambrian erosion which gave them their present shape.

In the centre of the sheet, and a little to the west, lies the great intrusive mass of Morin anorthosite, which has an irregular circular outline and an area of 990 square miles. It is surrounded by the Laurentian, the strike of which coincides with the outline of the mass except in the south-east, where the mass develops an arm-like extension and passes under the Palæozoic.

There are two large intrusions of acid rock, a granitic in the north-east of the sheet and a syenitic in the south-west.

The Laurentian occupies the rest of the map, with the exception of a few minor intrusions of anorthosite.

Three railways traverse this district, so that, considering the extreme ruggedness of the country, the travelling facilities are very good. The Canadian Pacific Railway, branching from the main line at St. Martin's Junction, runs over the Palæozoic almost to St. Jerome, then across the Laurentian to Piedmont; from thence it crosses the Morin anorthosite to Morisson's Station, and then unto the Laurentian again. Its

western terminus is beyond the limits of the map. The altitude of each station is printed underneath the name, and may be taken as approximate for the immediate surrounding country.

The Montfort Colonization Railway connects with the Canadian Pacific at Montfort Junction, and runs in a westerly direction, crossing the Laurentian, the southern edge of the Morin anorthosite, and at present terminates on the former, at Lac de Seize Isles.

The Northern Railway runs north-east from St. Jerome, but only for a short distance on the Laurentian.

This area of the Archæan, however represented on the map, is only a small part of the vast northern Protaxis, which extends from Labrador south-west to Lake Superior, and thence north-west to the Arctic Ocean, and from which the Continent of North America was in great part built up.

The Archæan in this particular district comprises the Laurentian proper and the anorthosites.

It forms a plateau, which rises abruptly from the Palæozoic plain in the south-east, its southern portion averaging about 1,000 feet above the level of the sea, but gradually rising towards the north, it attains at that limit a height of 1,900 feet. A few hills are higher, such as Trembling Mountain and those of Ste. Agricole. The surface of the plateau is very uneven, the hills being rounded and very often bare, while the valleys between them are filled with drift, and constitute good farming land. Lakes of all sizes abound, and are drained by several rivers, tributary to the Ottawa and St. Lawrence.

The Morin anorthosite, though somewhat higher than the surrounding Laurentian, in some places rising from it very abruptly, still has the same general characteristics.

The Laurentian proper is divided into the Fundamental Gneiss and the Grenville Series. The former, as far as our present knowledge concerning it goes, is of igneous origin. The latter is of partly sedimentary origin, but associated with much igneous material. It is composed of gneisses, limestones and quartzites, which are interbanded with one another, and are highly metamorphosed.

These bands, or strata, in the extreme east lie in a horizontal position, further west they undulate, increasing in intensity, until after Radstock and Ste. Emelie have been passed, they become highly contorted, continuing so to the contact of the Morin mass. This is excellently shown in three cross sections, which appear on the same sheet as the map. The gneiss at this contact shows evidence of being stretched, the least plastic rock or mineral in it having a tendency to pull apart.

The rocks of the Laurentian are divided into the following five classes: gneisses, quartzites, garnet rock, pyroxene rock, and crystalline limestones. The gneisses are characterized by their foliated structure, which may vary from very distinct to almost indistinct.

This was formerly supposed to indicate the lines of an almost obliterated bedding, in a rock of aqueous origin, but recently it has been proved that igneous rocks, under great pressure, develop the same parallel arrangement of their mineral constituents, so now it can no longer be the test to decide the origin of a rock.

Owing to the variety and complexity of the gneisses, they have been divided into three classes, namely: gneisses of igneous, aqueous, and of doubtful origin.

Gneisses of igneous origin contain a large amount of orthoclase felspar, with quartz, mica or hornblende in smaller quantities, and many acessory minerals. The three principal varieties are the augen, granulated and leaf gneisses, and they are connected to one another by transitional types.

The first variety occurs in the township of Brandon, associated with stratified rock of the Grenville series. It is composed essentially of quartz, orthoclase felspar in large amount, and hornblende in a fine-grained, ground mass of the two latter minerals. Under the microscope the orthoclase grains show strain shadows, and are very irregular in shape, having an angular outline, which is due to the constant breaking away of particles from the edges. The quartz appears rolled out in long lines, or as curved grains partly surrounding the orthoclase cores. Both minerals have an uneven extinction, but the latter only to a very slight degree. This rock was originally a coarse-grained granite, and received its present structure from pressure.

The granulated is the next type. A typical representative of this is the Fundamental Gneiss of Logan, Trembling Mountain being the great development of it. When fresh it is pale red in color, weathering to a grayish; it is uniform in appearance, and slightly foliated. There are two kinds of orthoclase, a fibrous, showing strain shadows, while the other does not, being derived from the crushed augen, for when the pressure is removed the strain shadows disappear. In chemical composition it is a granite, originally of the hornblende variety. The leaf gneiss represents the third and extreme type. It is found near St. Jerome, and is composed of orthoclase in large amount, having no distinct strain shadows, and quartz. The latter is in very thin layers, and when the rock is broken parallel to the line of foliation it seems to be spread over the orthoclase as in leaves, hence its name. "The structure suggests a completely granulated rock, in which the granulation has perhaps been effected, in part at least, by crystallization."

The gneisses of aqueous origin form the next class—are so determined chiefly from the fact that they have a chemical composition identical with shales or other sediments, but quite different from that of any igneous rock. These gneisses, in addition to the essential constituents of the igneous class, contain garnet, sillimanite and graphite. They are divided according to their mode of weathering—one variety crum-

bling to a rusty sand, caused by the iron pyrites it contains, and the other variety, being free from that mineral, not doing so.

An example of the former is found in a garnetiferous sillimanite gneiss occurring near St. Jean de Matha, interbanded with quartzite. It is dark gray on a fresh surface, and contains, in addition to the two minerals which give it its name, quartz, orthoclase, pyrite and graphite; the long crystals lie in one direction, and so give an indistinct foliation to the rock. It is considered probable that the pyrite was deposited by the agency of the carbon, in the form of graphite, before the rock had crystallized. Under the microscope no granulation is seen in the minerals which were crystallized in situ, but the rock has undergone some pressure since, as the quartz and sillimanite show uneven extinction. The garnet is isotropic, and holds inclusions of other minerals. The rock of the second variety, which contains the same constituents as the above, with the exception of the pyrite, is found north-west of St. Jean de Matha, occurring in horizontal beds. The rock is red in color, and contains a large amount of garnet. The microscopical characteristics are the same as the last. The chemical composition of this class is that of a shale, the percentages of alumina being high, while those of potash and soda are correspondingly low.

The crystalline limestones are important, not only economically, but also on account of their being found interbanded with gneisses; they form a valuable aid in the solving of the stratigraphical problems. In some places they are mixed with gneissic material, and so form calcareous gneisses.

In the eastern part of the map they lie in horizontal beds, some having a considerable thickness; near the Morin anorthosite, several outcrops appear, being parts of the same band, which has been repeatedly brought to the surface by folding, as illustrated in the cross sections. Beds of all sizes occur in every township in the south and west, some being quite pure, while others contain a great many minerals, such as graphite, tourmaline, serpentine, etc. With reference to the origin of the last named mineral, it was found that the core of the lump was pyroxene, so conclusively proving that the serpentine of the Laurentian crystalline limestones, here at least, is formed by the alteration of pyroxene.

Examined microscopically, the limestone is crystallized in its usual characteristic rhombohedral form; in some cases part of the crystal is very clear, while the remainder is turbid, which latter character offers an interesting field for future investigation.

The third class of gneisses, or those of doubtful origin, are numerous and occur in many parts of this area. The varieties include quartz orthoclase biotite gneiss, with and without garnet, garnetiferous hornblende gneiss, granulite, and pyroxene and amphibolite granulites. These, as in the case of the former classes, have been submitted

to intense pressure. In this class, however, as in many other classes of rocks, the work of the investigator is by no means ended, and the future will no doubt settle the problems concerning their origin, which are to-day unsolved.

The anorthosites belong to the gabbro family of igneous plutonic rocks, and occur in the Archæan as intrusive masses of all sizes, which masses break through the gneisses in various localities, from Labrador to Lake Superior. Sir William Logan and others, who had examined the Morin intrusion in this area, held that the anorthosites were of sedimentary origin, because they possessed a foliated structure, which was considered at that time to be the remains of a partly obliterated bedding. The formation was then called the Upper Laurentian, or Norian.

The result of modern research, however, shows that this foliated structure is of a secondary character and due to movements in the rock, brought about by the great pressure to which they have been subjected when deeply buried under a great mass of overlying rock.

As the Morin mass is by far the most important to this area it can be taken as a typical example. Anorthosite is composed essentially of nearly pure plagioclase felspar with accessory minerals in small amount, the most important being augite, hypersthene and ilmenite, the latter of which occurs in concentrations of large size.

According to the structure of the rock, it is divided into granulated and non-granulated, but as in the case of the gneisses there are many intermediate forms. The former variety is developed in the main mass, while the latter occurs along the borders of the mass and especially in the south-east arm which passes under the Palæozoic.

In the non-granulated rock the plagioclase is fresh and generally of a dark violet color, which, when examined microscopically, was found to be due to numerous rod-like inclusions. When these are absent the felspar is white. These rods are supposed to be composed of titaniferous iron. The felspar, which is a labradorite, is usually twinned and sometimes has as alteration products calcite, epidote, zoisite and saussurite. The augite is fresh and of a light green color, often seen growing around iron ore; the hypersthene closely resembles the augite. The iron ore is ilmenite, being exceedingly rich in titanic acid as contrasted with the iron of the Laurentian, which has none or very little. The microscope shows that the ilmenite is often found closely associated with magnetite in small amount. The rock examined in situ is very coarse in grain and contains dark patches or streaks, which are caused by a concentration of bisilicates and iron ore. On the same structure in rocks around Baltimore Dr. E. H. Williams remarks as follows:—"The most striking feature in the texture of the unaltered gabbro is the repeated and abrupt change in the coarseness of the grain which is seen at some localities. It was

undoubtedly caused by some irregularities in the cooling of the original magma, for which it is now difficult to find a satisfactory explanation," and further on he writes, the "streaks show a tendency to merge into one another as though they had been produced by motion in a liquid or plastic mass."

The streaking is well developed at other areas, notably in the Saguenay anorthosite, near Chicoutimi, which shows all gradations, from the massive to the well banded.

The granulated variety is composed of large fragments of plagioclase, in a fine grained ground mass of the same mineral. The stages illustrating the transition from non-granulated to the above is shown in an excellent manner by three microphotographs. In the first the rock is massive, the plagioclase being twinned polysynthetically; there are no strain shadows and just a trace of granulation in the lower part of the section. In the next the felspar individuals are much cracked, giving off broken grains, the twin lines are twisted and strain shadows are present, but no foliation. The third shows the remainder of a large crystal of felspar in the centre of the field which has furnished the ground mass of smaller grains, presenting a distinct foliation. The strain shadows appear in the large grains, but not in the small ones, for as soon as the pressure is sufficient to break a particle from its parent mass, the strain ceases and the shadow consequently disappears. So it is only by having such examples as the last described that it is possible to say definitely how the granulation was produced. In this variety the plagioclase is white, the reason of it being that the motion caused by pressure allows the free play of the constituents of the rock, by which means the iron ore which was disseminated through the felspar in the form of small grains becomes concentrated in certain spots.

When weathered this rock resembles crystalline limestone in a remarkable manner. In the south-east arm the hills protrude through the drift, as white rounded knobs, thus giving to this section of the country a characteristic of landscape peculiar to itself.

Minor intrusions occur at Lakefield, St. Jerome and in the townships of Kildare, Cathcart and Brandon. An interesting fact in connection with the position of the above rocks is that they occur along the edge of the Archæan Protaxis, which, in Cambrian time, bordered on the ocean. The modern volcano follows the same law as its primæval prototype.

Considerable attention has been given to the economic geology, with the result that the following minerals have been found, some of which are of importance: Magnetite, ilmenite, bog ore, ochre, graphite, apatite, mica, garnet rock, crystalline limestone and anorthosite. The latter makes a good paving stone, and has been used for that purpose in Montreal. No traces of gold or silver were discovered,

though numerous specimens were taken from localities where these precious metals were supposed to exist, but careful assays gave a negative result.

This report with the elaborate map, the general description of the country and rocks, the plates which illustrate in an admirable manner typical natural features and microscopic rock structure, and the amount of petrographical research contained therein, marks a great advance in the work on the Canadian Laurentian.

O. E. LEROY.

ABSTRACT FOR THE MONTH OF OCTOBER, 1897.

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet, C. H. McLEOD, *Superintendent.*

DAY	THERMOMETER.				BAROMETER.				†Mean pressure of vapor.	‡Mean relative humidity.	Dew Point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	§Max.	Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	59.22	65.8	48.7	17.1	30.1635	30.411	29.982	.429	3088	60.3	45.3	N.	21.04	1.7	10	0	77	....	....	...	1
2	47.17	54.8	39.1	15.7	30 5890	30.621	30.529	.092	.2002	62.2	34.5	N	14.46	0.0	0	0	97	....	...	....	2
SUNDAY..... 3	.....	62.0	35.0	27.0	.....	.....	. .	.....	.....	....	....	S.W.	12.63	...	..	..	87	....	....	....	3.....SUNDAY
4	54 43	66.3	41.8	24.5	30.3168	30.441	30.193	.248	.2717	64.2	42.2	S.W.	18.96	0.3	2	0	92	....	.....	....	4
5	56.30	69.4	43.3	26.1	29.9418	30.130	29.756	374	.2750	60.3	42.2	S.W.	15.33	1 5	3	0	93	....	....	....	5
6	52 63	64.6	46.3	18.3	29.7345	29 876	29.631	.245	.3182	79.5	46.2	S W.	17.67	7.0	10	0	16	0.05	....	0.05	6
7	42.67	47.2	38.3	8.9	30 0025	30.120	29.891	.229	.2010	73.2	34.7	N.W.	8.58	8 8	10	5	0	0.00	....	0.00	7
8	42.83	48.0	35.0	13.0	29 9932	30.143	29.763	.380	.2047	73.0	34.8	S.W.	8.83	8.2	10	5	36	0.02	....	0.02	8
9	41.87	53.3	31.5	21.8	30.0400	30.273	29.705	.568	.1777	64.2	30.5	W.	21.17	2.2	10	0	94	0.00	....	0.00	9
SUNDAY.....10	.....	39.8	26.0	13.8	.....	.....	.....	....	.....	....	...	N.W.	7.21	....	.	..	63	....	....	...	10 .....SUNDAY
11	52.22	64.7	30.4	34.3	29 9177	30 069	29.764	.305	.3260	75.8	44.7	S.W.	15 79	9.0	10	8	19	....	....	...	11
12	61.33	67.0	52.3	14.7	29.7600	29.993	29.642	.351	.4678	84.3	56.8	S W.	24.75	7 0	10	0	0	0.26	...	0.26	12
13	51.12	58.7	43.9	14.8	30.3292	30.454	30 116	.338	.2545	68 5	40.8	S.W.	15.17	0.2s	1	0	97	....	....	....	13
14	53.73	62.2	42.4	19.8	30.3072	30 500	30.106	.394	.2962	71 7	44 7	S.	13 75	4.8	10	0	52	...	....	..	14
15	68.58	77.8	44.0	33.8	29.9938	30.071	29.927	.144	.5185	73 8	59.7	S W	18.04	3.5	10	0	63	....	....	....	15
16	62.75	71.8	45.8	26.0	29 7802	29 897	29 632	.265	.4847	80.8	56.7	S.W.	25 25	7.0	10	3	15	0.13	....	0.13	16
SUNDAY.....17	....	44.5	37.4	7.1	.....	.....	.....	.....	.....	....	....	N.W	20 67	..	..	..	82	0.00	....	0.00	17.....SUNDAY
18	44.83	54 2	35.0	19.2	30.2990	30.442	30.191	.251	.1853	63.2	32.2	S.	22,88	5.5	10	0	41	...	....	....	18
19	49.27	55.2	42.8	12.4	30.1112	30.160	30.053	.107	.2468	65.0	39.5	S.W.	14.79	4.8	10	0	58	....	....	....	19
20	42.15	52.2	33.5	18.7	30.1223	30.203	30.063	.140	.1783	66.5	31.7	N.	17.79	0.8	3	0	94	....	....	....	20
21	44.00	53.8	35.5	18.3	30 0555	30.086	30 012	.074	.1877	64 2	32.5	N.	13.75	0.8	5	0	26	....	....	....	21
22	43.38	51.4	36.0	15.4	30.1872	30 270	30.100	.170	.1982	70 2	34.2	N.	8.33	4.3	10	0	37	....	....	....	22
23	44.83	54.8	34.0	20.8	30.3777	30.383	30.287	.096	.2335	78.5	38.0	S.	8.33	1.7	10	0	71	....	....	....	23
SUNDAY.....24	....	56.2	40.0	16.2	.....	.....	.....	....	.....	....	....	S.W.	12.63	...		..	68	....	...	....	24..... ...SUNDAY
25	49 75	58.4	41.3	17.1	30.0968	30.133	30.060	.073	.3235	83.5	46.7	N.	11.58	0 8	5	0	86	....	....	....	25
26	18.95	58.4	41.0	17.4.	30.1400	30.171	30.110	.061	.2740	79.3	42.7	N.	6.67	0.0	0	0	88	....	....	....	26
27	49 92	61.2	39.7	21.5	30 0998	30.187	29.972	.215	.2378	80.3	44.0	S.	10.33	1.3	8	0	08	....	.	....	27
28	50.62	60.5	44.4	16.1	29.6975	29.924	29.525	.399	.2882	76.8	43 5	S.E	16.29	5.3	10	0	38	0.16	....	0.16	28
29	35.70	44 5	31.0	13.5	29.7215	29.847	29 612	.235	.1593	67.3	23.5	N.W.	16.58	2.5	8	0	90	0 03	....	0.03	29
30	30.92	34.8	26.6	8.2	30.0050	30.134	29.884	.250	.1270	73 3	23.5	S W.	8.04	4.5	10	0	0	....	....	....	30
SUNDAY.....31	.....	42.7	29.6	13.1	.....	.....	.....	.....	.....	....	...	E.	8.71	...	..	..	6	....	..	....	31.....SUNDAY
Means.....	49.39	56.65	38.44	18.21	30.0666	30 1899	29.9425	.2474	.1690	71.77	40.42	S. 54¼° W	14 71	3.83	7.7	0.8	57.3	0.65	....	0.65	.....Sums.
23 Years means for and including this month	45.43	52.45	38.55	13.93	29.9985	.....	.....	.215	.2438	76.4			S 13.55	6.33	.	.	¶41.34	2.96	....	3.08	23 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction.....	N.	N.E.	E.	S E.	S.	S.W.	W.	N.W.	CALM.
Miles	1846	429	103	438	1536	4991	772	829	
Duration in hrs..	153	30	12	36	101	291	50	71	
Mean velocity....	12.07	14.30	8.58	12.17	15.21	17.15	15.44	11.56	

Greatest mileage in one hour was 38, on the 16th.

Greatest velocity in gusts 42 miles per hour on the 16th.

Resultant mileage, 4495.

Resultant direction, S. 54° 2 W.

Total mileage, 10,944.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit.

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only. s 11 years only.

The greatest heat was 77°8 on the 15th; the greatest cold was 26°.0 on the 10th, giving a range of temperature of 51.8 degrees.

Warmest day was the 15th. Coldest day was the 30th. Highest barometer reading was 30.644 on the 3rd. Lowest barometer was 29,525 on the 28th giving a range of 1.119 inches. Maximum relative humidity was 98 on the 16th. Minimum relative humidity was 39 on the 18th.

Rain fell on 9 days.

Aurora was observed on one night.

Lunar Coronas on the 4th, 5th, 9th, 10th, 12th, and 13th.

Fog on 5 days.

ABSTRACT FOR THE MONTH OF NOVEMBER, 1897.

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet, C. H. McLEOD, *Superintendent.*

DAY	THERMOMETER. Mean.	Max.	Min.	Range.	BAROMETER. Mean.	§Max.	Min.	Range.	†Mean pressure of vapor.	‡Mean relative humidity.	Dew Point.	WIND. General direction.	Mean velocity in miles per hour	SKY CLOUDED IN TENTHS. Mean.	Max.	Min.	Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	40.25	47.0	35.6	11.4	30.0282	30:087	29.996	.091	2392	94.7	38.8	S.E	11.67	10 0	10	10	00	0.35	....	0.35	1
2	35.20	37.8	31.7	6.1	29 8080	29.937	29.610	.327	.1885	91.7	32.8	N.	27.75	10.0	10	10	00	0.64	...	0.64	2
3	38 47	42.7	32.5	10.2	29.8098	30.053	29.597	.456	.2123	90.5	35.8	N	14.92	6 7	10	0	00	0.11	....	0.11	3
4	43.70	51.2	37.3	13.9	30.1597	30.190	30.129	.061	.2498	86.7	39.8	S.	13.13	3 0	7	0	00	....	.....	....	4
5	39 93	48.8	34.0	14 8	30.0005	30.168	29.832	.336	.2163	87.2	36.5	N.	13.67	6.8	10	0	27	0.00	....	0.00	5
6	46.22	51.4	37.7	13.7	29.7273	29.805	29.675	.130	.2520	79.0	40.0	S.W.	21.96	8 2	10	3	35	0.27	....	0.27	6
SUNDAY..... 7	.....	37.2	34.5	2.7	.....	.....	.	.....	.....	....	....	S.W.	22.13	...	..	..	00	0.00	0.0	0.00	7.....SUNDAY
8	33.83	37.5	29.4	8.1	29.8860	30.002	29.763	.239	.1642	84.0	29.7	S.	6.23	7.2	10	0	00	....	....	....	8
9	33.92	35.6	32.2	3.4	29 3813	29.699	29.100	.599	.1783	91.5	31.7	N.	21.38	10.0	10	10	00	....	8.7	1.10	9
10	31.38	35.6	27.7	7.9	29 7913	29 951	29.560	.391	.1525	86.2	27.7	S.W.	20.63	6.3	10	0	56	....	....	....	10
11	30.95	35.2	7	9.5	29.8068	29.963	29.596	.367	.1577	90.7	28.5	E.	12.08	7 5	10	0	00	....	3 2	0.41	11
12	32.40	33.6	30.2	3.4	29.5697	29.614	29 518	.096	.1730	94.0	30.7	N.	14.46	10.0	10	10	00	....	3.5	0.45	12
13	32.18	35.2	29.3	5.9	29.8018	29 973	29 665	.308	.1530	83.5	27 8	S.W.	25.08	9.7	10	8	9	....	....	....	13
SUNDAY.....14	.....	31.7	24.6	7.1	.....	.....	.....	....	.....	....	....	S.W.	21.33	....	..	..	93	....	....	....	14.....SUNDAY
15	29.03	36.3	20.5	15.8	30.1947	30.291	30.066	.225	.1420	87.0	26.0	E.	10.21	8.0	10	0	37	....	....	....	15
16	38.38	46.6	31.2	15.4	29.9063	30 129	29.715	.414	.2195	91.8	36.2	S.W.	21.13	9.7	10	8	00	0.51	....	0.51	16
17	25.95	28.8	23.0	5.8	30.3247	30.398	30.252	.146	.0967	68.5	17 5	S.W.	14.21	4.5	10	0	98	....	0.0	0.00	17
18	21.52	24.3	17.6	6.7	30.4150	30.439	30.395	.044	.0865	74.8	15.2	W.	9.46	10.0	10	10	6	....	0.0	0.00	18
19	15.32	18.2	11.6	6.6	30.3440	30.419	30.272	.147	.0653	74.5	8 8	N.	9.63	2.0	8	0	89	.....	..	....	19
20	22.07	35.8	11.0	24.8	30.1418	30.268	29.930	.338	.1082	86.3	18.7	N.	13.71	7.8	10	0	00	0.02	0.0	0.02	20
SUNDAY.....21	.....	43.6	35.5	8.1	.....	.....	.....	.....	.....	....	....	E	23.83	.....	..	..	5	....	....	....	21.....SUNDAY
22	21.07	26.3	16.9	9.4	30.0837	30 182	29.946	.236	.0772	67.8	12.5	S.W.	16.96	1.7	10	0	95	....	....	....	22
23	14.58	23.2	9.0	14 2	30.0470	30.225	29.913	.312	.0612	72.3	7.5	W	13.15	2.7	10	0	80	....	....	....	23
24	24.72	34.2	8.5	25.7	30.2225	30.257	30.166	.091	.1043	75.5	18.3	S.	17.96	7.0	10	3	12	....	0.0	0 00	24
25	32.58	35.3	26.2	9.1	30.1663	30.226	30.081	.145	.1637	87.8	29.5	S.W.	18.17	10.0	10	10	00	0.06	0.9	0.20	25
26	45 30	53.2	33.2	20.0	29 7553	30.019	29.575	.444	.2955	95.2	44.0	S.E.	23.17	10.0	10	10	00	0.49	.	0.49	26
27	24.55	54.2	16.2	38.0	30.2080	30.537	29.711	.826	.1113	78.5	19 0	W	20.33	5.0	10	0	67	0.21	0.0	0.21	27
SUNDAY.....28	.....	30.3	14.5	15.8	.....	.....	.....	.....	.....	....	....	S.E.	12.29	...		..	58	....	....	....	28.....SUNDAY
29	29.47	35.2	24.0	11.2	30.0608	30.316	29.941	.375	.1310	78.8	24.2	S.E.	24.21	5.3	10	0	00	....	2.3	0.27	29
30	13.13	19.3	8.8	10.5	30.1728	30 223	30.118	.105	.0612	77.0	7.5	S.W.	12.21	1.0	6	0	70	....	....	....	30
31																					
Means.....	30.62	36.84	25.00	11.84	29.9928	30.1297	29.8509	.2788	.1562	83.68	26.33	S. 35½° W.	16 92	6.93	9.7	3.5	27.9	2.66	18.6	5.03	.....Sums.
23 Years means for and including this month	32.45	38.90	26.50	12.41	30.0160	.....	.....	.267	.1602	79.9			16.07	7.36	..	..	¶23.59	2.41	12.75	3.71	23 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction.....	N.	N.E.	E.	S E.	S.	S.W.	W.	N.W.	CALM.
Miles	1976	791	901	147	1265	4305	1257	271	
Duration in hrs..	134	47	57	80	73	231	79	19	
Mean velocity....	14.75	16.83	15.81	18.37	17.33	18.64	15.91	14.26	

Greatest mileage in one hour was 35, on the 2nd.

Greatest velocity in gusts 46 miles per hour on the 2nd.

Resultant mileage, 3315.
Resultant direction, S. 35° ½ W.
Total mileage, 12,783.
Average velocity 16.92 m. p. h.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit.

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only. ε 11 years only.

The greatest heat was 54.2° on the 27th; the greatest cold was 8°.5 on the 24th, giving a range of temperature of 45.7 degrees.

Warmest day was the 6th. Coldest day was the 30th. Highest barometer reading was 30.588 on the 28th. Lowest barometer was 29.100 on the 9th giving a range of 1.488 inches. Maximum relative humidity was 99 on the 1st and 16th. Minimum relative humidity was 59 on the 23rd.

Rain fell on 11 days.

Snow fell on 11 days.

Rain or snow fell on 18 days.

Lunar halos on two nights. Lunar coronas on six nights.

Hoar Frost on two days.

Fog on 5 days.