Fig. 1, CRYPTOZOON BOREALE, Dawson.

Ordovician, Lake St. John, P.Q., Canada. *Two of the Branches of a large Compound Mass. Natural size.* Collected by Mr. E. F. Chambers.

(From a Photograph.)

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NOTE ON CRYPTOZOON AND OTHER ANCIENT FOSSILS.

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For many years my attention has been directed, in connection with the discussions regarding Eozoon, to the discoveries made from time to time of organic remains older than the Lower Cambrian, and to the study of fossils occurring in the Cambrian, and which might be supposed likely to be survivals from the Pre-cambrian periods. It is now well known that in the Lower Cambrian seas there already existed representatives of all the classes of Marine Invertebrates, and these represented probably by several hundreds of species of many genera, since the published lists of American forms alone contain more than 160 species.[1] In the beds immediately below the Cambrian, however, though several forms of life have been recognised by Billings, Matthew, Walcott and others, they are comparatively rare in numbers and sparsely distributed through great thicknesses of unproductive beds; and this in connection with the frequently disturbed and altered condition of the beds themselves, renders any attempt to

1 Walcott: Memoir on Fauna of Lower Cambrian, 1890. Publications of U.S. Geological Survey.

collect Pre-cambrian fossils tedious and difficult, as well as often unremunerative.

In the present paper I propose to notice some Pre-cambrian—or possibly Pre-cambrian—fossils, as much with the object of directing the attention of younger geologists to the collection of organic remains in these rocks as for any other purpose, since our knowledge of the Pre-cambrian fauna is yet in its infancy, and may be regarded rather as something to be hoped for in the future than as a present possession.

I am disposed to follow Matthew in placing as Pre-cambrian, though still Palæozoic, the beds in Southern New Brunswick designated by him as Etcheminian, and holding a few fossils of Palæozoic types, and to correlate with these the Signal Hill Series of Newfoundland and the Kewenian or Kewenawan of Lake Superior.[1] Below these, so far as yet known, we have only the Huronian, probably divisible into an upper and lower member, the Grenvillian or Upper Laurentian—the two constituting the Eozoic group,—and the Lower Laurentian, Ottawa gneiss or Archæan proper.

I. Cryptozoon.

In 1882 Prof. James Hall described certain remarkable stromatoporoid forms found by him in a limestone of the Calciferous formation at Greenfield, Saratoga County, New York, and which he named *Cryptozoon proliferum*.[2] The specimens occurred abundantly on the surface of the bed, and were of rounded form and closely grouped together, as if by a process of lateral gemmation. Each individual is described as consisting of "a number of irregular concentric laminæ of greater or less density and of very irregular thickness. The substance between the

[1] Matthew, Trans. Acad. Science, N.Y., March, 1896; Trans. Royal Soc. of Canada, 1889, etc. See also "Canadian Record of Science," 1896.

[2] Thirty-sixth Regents' Report on New York State Cabinet.

concentric lines, in well-preserved specimens, is traversed by numerous minute irregular canals, which branch and anastomose without regularity. The central portions of the masses are usually filled with crystalline, granular and oolitic material, and many specimens show the intrusion of these extraneous and inorganic substances between the concentric laminæ."

In general form the masses are hemispherical or broadly turbinate, and the layers are concave upward as if they had grown from a central point or circle and expanded very rapidly in ascending, the general result resembling a series of bowls one within another. The larger masses are from one to two feet in diameter.

Thin slices, from specimens kindly presented to the Peter Redpath Museum by Prof. Hall, show that the primary laminæ are thin and apparently carbonaceous, as if originally of a corneous or membranous character, and they are usually finely crumpled as if by lateral pressure,[1] while they can occasionally be seen to divide into two laminæ with intervening coarsely cellular structure. The thick intermediate layers which separate these primary laminæ are composed of grains of calcareous, dolomitic and silicious matter, in some specimens with much fine carbonaceous material. This last, under a high power in thin slices, is seen to present the appearance of a fine network or stroma in which the inorganic particles are entangled. The canals traversing these intermediate layers appear to be mere perforations without distinct walls, and are filled with transparent calcareous matter, which renders them, under a proper light, sufficiently distinct from the grey granular intermediate matter which they traverse. So far as observed, the canals are confined to the intermediate layers, and do not seem to penetrate the primary laminæ, though these sometimes present a reticulated appearance

[1] This may, however, represent an originally corrugated structure of the laminæ.

and seem to have occasional spaces in them which may have been communicating pores or orifices.[1]

In 1885 Prof. N. H. Winchell recognised a similar structure in stromatoporoid forms found in a limestone underlying the St. Peter sandstone, and therefore of Upper Cambrian age. These are noticed in his 14th Annual Report under the name *Cryptozoon Minnesotense,* and are stated to differ from Hall's specimens in their habit of growth, the laminæ being convex or conical upward. The structure also is somewhat different, the lamination being much finer.

In 1889 the Minnesota specimens were again noticed by Mr. L. W. Chaney, more especially with reference to the great size attained by some of them, though there seemed to be doubt as to whether the very large specimens may not have been enlarged by aggregation of concretionary matter. In this paper also, the discovery of Cryptozoon in the calciferous of the Champlain Valley, by Prof. H. M. Seely, is mentioned.

About this time I had obtained from the Calciferous of Lachute, P.Q., a large stromatoporoid mass, and in examining it microscopically found that, though less perfectly preserved than Hall's specimens, it might be referred with probability to the same genus. The laminæ are more waved, and often connected with each other, and the canals less curved and more frequently expanding into irregular cavities. I cannot positively affirm that this is a distinct species, but may provisionally name it *C. Lachutense.*

In 1890, the Cryptozoa of the calciferous of the Champlain Valley are referred to by Messrs. Brainard and Seely, and one species is named *C. Steeli,* in honour of Dr. Steel, who first observed them in 1825.[2] This species is stated

1 Thin horizontal sections of the laminæ in the best specimens indeed appear as if constituting a reticulated mat, more dense than that seen in the intermediate layers.

2 Bulletin Geol. Socy. of America, Vol. I, p. 502.

in the same paper to appear in the calciferous of Philipsburgh on the Canadian frontier. Prof. Seely informs me in a private letter that he has since recognized in the Champlain Valley what appear to be two additional species of Cryptozoon.

Cryptozoon Boreale, Dawson (Fig. 1).—A quite distinct and very interesting species was obtained in 1888 by Mr. E. F. Chambers, of Montreal, at Lake St. John, P.Q., associated with fossils of Trenton age. It consists of a mass of cylindrical or turbinate branches, proceeding from a centre and also budding laterally from each other. Each branch shows a series of laminæ concave upward. The spaces between the thin laminæ are filled with a very fine granular material, in which are canals, less frequent straighter and more nearly parallel to the laminæ than in the typical species. This species is remarkable for the slender and coral-like shape of its branches, for its resemblance in general form to the disputed specimens resembling Eozoon from the Hastings (probably Huronian) of Tudor, Ontario, and on account of its being the latest known occurrence of Cryptozoon. It was very shortly described and commented on in the "Canadian Record of Science" for 1889.

Cryptozoon Occidentale, S.N.—So far our specimens of Cryptozoon have been Upper Cambrian or Ordovician, but Dr. C. D. Walcott, in his memoir on the Fauna of the Lower Cambrian, mentions at p. 550 that in the Grand Cañon section in Arizona, there are unconformably underlying the Lower Cambrian "12,000 feet of unaltered sandstone, shale and limestone," which may be regarded as Pre-cambrian, and probably in whole or in part representing the Kewenian of Lake Superior and the Etcheminian of Southern New Brunswick. In these beds, 3,500 feet below the summit of the section, he found "a small Patelloid or Discinoid shell," a fragment probably of a Trilobite, and a small Hyolithes, in a bed of bituminous limestone.

"In layers of limestone still lower in the section an obscure *Stromatoporoid form* occurs in abundance, along with fragments of a Trilobite and a Salterellæ." Small specimens of these stromatoporoid forms were kindly supplied to me by Dr. Walcott, and on being sliced, though most of them were imperfectly preserved, one of them exhibited the concentric laminæ of Cryptozoon, and the intermediate layers composed of microscopic grains which were ascertained by Dr. Adams to be partly silicious and partly calcareous (Dolomite and calcite). Instead of the irregular curving canals of the typical Cryptozoon, where best preserved they show ragged cells, giving off on all sides numerous small tortuous and branching canals (Fig. 3), but this structure I regard as possibly corresponding to that of Cryptozoon, and I would therefore venture to name the species *C. Occidentale*, in hope of the discovery of better specimens.

II. Archæozoon.

Still older specimens referable to the same general type have been found by Dr. G. F. Matthew in the Upper Laurentian (Grenville Series) of Southern New Brunswick. Dr. Matthew having kindly presented a large slab of these fossils to the Peter Redpath Museum, I have been enabled to study them both macroscopically and microscopically. As described by Matthew, with reference to their mode of occurrence *in situ*, they consist of cylindrical or polygonal columns apparently multiplying by budding, and composed of laminæ and intermediate layers which are convex upwards and are in places separated by spaces occupied with calcite.[1] The laminæ have the same aspect with those of Cryptozoon; but the intervening thick granular layers, which have a very uniform appearance,

[1] In the slab presented to the Peter Redpath Museum the individual masses are apparently not *in situ*, but more or less broken and piled up together; some of them are six inches in diameter. The laminæ of white calcite in several of the specimens I regard as inorganic and filling lacunae or cavities.

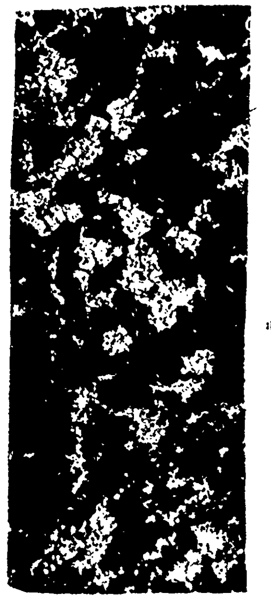


Fig. 2. Fig. 3.

Fig. 2.—Section of part of Cryptozoon proliferum, Hall, x 48, showing two of the primary laminæ at (a, a), and portions of three of the canaliferous layers.

Fig. 3.—Section of part of C. Occidentale, S.N., x 48, showing one of the primary laminæ at (a), and portions of two of the cellular and canaliferous layers.

(From micro-photographs by Prof. Penhallow.)

exhibit canals only in places. Elsewhere they may have perhaps been destroyed by decay and pressure. Matthew regards these forms as fossils; and if so, they are undoubtedly allied to Cryptozoon, if not properly belonging to the genus. They are in any case the oldest known forms referable to this type. In other beds of the same age fragments of Eozoon showing the canal systems have been found, and also needles supposed to be spicules of sponges, and carbonaceous films and fibres which may be of vegetable origin.

III. General Remarks on Cryptozoon and Archæozoon.

If we endeavour in imagination to restore these curious organisms, the task is a very difficult one. They no doubt grew on the sea bottom, and must have had great powers of assimilation and increase in bulk. Still, it must be borne in mind that they were largely made up of inorganic particles collected from the mud and fine sand in process of deposition. The amount of actual organic matter in the hard parts even of large specimens is not very great, and the soft living material, if they were animal, must have been confined to the canals and to the exterior surfaces.

As the only marine animals known to accumulate foreign matter in this manner are the Protozoa of the Rhizopod type, one naturally turns to them for analogies, and perhaps species of the genus Loftusia most nearly resemble them in general arrangement. But this type is, I believe, not known lower than the Lower Carboniferous; *L. Columbiana*, A. M. Dawson, found with the genus Fusulina in rocks of that age in British Columbia, being the oldest known species.[1] I am not aware that any of the Stromatoporæ, properly so called, as nearly resemble Cryptozoon, unless my genus Megastroma from the Carboniferous of Nova Scotia is referable to that group.

[1] Journal London Geol. Survey, Vol. 35, p. 69, et seqr.

This curious fossil was described with some other Carboniferous forms in the Report of the Peter Redpath Museum for 1883, and as that publication is not very generally accessible, the description may be repeated here:—

Megastroma laminosum, Dawson.

"Broadly expanded layers about one millimetre in thickness, and two millimetres or more apart. Each layer consists of a double membrane, beset with numerous spicules pointing inwards and looking like two brushes facing each other. The membranes are penetrated by openings or oscula, and appear to be porous or reticulate in their substance and to have cellular thickenings in places, giving them a netted appearance. The layers sometimes though rarely unite, and are not always continuous when seen in section; this appearance being perhaps produced by large openings or spaces. In each layer the ends of the opposing spicules are sometimes in contact, sometimes separated by a space, empty or filled with calcite. The intervals between the layers are occupied by organic limestone, consisting of small shells and fragments of shells and corals. As many as twelve or thirteen layers are sometimes superimposed, and their horizontal extent seems to amount to a foot or more. The layers have a deep brown colour, while the enclosing limestone is of a light gray tint.

"This remarkable body was found in the fossiliferous limestone of Brookfield, in patches parallel with the stratification, and at first sight resembled a coarse *Stromatopora*. When sliced and examined under the microscope, it presents the appearance above described. The membranes referred to, from their deep brown color, would seem to have been of a horny or chitinous character. They are sometimes bent and folded, as if by pressure, and appear to have been of a flexible and tough consistency.

The spicules connected with them, if organic, would seem to have been set in the membrane, and to have been corneous rather than silicious. I have, however, no absolute certainty that these apparent spicules may not be rather the effect of prismatic crystals of calcareous spar penetrating a soft animal matter and impressing on it their own forms. If the spicules are really organic, the structure must be of the nature of a sponge. If otherwise, it must have consisted of double membranous layers enclosing between them a softer organic matter, and sufficiently firm to retain their form till filled in with calcareous fragments. Unless the structure was of vegetable origin, which I do not think likely, it was probably a Protozoan of some kind. In either case it is different from any fossil hitherto found in the Lower Carboniferous limestones of Nova Scotia." It is introduced here merely as a possible successor of Cryptozoon.

I think we are justified in holding that the fossils of the type of Cryptozoon constitute a type differing from that of the ordinary stromatoporæ, and probably inferior to them in organization. At one time I supposed that the Ordovician forms contained in the genus Stromatacerium of Hall might be a connecting link, and in some respects of general arrangement they certainly conform to Cryptozoon: but in so far as I have been able to examine them microscopically, their affinities seem to be with the typical Stromatoporæ. Still, there remains even in my own collection a large amount of material referred to Stromatocerium which has not not yet been sliced and examined.

Of modern forms, that which seems to approach nearest to Cryptozoon is the remarkable organism dredged by Alexander Agassiz in the Pacific,[1] and which has been described by Goës as an arenaceous foraminifer, under the

[1] Lat. 10 7' N. Long. 80 4' W., 1,740 fathoms.- "Albatross" Expedition.

name *Neusina Agassizi.*[1] It is of considerable size, the largest specimens measuring 190 mm. in breadth, but is very thin, being only 2 mm. in thickness. The general form is fan-like or reniform, with concentric lines or bands, from the edges of which loose tubes or hollow bundles of fibres project into the water. These bands are described as "chambers," which are, however, crossed by innumerable thick partitions dividing them into chamberlets, and these partitions are composed of a fine corneous stroma or network, in which and on the surface are contained the arenaceous grains that give consistency to the whole. It is evident that such a structure, if fossilized, would resemble a flattened Cryptozoon in form, appearance and structure, except in having rounded chamberlets instead of short tortuous canals, a difference not of essential importance. Goës mentions as probably an allied form *Julianella fœtida*, Schlumberger, from shallow water (five metres) on the West Coast of Africa. It wants the filamentous stroma and has the chamberlets larger and more regular and the lateral tubes more numerous. If these forms are rightly included in Foraminifera, they would strengthen the same reference for Cryptozoon and Archaeozoon. In any case they indicate the persistence up to the modern time of organisms apparently of the same general structure.

IV. GIRVANELLA, Nicholson (*Streptochetus*, Seely).

These peculiar fossils were first detected by Nicholson and Etheridge in the Silurian of Girvan in Scotland,[2] and were illustrated by Mr. Wethered, of Cheltenham, at the meeting of the British Association in Liverpool last autumn.[3] A similar form discovered in the Chazy of Vermont by Prof. Seely, of Middlebury College, was

[1] Bul. Mas. Comp. Zoology, Vol. XXIII., No. 5, 1892.

[2] Nicholson and Lydeker, Palaeontology, 1889, first described in Memoir on Girvan, 1878.

[3] New Cotteswald Naturalists' Club, Vol. XII, Pt. 1, 1895-6.

described by him as a sponge, under the name *Streptochetus ocellatus*,[1] and appears to be generically the same with Nicholson's species, though belonging to an older formation. These bodies occur in small rounded or elliptical masses, presenting a concentric structure resembling that of Cryptozoon on a small scale. Under the microscope, in specimens kindly communicated to me by Prof. Seely and Mr. Wethered, the layers are seen to be made up of minute tubes twisted together in a most complicated manner. The tubes are cylindrical, smooth, and apparently calcareous, and they do not occupy the whole space, but leave irregular unoccupied cavities. The tubes make up the layers and there do not seem to be any distinct separating laminæ between the layers, or any included earthy matter. In these respects they differ structurally from Cryptozoon, and are certainly at least generically distinct, though having some resemblance in general manner of growth.

Girvanella gives us little assistance in determining the affinities of Cyptozoon, and its own relationships have been very variously interpreted. It has been referred to Hydroids, Protozoa and even to Algæ. Prof. Penhallow, however, who has examined my specimens, does not seem inclined to refer it to the latter, though it has certain resemblances to some of the Siphoneæ. Perhaps the most probable conjecture as to its affinities is that advanced by Nicholson,[2] who compares it with the recent tubulous Foraminifora of the genera Syringammina and Hyperammina of Brady, whose tests present masses of tortuous and in some forms branching tubes, sometimes in concentric layers.

I have recently been able to extend the range of this curious organism downward, by the discovery in a boulder in a conglomerate at Little Metis of numerous examples

1 American Journal of Science, 1885.
2 Nicholson and Lydeker, Manual of Palæontology, 1889, p. 127.

of a species which is probably of Lower Cambrian age. It occurs in a laminated imperfectly oolitic limestone, in oval, somewhat flattened masses, the largest of which is 18 mm. in its longest diameter. They show an obscure concentric structure, and are mostly in the state of granular calcite, but in places have the characteristic tubes of Girvanella, though less curved and twisted than those of the Chazy and Silurian specimens, and also of smaller diameter.

The formation holding the conglomerate is the Sillery (Upper Cambrian), but the fossiliferous limestone boulders which it contains are, so far as known, of Lower Cambrian age, to which therefore the specimens in question may with probability be referred. The difference in structure as well as in age entitles this form to a specific name. It may be named *Girvanella antiqua*, and may be defined as similar in size and general structure to *G. ocellata* of the Chazy, but with less convoluted and narrower tubes.

V. Receptaculites, Archæocyathus, &c.

In "The Dawn of Life" (1875), reference was made to the singular and complicated organism known as *Receptaculites*, which at that time was generally regarded as Foraminiferal, and is still placed by Zittel, in his great work on Palæontology, among forms doubtfully referable to that group. It has also been referred to sponges, though on very uncertain grounds. It has not, however, been traced, so far as I know, any farther back than the Upper Cambrian, and no structural links are known to connect it with Cryptozoon or with Archæozoon. It may, however, be regarded as a possible survivor of an ancient type, probably a protozoan, forming an unusually large and complicated skeleton, sometimes a foot in diameter, and which may not improbably have existed much earlier than the time of the formations in which it has hitherto been found. In any case it should be looked for in the Pre-cambrian beds.

The latest attempt known to me to unravel the relations of Receptaculites is that of Dr. Rauff in the Transactions of the German Geological Society. He repeats and confirms the observations of Billings as to its structure, differing only in rejecting the pores of the internal wall. He also rightly concludes that it must have been a calcareous organism, and consequently cannot be referred to any of the groups of silicious sponges; but seems to regard its systematic position as still quite uncertain. It may possibly remain so, till either modern analogues, or more ancient and simpler forms, shall be discovered. Receptaculites and its allies are at present known as low as the Lower Ordovician on the one hand, as high as the Carboniferous on the other.

Another primitive and apparently very generalised type is the genus *Archæocyathus* of Billings, one of the oldest and most curious Cambrian fossils. It deserves an additional notice here, in connection with facts and publications of recent dates.

As early as 1865 my attention was attracted to these forms by specimens presented to me by Mr. Carpenter, a missionary to Labrador, and about the same time Mr. Billings was kind enough to shew me specimens which had been obtained by Mr. Richardson of the Geological Survey, in what was then known as the "Lower Potsdam" of L'Anse à Loup in that region, and which he had described in 1861 and 1864, stating that he was in doubt whether they should be referred to corals or sponges. Slices of the specimens were made for the microscope, when it appeared that, though they had the general aspect of turbinate corals, like Petraia, etc., they were quite dissimilar in structure, more especially in their porous inner and outer walls and septa, yet they did not closely resemble the porous corals, which besides were regarded as of much more recent date. Nor could they with probability be referred to sponges, as they were composed of solid calcareous plates which, as was evident from their texture, could not have been spicular, and which, it appeared, must have been composed of ordinary calcite and not of aragonite. One seemed thus shut up to the idea of their being foraminiferal, and if so very large and complex forms of that group, consisting of perforated chambers arranged around a central funnel and occasionally subdivided by thinner curved lanellae. I mentioned them in this connection in the "Dawn of Life" in 1875, not as closely related to Eozoon, but as apparently showing the existence of very large foraminifera in the Lowest Cambrian.

The specimens thus noticed were those named *A. profundus* by Billings, and were from the Lower Cambrian. He had, however, referred to the same genus silicified specimens from the Calciferous or Upper Cambrian, which were subsequently found to be associated with spicules like those of lithistid sponges, and which may have been very different from the species of the Lower Cambrian, and are now indeed placed in a different genus. The subject became in this way involved in some confusion, and the genus of Billings was supposed by some to be referable to corals and by others to sponges. I, therefore, asked my friend Dr. Hinde to re-examine my specimens, and at the same time Mr. Billings placed in his hands examples of the later form, and he also obtained specimens from European localities which agreed substantially with the older of the Labrador specimens, and were from the same ancient horizon. Hinde retains the original and older type from Labrador in Archæocyathus,[1] and places the later form, *A. minganensis* of Billings, in a new genus Archæoscyphia. In this Walcott, in his memoir on the Lower Cambrian fauna, substantially agrees with Hinde. Hinde, however, rejects my foraminiferal suggestion, and

[1] Journal Geol. Society of London, Vol. 45, 1889, pp. 125, *et sequ.*

prefers to regard Archaeocyathus as a coral, though he admits that it is of a very peculiar and generalized type, unknown except in the lowest Cambrian; but there very widely diffused, since it occurs in different parts of North America, in Spain and in Sardinia. I think, however, we may still be allowed to entertain some doubt as to its reference to corals, more especially as its skeleton does not seem to have been composed of aragonite. I still continue to hope that, whether Protozoon or coral, it may be traced below the Lower Cambrian, and may form a link connecting the fauna of that age with that of still older deposits. In my description of it in "The Dawn of of Life," in 1875, I have written of it in the following terms:—"To understand Archaeocyathus let us imagine an inverted cone of carbonate of lime, from an inch or two to a foot in length, and with its point buried in the mud at the bottom of the sea, while its open cup extends upward into the clear water. The lower part buried in the bottom is composed of an irregular acervuline network of thick calcareous plates, enclosing chambers communicating with one another. Above this, where the cup expands, its walls are composed of thin outer and inner plates perforated with numerous holes in vertical rows, and connected with each other by vertical partitions, also perforated, establishing free communication between the radiating chambers, into which the thickness of the wall is divided." Such a structure might, no doubt, serve as a skeleton for a peculiar and generalized coral, but it might just as well accommodate a protoplasmic protozoon with chambers for its sarcode and pores for emission of its psendepods both outwardly and by means of the interior cup, which in that case would represent one of the oscula or funnels of Eozoon or of the modern Carpenteria.

VI. Pre-Cambrian in Wales.

In the past summer I was enabled to spend a few days, with the assistance of my friend, Mr. H. Tweeddale Atkin, of Egerton Park, Rock Ferry, in examining the supposed Pre-Cambrian rocks of Holyhead Island and Anglesey. Fossils are very rare in these beds. As Sir A. Geikie has shewn, the quartzite of Holyhead is in some places perforated with cylindrical worm-burrows: and in the micaceous shales there are long, cylindrical cords which may be algae of the genus *Palæochorda*, and also bifurcating fossils resembling *Chondrites*, but I saw no animal fossils. I have so far been able to discover no organic structure in the layers of limestone associated with apparently bedded serpentine in the southern part of Holyhead Island. In central Anglesey there are lenticular beds of limestone and dolomite associated with Pre-Cambrian rocks, which Dr. Calloway regards as probably equivalent to the Pebidian of Hicks. In these there are obscure traces of organic fragments; and in one bed near Bodwrog Church, I found a rounded, laminated body, which may be an imperfectly preserved specimen of Cryptozoon or some allied organism. The specimens collected have not, however, been yet thoroughly examined. These, and other pre-Cambrian deposits in Great Britain, correspond in their testimony with the Eozoic rocks of North America, as to the small number and rarity of fossil remains in the formations below the base of the Palæozoic, and the consequent probability that in these formations we are approaching to the beginning of life on our planet. Mr. Edward Greenly, F.G.S., of Achnasheaw, Bangor, is now engaged in a careful revision of the geological map of Anglesey, and will give special attention to Pre-Cambrian fossils. He has already discovered, in rocks supposed to be of that age, organisms recognized by Dr. Hinde as spicules of sponges.[1]

1 Journal Geological Society, Nov., 1896.

In conclusion, it is interesting to note how many large but obscure and problematical organic remains, all apparently of low types and generalised structures, and therefore difficult to classify, cluster about the base of the Cambrian, and appear to point to a primitive world beyond, of whose other inhabitants we know little else except indications of marine worms, of sponges, of a few Protozoa, and possibly of plants. Like the floating *débris* of the land noted by Columbus on his westward voyage, they raise our hope that we are one day to reach and annex to the empire of geological science a new region in which we may be able to see the beginnings of those great lines of life that have descended through the ages, and are alike mysterious in their origin, their development, the decay and disappearance of some of them, and the addition from time to time of new types to their number.

I may add for the benefit of searchers in this field two practical points: (1) Such organisms as most of those referred to in this paper are not attractive to the ordinary collector; because externally they shew little of their structure, which becomes manifest only after they have been cut and etched with dilute acid or prepared in transparent slices for study under the microscope. There can be little doubt that many of them are overlooked for this reason. (2) In Cambrian and Pre-Cambrian formations fossils are often abundant on certain surfaces or in certain thin layers, while intervening beds of great thickness are barren. Hence the importance when productive beds are found, of working them thoroughly when possible. In this the local collector who can revisit the same spot many times and spend days in working at it, has great advantages. Otherwise such productive spots can be adequately worked only by spending money in securing good collectors and giving them sufficient means for excavation.

A Few Notes on Canadian Plant-Lore.

By Carrie M. Derick, M.A., McGill University.

In that part of the Province of Quebec known as the Eastern Townships, are to be still found lingering superstitions and quaint ideas, which reveal the story of the past. Clarenceville, which lies between Missisquoi Bay and the Richelieu River, is peopled by the descendants of Dutch United Empire Loyalists. Owing, however, to intermarriage with other nationalities, many of the traits of the Dutch ancestors have been lost, and the current folk-lore can frequently be traced to English, Irish, and Scotch sources. Coming, as they did, more than one hundred years ago to hew out a new home in the heart of the primeval forest, they lived close enough to nature to lay up a rich store of weird fancies and strange legends for the delight of their children's children. But the struggle for existence was too keen and the people too closely occupied with the sternly practical side of life to weave new stories of the mysterious world around them, and even the old were forgotten. Moreover, the effects of the late war were so deeply impressed upon their hearts that the reminiscences of old age were of the intense realities of the immediate past rather than of the superstitions about field and wood. It is not surprising, therefore, that the plant-lore of the community is largely medicinal.

The doctrine of signatures, which supposed that plants by their external characters indicated the diseases for which nature intended them as remedies, has been superseded by a scientific knowledge of the true medicinal properties of plants. Nevertheless, many can recall some old woman whose famous cures were effected by means of herbs, and whose garret was redolent with the peculiar odors of dried pennyroyal, mint, and tansy.

Among the time-honoured medicinal plants, are many still considered most useful in home pharmacy. Celandine (*Chelidonium majus*) is much valued as the basis of an ointment used in various malignant diseases of the skin, and it is said to be a permanent cure for scrofula. The plant was held in high esteem in ancient times and was very popular as an eye remedy. Culpepper says the plant is called celandine from χελιδών, the swallow, because "if you put out the eyes of young swallows, when they are in the nest, the old ones will recover their eyes again with this herb."[1] But Gerarde assures us such "things are vain and false; for Cornelius Celses, lib. 6, witnesseth, That when the sight of the eies of divers birds is put forth by some outward means, it will after a time be restored of it selfe, and soonest of all the sight of the swallow; whereupon (as the same author saith) the tale grew, how thorow an herb the dams restore that thing which healeth of it selfe."[2]

In Clarenceville, a salve made from the leaves of the chamomile (*Anthemis nobilis*) is frequently used, though it is not, as in the past, considered "a remedie against all wearisomnesse."[3] In the Townships, it is said that few people can grow the plant, for "while some can handle it, as soon as others touch it, it dies." This view is directly opposed to the old English proverb,

> "Like a camomile bed,
> The more it is trodden,
> The more it will spread."[4]

Several species of Aralia are in great repute and probably do possess remedial properties. They are sought not only by the Canadian "simpler," but sarsaparilla is the chief ingredient of a popular patent medicine. Ginseng (*Aralia quinquefolia*), whose roots bear a supposed resemblance to the human body, was highly esteemed

1 Culpepper's "Complete Herbal and English Physician enlarged."
2, 3, "The Herball or General Historie of Plants," by John Gerarde.
4 Dyer's Folk-Lore of Plants.

by the Chinese and Japanese and by North American Indians. Père Lafitau discovered the plant in Canada in 1716[1], and the greatest excitement ensued on account of the high price the plant commanded in the market. M. Garneau says: "Le ginseng que les *Chinois tiraint à grand* frais du nord de l'Asie, fut porté des bords du St. Laurent à Canton. Il fut trouvé excellent et vendu très cher; de sorte que bientôt une livre, qui ne valait à Québec que *deux francs*, y monta jusqu'à *vingt-cinq francs.* Il en fut exporté, une année pour 500,000 francs. Le haut prix que cette racine avait atteint, excita une aveugle cupidité. On la cueillit au mois de mai au lieu du mois de septembre, et on la fit sècher au four au lieu de la faire sècher lentement et à l'ombre: elle ne valuit plus rien aux yeux de Chinois, qui cessèrent d'en acheter. Ainsi, un commerce qui promettait de devenir une source de richesse, tomba et s'éteignit complètement en peu d'années."[2] As a blood-purifier, ginseng has ever been a popular home medicine, and of late it has again become a readily marketable commodity. Another member of the family, spikenard (*Aralia racemosa*), is used for poultices and as a salve in skin diseases.

The Compositae furnish several famous remedies. Southernwood (*Artemisia abrotinum*), as in the time of Galen and Dioscorides, is thought good for inflammation of the eyes.[3] And the greatest of panaceas for all the ills of man and beast, according to the simpler, is wormwood (*Artemesia absinthium*).[4] From early times it has been held in deep veneration as a cure for inflammation, sprains, wounds, and all "ill-humours and weaknesses." Wormwood is a favorite disinfectant also. An old rhyme by Tusser asks:

1 Mémoire á La Duc d'Orleans, concernant la Precieuse Plante du Ginseng de Tartarie Découverte en Amérique par le Père Joseph-François Lafitau de la Compagnie de Jesus.

2 L'Histoire du Canada, par F.-X. Garneau.

3. 4. Gerarde's "Herball."

> "What savour is better, if physicke be true,
> For places infected, than wormwood and rue?"[1]

The root of elecampane (*Inula helenium*) "taken with hony or sugar made in an electuary . . . prevaileth mightily against the cough,"[2] and a candy made from it and molasses is most popular with the victims of whooping-cough, whether from the healing properties or soothing qualities of the sweet, it would be difficult to say.

The dyspeptic natures of the Clarenceville people demand varied treatment, and boneset tea (*Eupatórium perfoliatum*), "dandelion bitters" (*Taraxacum dens-leonis*), and tansy tea (*Tanecetum vulgare*) are mentioned in respectful tones by older people who measure the efficacy of a medicine by its unpleasantness. Dandelions are favourite "greens," and Culpepper, who is fond of preaching a sermon, says of the herb "the French and Dutch do eat it in the spring," showing, he adds, that "foreign physicians are not so selfish as ours, but more communicative of the virtues of plants to people."[3]

Rheumatism is a disease of which the so-called cures are as varied as the victims. The favourite remedy is to carry in the pocket a potato, which in some mysterious way absorbs the disease. A piece of flax bound round the afflicted member, or applications of smartweed (*Polygonum hydropiper*) are also commonly used.

Saffron (*Crocus sativus*) is a Clarenceville cure for measles, but it is not a local remedy. Gerarde says, "the eyes being anointed with the same dissolved in milke or fennel or rose water are preserved from being hurt by small-pox or measles."[4] The use of saffron in cases of jaundice is probably due to the bright yellow color of the flower, of which Dioscorides said "it maketh a man well-coloured."[5]

1 "The Folk-Lore of Plants" by T. F. Thistleton Dyer.
2, 4, 5. Gerarde's "Herball."
3 Culpepper's Complete Herbal.

Throat and lung troubles are very prevalent in the Eastern Townships, and many old remedies for coughs are still used. Elecampane has been already noticed, hemlock (*Tsuga Canadensis*) is steeped and taken for ordinary colds, and a decoction of horehound (*Marrubium vulgare*) is esteemed by consumptives. More popular than any other, however, is the Mullein (*Verbascum thapsus*), once called the witches' taper. It is interesting to note that in New England the mullein is made into a poultice for tooth-ache. Gold-thread (*Coptis trifolia*), or "goold-thread" as it is often called, is used for the cure of sore throats. "Smellage" or smallage (*Apium graveolens*) is considered an excellent purifier of the blood. The plantain (*Plantago major*) is used for the healing of wounds, and the application of a dock-leaf to the sting of a nettle is as well known as the old English adage—

> "Nettle out, dock in—
> Dock remove the nettle sting."[1]

Applications of the dried and pulverized root of "yellow-dock" (*Rumex britannica*) or of galium will at once, it is believed, stop the bleeding of a wound.

Although, in New England, plants with milky juice are supposed to cause warts, in Clarenceville, the juice of the milkweed (*Asclepias cornuti*) is considered an infallible cure for them.

Hops will allay pain and induce sleep. An ear-ache may be cured by an onion poultice. The ash, which in many places is considered a protection against serpents,[2] and with which a charm seems to have been always connected, is another cure for an ear-ache. A piece of root is cut, one end is charred in the fire, the sap oozing from the other end is caught and dropped into the ear, whereupon the pain ceases. Catnip, catnep, or catmint (*Nepeta cataria*), so-called because cats love its odour and

1 Dyer's Folk-Lore of Plants.

2 Fiske's Myths and Myth-Makers.

roll and tumble in it, has since the time of Gerarde been steeped and taken to relieve pains of all kinds.

In the past, it was not so much the inherent remedial properties of plants which brought them into repute as supposed magical virtues or some peculiar method of applying the remedy. This superstitious feeling still exists, and a striking instance was afforded, in Clarenceville, by an old man, who cured wounds and sores, especially of animals, by means of "the sticks." Up to the time of his death, four years ago, he was in great demand in cases which had defied the skill of a veterinary surgeon, and even those who were ashamed of their belief said he effected wonderful cures. His great age, pompous manner, absolute faith in himself, and his supposed wisdom, derived from some Indians over whom he had been captain, combined to make the application of the sticks an impressive ceremony. A charm or formula, which was kept a profound secret, was used. So far as is known, the cure was wrought as follows:—three slender twigs, about four inches long, were cut from a sweet-apple tree, and sharpened at both ends. Having been inserted in the wound for a few minutes, they were removed, wrapped in paper, and carefully tied up. As it was most important that they should be kept warm, the operator carried them in an inner pocket during the day and placed them under his pillow at night. These precautions having been taken, the most dangerous wound invariably healed rapidly. The use of the number three and of the sweet-apple tree, which has in many places and at all times had mystic virtues ascribed to it, perhaps indicate that this curious local custom had its origin in an ancient practice.

The live-for-ever (*Sedum telephium*), which in Westphalia is used as a charm against lightning, and which serves as a love charm[1] in some parts of England, was formerly used by the Germans and the English as a cure

[1] "The Folk-Lore of Plants" by Dyer.

for various diseases. It is, however, in ill-repute in Clarenceville. Few will allow even a sprig of it in their houses, believing that its tenacity of life is due to a power of feeding upon the very existence of human beings, and that it keeps fresh and green at their expense.

Although the old superstitions have lost their power, some have a lingering belief in the possibility of finding water by means of a witch-hazel twig, and in the protection from lightning, which is afforded by a beech-tree, and many more own to a decidedly uncomfortable feeling if an apple-tree blossom in the fall. This is due to a belief common in New England and embodied in an old Northamptonshire proverb—

> "A bloom upon the apple-tree, when the apples are ripe,
> Is a sure termination to somebody's life."

The idea of any unseasonable event or dream being a token of ill-luck is voiced in a saying "to dream of fruit out of season is to sorrow out of reason." This is a wrongly quoted and misapplied English rhyme,[1] which is an example of the many changes which plant-lore undergoes in its travels from one country to another. A curious instance of differences in word and thought is furnished by a Clarenceville and New England dictum. "An apple in the morning is golden, at noon it is silver, but at night it is lead." While a Devonshire rhyme says:

> "Eat an apple going to bed,
> Make the doctor beg his bread."[2]

Little can be added to the plant names, weather-lore, love-charms, and children's games, mentioned by the writer in a former paper.[3] The compass plants of different countries vary greatly, and a bit of local woodcraft is the belief that the topmost branch of a pine or hemlock always points to the north. The weather-wise say that "the turning up of leaves so as to show the lighter under side is a sure sign of rain." This appearance, which is

1. 2. "The Folk-Lore of Plants" by Dyer.
3 Canadian Record of Science, April, 1893.

an adaptation to reduced transpiration, is really due to the curling of a leaf in times of drought, so as to present the edge to the rays of the sun. Several curious expressions are common. A man, from fear or ague, may "shake like a popple-leaf," a calm person is "as cool as a cucumber," and a wealthy man is "worth a plum," while a valueless object or person "is not worth shucks." As in New England,[1] "shucks" for nut-shells, the "tossell and silk" of the corn and "corn-cob" are common terms.

In regard to plant names, there is a lack of interesting matter. Little discrimination is shown, and, to the majority, all small, pale, spring-flowers are "mayflowers." Popular English plant names are sometimes misapplied, for instance, the marsh-marigold (*Caltha palustris*) is called "the cowslip," periwinkle (*Vinca minor*) is known as "myrtle," and the jewel-weed (*Impatiens fulva*) is often styled "smart-weed." Another popular name for the jewel-weed, "touch-me-not," referring to the sudden bursting of the pods when touched, may account for a curious idea that the plant is poisonous to the touch and will cause blindness.

A favourite amusement, transplanted from England, is to pluck the rays of a daisy one by one, at the same time repeating the formula, "Rich man, poor man, beggar man, thief, doctor, lawyer, merchant, chief." The term used with the last ray indicates the status of the future spouse of the experimenter. As elsewhere, four-leaved clovers exercise their magic spell, dandelion curls and whistling grasses rejoice the hearts of successive generations of boys and girls, and practical jokes owing to the confusion of lady's thumb knotweed (*Polygonum persicaria*) and the smartweed (*P. hydropiper*) have a perennial freshness. Thus the fancies and games of childhood prolong the fading romance of the past, and furnish connecting links which prove the whole world kin.

[1] The Century Magazine, April, 1894.

On the Occurrence of Cancrinite in Canada.

By Alfred E. Barlow, M.A., Geological Survey of Canada.

The presence of this mineral in Canada was first detected by Dr. B. J. Harrington, of McGill University, in the elæolite syenites of Montreal and Belœil, in the Province of Quebec. Dr. Harrington thus writes of its occurrence at these localities:[1] "Some of the syenites are traversed by segregated veins, which contain the minerals of the enclosing rock as well as a number of additional species. One of these veins has afforded both acmite and cancrinite as to be readily available for analysis." *During the past summer (August, 1896) this mineral* was also noticed as an occasional constituent in one of the masses of elæolite syenite occurring in the north-west portion of the township of Dungannon, Hastings County, Ontario. The cancrinite occurs usually in small irregular masses, with rather ill-defined boundaries, and so intimately associated with nepheline as to be separable only with extreme difficulty. The nepheline is present in large cleavable masses and coarse crystals, with a distinct greasy lustre, thus constituting the variety to which the name elæolite has been applied. The cancrinite is *translucent, of a pale citron-yellow color, gradually fading* on exposure to the weather. It has a subvitreous and somewhat greasy lustre. The alteration from nepheline is undoubted, the cleavage planes, in contiguous masses or areas, being common to both, while the boundaries between the two are rarely, if ever, sharp or distinct. Sodalite, biotite, albite and molybdenite are some of the other minerals with which the cancrinite is associated. Specimens for analysis were handed to Dr. Harrington, but the material so supplied was unsuitable. Better and more abundant material has been secured, and a complete analysis of *the material will shortly be undertaken by Dr.* Harrington and published.

[1] Trans. Roy. Soc. Can., Vol. I., Sect. III., p. 81—1882-83.

HIPPOPOTAMUS REMAINS.

By W. E. DEEKS, B.A., M.D.

Considerable interest is attached to the discovery of the Inferior Maxilla of a Hippopotamus in the river bed opposite Montreal, early in November, 1896. It was obtained by one of the Harbour Commissioners' dredges in the clay about 5 feet below the bed of the river, the water being here 28 feet deep. When discovered, it was in a perfect state of preservation, except for the absence of the tusks. Unfortunately, the workmen, not realizing its scientific value, had broken it in pieces before it was reclaimed, and some fragments are still missing.

The bone tissue itself is in a good state of preservation, not having been mineralized to any extent. In regard to its anatomical characters, it is more nearly allied, if not identical, with the present living African species, Hippopotamus amphibius, than any other form, recent or fossil.

On comparing it with a specimen of the African species in the Redpath Museum, there are, however, several points of difference observable. These characters may, however, depend on sex or on age, as the museum specimen is much younger, the last pair of molar teeth being only partially developed.

The articulating end of the discovered specimen is much deeper, so that the rami are much more elevated at the posterior ends from the table upon which it rests. The hook-like flange so characteristic of H. amphibius is not nearly so well developed. The symphisis is not perfectly united between the rami, whereas in the younger specimen it not only is, but a ridge is also developed in this situation, and this is produced backwards into a tubercular process. The positions of the various foramina also vary somewhat and there are a number of other minor points of difference.

If this be the African species, it has probably been brought here by some African merchantman and wittingly or accidentally dropped overboard. There is no record of an animal dying in this vicinity. The absence of the tusks, the only part of any value, as well as the absence of the other bones, points to its being an importation. If, on the other hand, it should prove to be a new variety of species, it would certainly be of great interest, as no Hippopotamus remains have ever been discovered on this continent heretofore, and further dredging operations in this vicinity will be awaited with interest in view of the possibility of more extended discoveries.

THE ANORTHOSITES OF THE RAINY LAKE REGION.[1]

By PROF. A. P. COLEMAN, School of Practical Science, Toronto.

A number of eruptive masses rising through the Keewatin (Huronian) schists and schist conglomerates of the Rainy Lake region in western Ontario were mapped and described by Professor A. C. Lawson in 1887, the most interesting group of eruptives occurring along the southern shore of Seine Bay and between Bad Vermilion and Shoal Lakes, just to the east.[2] Here very basic and very acid rocks are found associated. The acid members of the group, quartzose granites containing much plagioclase, have been studied somewhat carefully from the fact that they contain important gold-bearing veins, but the barren *anorthosites have been neglected*. The *soda granites*, which often weather into the greenish sericite variety, protogine, and have been sheared and metamorphosed into sericitic schists near the quartz veins, have been described

[1] Reprinted from the Journal of Geology, November-December, 1896.
[2] Geol. Sur. Can., Part F, 1887, pp. 56 and 99.

by Winchell and Grant[1] and the present writer,[2] and need no detailed mention here. The basic rocks of the group, briefly described as saussuritic gabbro by Lawson, but afterward identified by him as anorthosite,[3] deserve some further mention.

The largest area of anorthosite encloses the southern arms of Bad Vermilion Lake, and surrounds or is bordered by three areas of eruptive granite. Two or three miles to the west, on Seine Bay, a series of points and islands of anorthosite extend, with some interruptions, westward along the southern shore of the bay for about ten miles. The rock is generally white, almost like crystalline limestone, with only a very small proportion of darker minerals occupying spaces between more or less perfect phenocrysts of plagioclase, which range in size from a quarter of an inch to a foot in longest diameter. Towards the western end of Bad Vermilion, however, there are points where the green constituent becomes more important, and the rock may be called a porphyritic gabbro.

Frequently portions of chloritic or sericitic schist have been enclosed by the anorthosite, showing its post-Keewatin age; and occasionally a green massive rock, apparently weathered diabase, is seen, probably portions of massive Keewatin rocks swept off by the molten anorthosite.

The rock, though clearly an anorthosite, presents some points of difference from the typical rocks of the name, so well described by Dr. Adams from the province of Quebec, the feldspars being always white, never purplish in color, and comparatively rarely showing the sheared and granulated character so often found in eastern Canada.[4] The marked tendency toward idiomorphism in the feldspars is apparently unusual in other regions. The loss of the

1 Winchell and Grant, Geol. Nat. Hist. Sur. Minn., 23d Ann. Rep., pp. 58–60.

2 Ontario Bureau of Mines, 1894, p. 89.

3 Geol. Nat. Hist. Sur. Minn., Bull. No. 8, 1893, 2nd part, p. 7.

4 Ueber das Norian, Separat Abdruck, Neues Jahrbuch für Min., Beilageband VIII.; and Can. Rec. Science, Vol. VI., No. 4, p. 190.

purplish color is no doubt the result of weathering, which has generally progressed rather far, though cleavage surfaces showing twin striations can be found generally. The freshest example studied comes from a hill at the mouth of Seine River.

In the numerous thin sections examined more than nine-tenths of the rock is seen to consist of plagioclase, usually sprinkled with zoisite particles or more or less completely changed to a saussuritic mass. The darker portions lying here and there in angles between the feldspars consist mainly of a fibrous or scaly mineral with parallel or nearly parallel extinction and low double refraction, probably serpentine, but perhaps a member of the chlorite group. Augite was found as a remnant only once, and then was not of the diallage type. No other primary minerals were observed, not even magnetite; and very few secondary ones require to be added to those mentioned, only epidote, probably some albite, and a very little calcite. The feldspars, where fresh enough to study, show broad twinning according to the albite and frequently also the pericline law, the former ranging in angle of extinction from the twin plane between 17° and 37°. The average extinction angle in thin sections from Bad Vermilion Lake is about 24°, and from the mouth of Seine River 32°. The former feldspar is therefore bytownite and the latter anorthite, both more basic than that of the typical anorthosite, which Dr. Adams finds to be labradorite.

In the freshest section studied (783, mouth of Seine River) the large interlocking feldspar individuals often show a thin band of fresh, clear feldspar where one joins the other; and this clear feldspar strip is seen, when examined with a high power, to form a secondary enlargement of the adjoining crystals, the twin striations running out into it. The extinction angles of these secondary feldspar rims vary from 8° to 14°, corresponding to labradorite, so that the later feldspar is more acid than the older. In one case a bytownite crystal has been broken, the parts slightly shifted, and then cemented with labradorite, most of the twin lamellæ running across the strip of cement.

An analysis of a specimen from the mouth of Seine River was made by Mr. William Lawson in the laboratory of the School of Practical Science, Toronto, the results being given in column No. I. In No. II an analysis of anorthosite from Rawdon, Que., made by Sterry Hunt and quoted by Dr. Adams, is given for comparison.[1] No. III gives the results of an analysis of granite adjoining the Bad Vermilion anorthosite area, and is the work of Mr. Lawson.

[1] Ueber das Norian, p, 494.

	I.	II.	III.
SiO_2	46.24	54.45	76.20
Al_2O_3	29.85	28.05	14.41
Fe_2O_3	1.30	0.45	....
FeO	2.12	....	1.49
MnO	trace	....	....
CaO	16.24	9.68	2.19
MgO	2.41	...	0.65
Na_2O	1.98	6.25	3.32
K_2O	0.18	1.06	2.44
Co_2	1.03	(H_2O) 0.55	....
	101.35	100.49	100.70
Sp. Gr.	2.85	2.69	2.65

The low percentage of silica and soda, and the high percentage of lime, as compared with the anorthosite from Quebec, are notable, and correspond to the results of microscopic examination, the specimen from Seine River consisting chiefly of anorthite, and that from Rawdon of labradorite. The specific gravity, 2.85, is very high, perhaps because of the presence of considerable zoisite. The specific gravity of a specimen from Bad Vermilion Lake was determined to be 2.76, corresponding to its slightly more acid character, since it consists of bytownite.

The results of the analysis show that the anorthosite from the mouth of the Seine is one of the most basic of the massive rocks, having about 8 per cent. less silica than the typical rocks of eastern Canada, but it is probably wiser to include it among the anorthosites, since the somewhat more acid rock from Bad Vermilion Lake links it to the eastern ones.

It would, perhaps, be most logical to name the whole series of rocks consisting essentially of plagioclase anorthosites or plagioclasites,[1] adopting a binomial nomenclature like that tacitly admitted in the classification of other rocks, such as the granites. We should then speak of anorthite, bytownite, and labradorite anorthosites or plagioclasites; and the list might require to be extended to include andesine and oligoclase rocks, perhaps also albite rocks. The albitites described by Turner from California, under the head of syenites, are dike rocks apparently, and should, perhaps, not be classed with the plutonic rocks referred to here.[2] The name anorthosite has priority, but has a very tautological sound in the term describing the rock just discussed, anorthite anorthosite.

Lawson looks on the anorthosite and granite areas of Bad Vermilion Lake as representing the truncated base of a Keewatin volcano which served as one of the vents for the pyroclastic materials so widely found in the Keewatin rocks of the region, the basic rock coming first and the acid afterwards.[3] In this he is probably not correct, for there is good evidence to show that the anorthosite, which probably solidified under a considerable thickness of superincumbent rock, was so far exposed by denudation that fragments of it could be rolled into boulders and become part of a conglomerate before the eruption of the granite. The latter rock has sent apophyses into the anorthosite,

1 See Viola as quoted by Rosenbusch in Massige Gesteine, Erste Halfte, p. 298.
2 American Geologist, June, 1896, p. 379, etc.
3 Geol. Sur. Can., loc. cit.

and has pushed its way through a schist conglomerate containing pebbles and boulders of quartz-porphyry, sandstone, green schist, and occasionally also anorthosite quite like some facies of the adjoining mass. Apparently a long interval separated the anorthosite eruption from that of the granite. The sharp segregation of a magma into a basic anorthosite and a very acid granite would in any case be rather surprising.

On the Structure of Europe.

A Lecture by Professor Edward Suess.

(Translated from the German by Nevil Norton Evans, M.A.Sc.)

I wish to address you to-day upon the structure of Europe, partly because I can assume as familiar to each one of you not only the main outlines but also the details of the relief, and further because in this portion of the world which we inhabit we are dealing with the most complicated part of the earth's surface. Before, however, proceeding to my subject proper, permit me to make a few remarks upon the structure of mountains in general.

On this chart we have the series of formations[1] into which it is customary to divide the rocks which form the crust of the earth. We ascend from the oldest, the Archæan, through the long series of stratified formations to the youngest deposits of the Tertiary formation and of the present time.

The names as here tabulated present to us a chronological scale, a scheme, according to which we are able to state, from existing remains, which are the older and which the younger sediments; the absolute age of any is unknown to us. We do not know the number of millions of years which measure these periods of time.

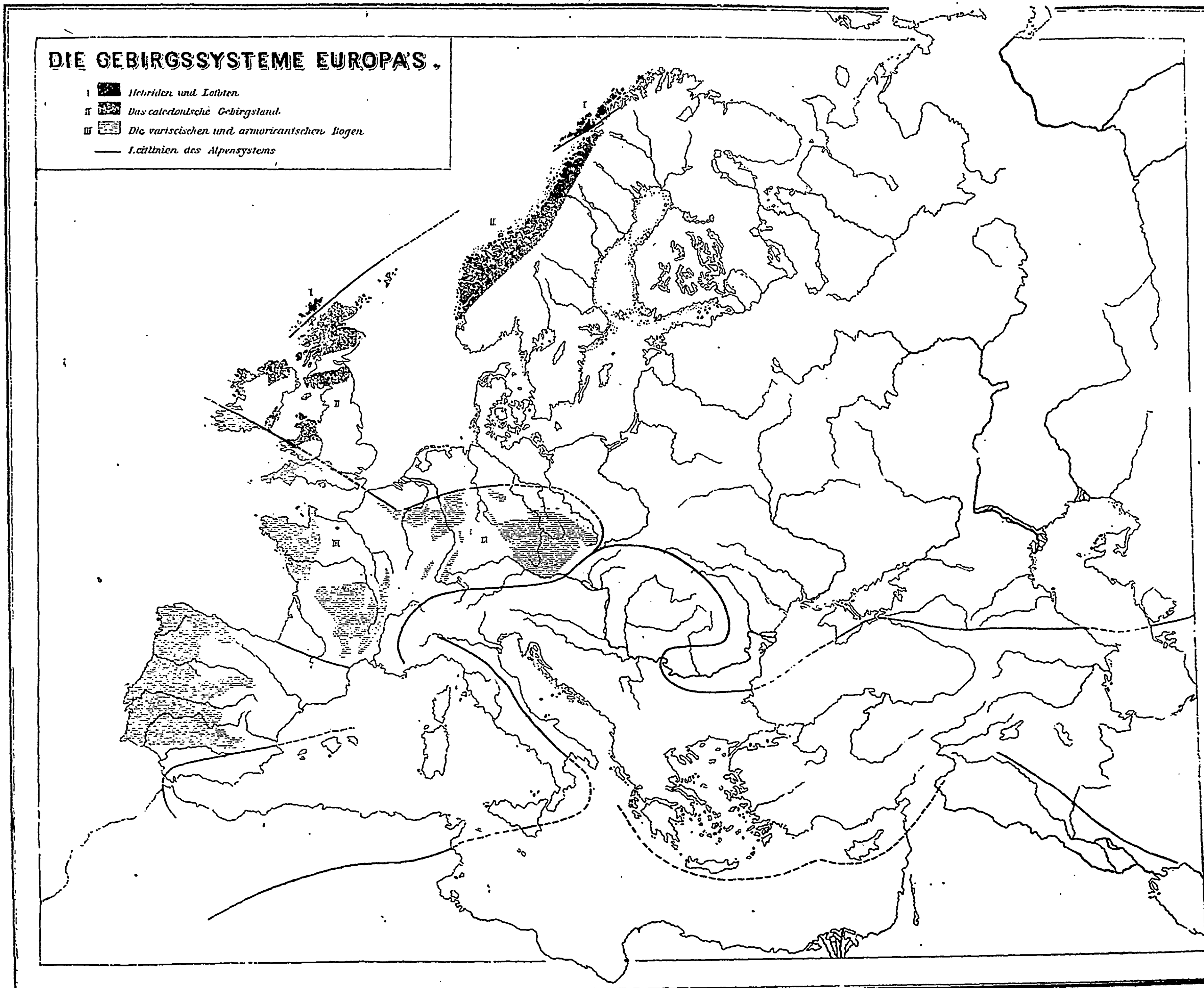
[1] 1. Archæan. 2. Cambrian. 3. Silurian. 4. Devonian. 5. Carboniferous. 6. Permian. 7. Triassic. 8. Jurassic. 9. Cretaceous. 10. Tertiary.

These deposits are accompanied by a number of volcanic rocks, with which, on account of the shortness of our time, we cannot further concern ourselves here.

Out of such various kinds of rocks are formed mountains, hills and plains.

It was formerly believed that mountains were formed by elevation—that some sort of power forced them up from below and then left them standing in the form of folds, blocks, plateaux, etc. To-day it is known that such is not the case. The majority of geologists are of opinion that mountains cannot originate in this way, that nature does not exert such a power, but that the causes of the relief are to be found primarily in the shrinkage which the earth has as a whole undergone during the long time of its cooling. An actual shortening of the radius takes place, small indeed as compared with the diameter of the earth, but which is the cause of two kinds of phenomena: in some places portions of the crust fall in producing, for instance, the abysses of the oceans; in other places it may be observed that owing to the contraction of the interior, portions of the crust have become too large, and have therefore crumpled up, as we find in the Alps. Frequently these folds are pressed against more rigid portions of crust, which do not fold with them.

Mountain folds are sometimes turned completely over. In many cases they form a series more or less regular synclinals alternating with anticlinals. Denudation, that is, the destructive action of running water, of frost, of ice, etc., has cut into this folded mass, producing the relief as it exists to-day, and in which may still be distinguished the anticlinals and the synclinals. Thus, we see upon the surface of the earth table-lands and plateaux such as Central Russia and the Sahara, and highly folded masses such as the Alps and the Pyrenees. The folded areas are generally very long, and follow definite curved lines called axes.


DIE GEBIRGSSYSTEME EUROPA'S.
I Hebriden und Lofoten
II Das caledonische Gebirgsland
III Die variscischen und armoricanischen Bogen
Leitlinien des Alpensystems
I
II
III

It sometimes happens that in certain districts table-lands break down, the subsidence occurring unevenly, generally in streaks, wider or narrower, one streak subsiding more and another less. That portion which sinks least, and which may frequently be observed standing out in relief, is called a *Horst*. This horst has not been produced by upheaval, but owes its prominence to the subsidence of the surrounding parts; here, too, erosion may act and remove the horst wholly or in part. Its original structure can, however, easily be discovered by an ideal restoration of the separate strata. Such a horst is called a table-horst. It may also happen sometimes that mountain ranges break down, and then most complicated relations are produced, and it is one of the most difficult problems of tectonic geology to discover in a horst which has been produced in this way the original folded mountain range.

Look, for instance, at the stock of Morvan in Central France, or the peninsula of Cotentin, on a geological map of Europe. We see immediately that these are horsts, and, moreover, fragments of folded mountain ranges bounded by immense lines of fault. Closer examination shows, however, that the strike of the folds has nothing to do with the direction of the lines of fault. This is most clearly seen where a folded horst is broken off by the sea, as, for example, in Southern Ireland, Cornwall and Brittany.

The comparison of these two concepts: table-land and folded mountain range, table-horst and folded horst, with this chronological table, is a complicated work which has produced the general view regarding the structure of this portion of the world. I will endeavor, as far as the hour will allow, to give you a sketch of it.

We see on the map various colors.[1] The volcanic areas

[1] The lecture was illustrated with a colored map. The blue and red tones mentioned in the lecture are replaced in the figure by darker and lighter shading.

are not indicated, but these play no very important part in the general relief. Iceland is such a mass of volcanic origin, young rock ejected from the interior of the earth; I shall not deal with it any further. We proceed immediately to the first zone of old rocks. This forms the Hebrides and the Lofoten Islands, two areas forming the extreme north-west of the continent and made of the oldest rocks, the Archæan. Here the first boundary-line may be drawn. This line goes through the extreme north-western foothills of Scotland and Loch Eriboll, west of the Orkney and Shetland Islands, and then from the great Westfjord in Norway through the peninsula and islands of the north to Mangeroe; it is indicated in Scotland by a great overthrust, the limit of the first element which takes part in the construction of Europe. It is the gneiss of the Hebrides and Lofotens.

Next we come to a second, much larger area, which includes a series of mountain fragments, colored blue on the map. This is a region of ancient folding, much of which has subsided, leaving folded horsts represented by the blue spots.

The north of Ireland shows two small horsts, which find their continuation in the north of Scotland. The Scotch Highlands form the transition to Western Norway, where rocks of similar kind stretch far to the north. These are fragments of a great ancient mountain system.

The folds in these horsts all have a north-easterly strike, and the whole area is known as the Caledonian Mountain System. To this system belongs a spur further south, which reaches to the English boundary, and also includes the greater part of the principality of Wales and a portion of southern Ireland.

The two northern horsts are separated by a portion of central Scotland having subsided, and having thus formed a huge ditch.

If the folds in these horsts are more closely studied, we make the remarkable discovery that the Caledonian Mountain System was completely established by Devonian time, because the deposits of the Devonian formations lie horizontally on the Caledonian horsts. The folding which formed this system may therefore be placed at the junction of the Silurian and Devonian. Subsequently, at different times, portions of these folds subsided, forming the low-lying parts of Ireland and England and the North Sea. Denudation has removed from the upper portions of the horsts most of later formations deposited horizontally upon them whereas they still remain for the most part in the depressions.

To these deposits still existing belong first and foremost the Scotch coal measures. And it may here be parenthetically stated that the development of the industries and the large towns of Scotland is connected with the abovementioned depressed belt: here lie Edinburgh and Glasgow.

The Caledonian folds terminate towards the south at a line which is indicated by the following points: The boundary line begins south of the mouth of the river Shannon in western Ireland, enters the southern part of Wales, embraces the southern peaks of that country, reaches England at the Bristol Channel, and may again be recognized between Boulogne and Calais and in the Belgian coal measures. From this point it cannot be actually traced until it is again met with not far from Ostrau in Mähren.

This line separates the Caledonian horsts from a second group of horsts which are depicted red on our map. These latter are very numerous, and embrace that area which has been designated as the Massengebirge of central Europe. To it belong Portugal and a large part of Spain, the plateaux of the so-called Meseta; then, in France, Brittany and a part of Normandy; Cornwall; in Germany, the mountains of the middle Rhine, Taunus, Vogesen, Black Forest; then the Harz, and finally the ranges of Bohemia.

This whole area, like the last, consists of fragments of old, broken-down, folded mountain ranges; the folds may easily be followed in Vogesen and the Black Forest, and a parallel curve occurs in the Taunus.

In this broad area two directions of folding may be distinguished: in the west the dominating folding is towards the north-east, and in the east a similar one towards the north-west. These two directions of folding meet one another in the middle of the central plateau of France.

Where the rocks of the Caledonian Mountain system abut against the Hebrides, there are enormous overthrusts, the strata are turned upside down, older formations being pushed over younger. Phenomena quite similar are found on the northern edge of the second-mentioned series of horsts.

These inversions are distinctly seen in the Belgian coal measures; indeed, in many places, they alone determine the boundary between this formation and the Caledonian.

The great western curve is called the Armorican, because its principal development occurs in Brittany. The highest parts of these ancient mountains were here. The eastern curve is called the Variscian, after the people of Variscа, who once lived in the Vogtland, where mountain cores formed of old rocks are found. The most important phenomenon of the whole system, Armorican as well as Variscian, is that the whole palæozoic series up to the middle carboniferous is included in the folds. Hence this second system of folds and subsidences is somewhat younger than the preceding system of pre-Devonian folds. It includes the Silurian, the Devonian, and a great part of the Carboniferous; the Belgian coal measures mentioned above have taken part in the movement.

The Upper Carboniferous and the Permian or Rothliegende lie horizontally on the Armorican and Variscian folds.

The whole series of horsts is sharply bounded on the south by a line which distinctly appears in the relief, and which forms the northern edge of the third and youngest mountain system of Europe, that of the Alps, the Carpathians and a series of other ranges. This system of folds has been forced up from the south against the ruins of the Armorican and Variscian system. The boundary is as follows: in southern France the western edge of the Alps, further east the northern edge of the Alps and the Jura Mountains, the northern edge of our sandstone zone, and then at Vienna the line bends back on itself.

These most recent foldings we must consider more in detail.

This is called the Alpine system of folds, because the Alps form its most conspicuous representatives. We see, in the first place, that the Alps are much younger than all the mountains already mentioned, as they embrace the whole series of older stratified rocks and a large part of the Tertiary formation. If the foldings of the Alps are examined, it is seen that they have a much greater continuity than the older foldings, because the breaking down has not been so extensive; the reliefs are here much more easily seen because destroying influences have not gone so far. A further phenomenon, which, for our conception of the formation of mountains, is of great importance, may here also be observed—the development of these Alpine folds has been hemmed in by the older horsts which have resisted this action. The Alps on the eastern edge of the French central plateau abut against a small horst at Besançon, on the southern boundary of the Black Forest against the edge of the Bohemian horsts, which in a high degree have prevented the northward trend of the folds.

A similar phenomenon is to be seen in the folded mountains of southern Spain. The old horst is here broken off, and the break appears on maps as the range of the Sierra Morena, which is in reality the edge of a plateau, the margin of the Spanish horst. Against it are piled folded mountains. The chain of the Sierra Nevada abuts against the Spanish horst, just as our eastern Alps, for instance, against the Bohemian mass.

Further, a series of lines may be traced which are curved in a most complicated manner, and show us the development of the axes of folding. One of these curves comes from far away in Asia, from Tianschan; it reaches and crosses the Caspian Sea, forms the northern edge of the Caucasian folded mountains, crosses the Crimea, and then follows the northern margin of the Balkan Mountains. In the neighborhood of the Iron Gates it bends round upon itself, follows the Siebenburgischen chain, the edge of the Carpathians, and passes not far from Vienna.

Another broader arc goes from the edge of the Alps to the Gulf of Tarentum, and across Sicily to the Atlas Mountains, finally bending round again toward Spain.

Finally, an arc is described by the foldings in Greece, and the large islands of the eastern Mediterranean. It is the district of the Dinarian chain.

This completes the count of the youngest foldings.

When a general survey of Europe is made, the following is observed: The oldest mountains in the north are the Hebrides and the Lofotens. Against this first mountain system folds are thrust over, as in north-west Scotland and in the north the great folds of Norway. These are mountains of the Silurian age. Here the Devonian lies undisturbed. Later two new ranges of mountains have been pressed against the Silurian mountains: the Armorican and the Variscian, like their predecessor, overthrust on their edges. They belong to the Carboniferous time, and show subsidences. Finally, there has been formed a new complicated system of foldings, pressed in their turn against those lying further north.

It seems almost to be a law of nature that every new series of foldings should be piled up from the south against the older mountains, a phenomenon the recognition of which belongs to most recent times. We can also observe how these most recent foldings are to-day being broken down, how on their inner edges here and there masses of volcanic rock occur.

It was formerly believed that the upheaval of mountains was brought about by volcanic masses being forced up from the depths, pushing before them the superincumbent rocks. To-day we see, on the contrary, that molten masses have passively appeared, where disturbances of the earth's surface have presented to them this possibility, just as blood wells out of a wound. From these subsidences we see that the whole inner concave side of the youngest system is engaged in caving in. The west coast of Italy exhibits a whole series of saucer-shaped depressions, bounded each by two pillars which remain standing.

The ground on which we stand here in Vienna is an example of such a cave-in, and here this phenomenon was first accurately studied.

The outer margin of the Alps runs to Kahlenberg, continues to Bisamberg and forms little solitary hills in Nikolsburg, which forms the connection with the first spurs of the Carpathians.

Behind this a breach has been formed. On the further side of this gap the inner zones of the Alps stretch from the Rosalien mountains and Letha mountains to the Hundsheim mountains and the Carpathians. Along the faults hot springs arise: Baden, Vöslau; and on this sunken portion lies Vienna. Thus was formed a portal for the exit of the Danube; in this way the northern slopes of the Alps were given the possibility of draining to the southward. This way was traced out by nature, and this is the reason why just this place has attained such a historical significance in Carnuntum and Vienna.

Such depressions are found in many places. It seems, indeed, as though the younger mountains were approaching the same condition that the older ones have reached.

Permit me now briefly to summarize all that we have so far said:

The earth is decreasing in volume. Hence proceed in one place subsidences, in another place foldings; if subsidences occur, stratified table-horsts are produced with depressed areas.

If the subsidences occur in mountainous districts of folded rocks, folded horsts are formed. In each such horst may be seen a portion of the old folded structure, often indeed only in an indistinct, ruinous condition. The geologist, however, can from the fragments thus obtained restore the original structure, just as a student of art frequently finds a portion of moulding sufficient to enable him to restore to his mind's eye the whole monument.

If we put together all these results, and attempt to follow them out on the map of Europe, we arrive at the conclusion that Europe may be divided into a series of zones, which are separated from one another by lines of overthrust, and that from north to south we ever meet younger and younger phases of mountain formation.

In the far north we have the Hebrides and Lofotens, composed entirely of Archæan rocks; south of these the Caledonian mountain district. The Caledonian mountain district is divided up into horsts.

Then comes the second period, that of the Armorican and Variscian mountains. These mountains also are shattered. Folds are present, and the overthrust regions may be traced for great distance. This mountain system reaches into the Carboniferous formation. All this has been broken up, and then new and more complicated systems of folds have been formed, including the Alps, the Jura, the Apennines, the Atlas, Southern Spain, the Pyrenees, etc. This region of flexing belongs to the Tertiary formation. Subsidence has begun and continues. The greater part of the phenomenon known as earthquakes is nothing more than the continuation of the working of these inner forces which have produced the relief, or, more correctly stated, have produced the foundations of the relief; for the surface forms of to-day have in their details been worked out essentially by the forces active at the surface of the earth: wind and weather, water and ice.

In the whole treatment I have not spoken of the eastern part of Europe. There is seen a phenomenon quite foreign to western Europe. To the north, near St. Petersburg, in north Russia, in southern Sweden, everything lies horizontally. In the course of geologic periods no important change has here taken place; even the Cambrian strata lie horizontal. The surroundings of the Baltic have been entirely uninfluenced by the movements above mentioned, and have remained undisturbed. The Archæan rocks which lie under these are folded; this, however, can be seen in only a few places: for instance, on the little peninsula in the north-western part of Lake Ladoga. These show a folding of the rocks which is older than the Cambrian time, and older than all the other phenomena with which we have been here dealing.

Very remarkable is the following fact: In eastern Galicia, on the upper Dniester, the river cuts very deep into the land, and there is seen a horizontally bedded series of rocks, which is no other than the continuation of the rocks of Livland, Esthland, St. Petersburg, which lie hidden under the whole plain, and which here again become visible, and are completely undisturbed as compared with the overturned Carpathians. In what way these two so different districts can approach one another so closely is still a riddle to us; but it is, nevertheless, a fact that in this part of the earth old table-lands and most recent foldings meet one another.

We have similar points in our Fatherland (Germany). If one travels from Vienna on the Northern Railway towards Ostrau and Krakau, he seldom thinks that in the neighborhood of Weisskirchen and Prerau the bent-over folds of the Variscian rocks abut against the Carpathians, one of the few points of contact of two systems of mountains which are distinctly observable.

So we arrive at a picture which is only partially completed. If the relief be more closely studied, many details will become visible. One can see how the notched coast of south-west Ireland is nothing else than the stretching out of the folds into the sea. It may repeatedly be seen, as for example at Brest, how separate lines of folding form so many separate lines of foothills, and much else that I must here pass over.

This, ladies and gentlemen, is the ground-work of the geological structure of Europe, as it appears to-day from a series of studies. I say, to-day; I must add, that it is that which we *now* know; in ten years we shall know more. Knowledge progresses continuously. Of that which I have told you to-day there was no knowledge thirty years ago. So science advances.

Thirty years ago I was in the habit, when I signed papers, of affixing a flourish to my name. At that time I also considered it necessary to close my lectures with a few remarks of a general nature. To-dav I no longer add a flourish to my name, and I have slowly come to the conviction that at the close of a lecture one may leave the hearers to reflect as to how far we have come, and what wonderful and unexpected knowledge science has given us—in this case, above all, that Europe has been three times built up, each time broken down and rebuilt.

Geological Report and Map of the District about Montreal.

By John A. Dresser, B.A.

As was mentioned in the last number of The Record of Science, the Annual Report of the Geological Survey of Canada (New Series, Vol. VII.), which has recently been issued, contains a report and map of that portion of the Province of Quebec comprised in the Montreal sheet of the series of maps now being issued by the Geological Survey of Canada. As this embraces the district immediately about Montreal, it is of especial interest to members of the Natural History Society.

The report is written by Dr. R. W. Ells, the chapter on the Laurentian north of the St. Lawrence River by Dr. F. D. Adams, while the appendix, containing a list of fossils, is the work of Dr. H. M. Ami. The map is from the surveys of Dr. Ells and Dr. Adams, together with the earlier work of Sir W. E. Logan. It was originally drawn by the late Robert Barlow in 1868, and has been corrected to 1895; it is engraved by the Sabiston Lithographic Co. The coloring of the map is generally distinct, thus clearly indicating the different geological systems, while their subdivisions are easily recognized by the system of well-arranged distinctive markings, as well as by letters and numbers.

The topographical features are also minutely shown, which lends much additional interest and value to the map, the whole execution of which must be regarded as excellent.

It is, however, not very detailed. The different series are not subdivided so as to show the subordinate formations which they comprise, and in some cases a whole geological system, as the Cambrian, is undivided. Also the delimitation of the various systems is often somewhat approximate.

These facts are not mentioned in adverse criticism of the work already done, but to indicate the vast amount yet to be performed before the map can be completed, even with as much detail as its present scale, four miles to one inch, admits. The map of 1896 marks an important step in the geological investigation of this section of the province. It should be in the hands of every local naturalist, to whom it affords an almost indispensable basis for more *minute investigation than its scope allows.*

The area represented on this map extends from the vicinity of Ste. Agathe to Warwick, in the County of Drummond, on the north, and to the international boundary line, from Huntingdon to Stanstead, at the south. It comprises more than 7,000 square miles.

Towards the north-western and south-eastern corners of this district the country is mountainous, while the central portion, which is much greater in extent, is occupied by the basin of the St. Lawrence River. This is a uniformly level area, extending in a south-west and north-east direction beyond the limits of the sheet. The mountainous portions on the opposite sides of this basin are of older formation than the interior, and hence the strata, whose geological position is the lowest, form most of the higher landscape features of the district. Occurrences of the following geological systems are described in descending order :

DEVONIAN.—Consisting of slates and shales at Sargent's Bay, and limestones at Owl's Head, Lake Memphremagog.

SILURIAN.—Comprising the dolomitic conglomerate of St. Helen's Island ; reddish sandstones and shales in Wendover and Pierreville on the lower part of the St. Lawrence River, and the limestones and dolomitic slates, which nearly surround Lake Memphremagog.

CAMBRO-SILURIAN.—This consists of

1. The Lorraine or Hudson River formation, which

comprises the gray sandy shales of a considerable area south of the St. Lawrence.

2. Utica, black or brown shales. These occur along the south shore of the St. Lawrence River, near Montreal. and extend to the upper part of the River Richelieu.

3. Trenton, which consists chiefly of limestones and black slates. They occur at Montreal, Philipsburg, Farnham and other points on both sides of the St. Lawrence.

4. Chazy limestones, conglomerates and slates south and west of Montreal; also at Mystic and Cowansville.

5. Calciferous, which is closely associated with the Chazy, and resembles it in character. They contain somewhat different fossil remains.

6. Potsdam sandstone of Ile Perrot and Beauharnois.

CAMBRIAN.—This system is largely developed in the eastern part of the area, especially in connection with the older series of the Eastern Townships.

The HURONIAN, which forms the Sutton and Stoke mountain ranges of the same section.

The LAURENTIAN, which occupies the mountainous district which occupies the north-western part of the sheet.

It will be noticed that both Calciferous and Potsdam have been classed with the Cambro-Silurian system. The latter is usually regarded as a part of the Cambrian. Concerning this change in classification, Dr. Ells says (p. 50): "It may, however, be said that, in view of all the evidence, both palæontological and stratigraphical, it has been considered most in accordance with the facts to regard the Potsdam sandstone formation, as developed in the St. Lawrence and Lower Ottawa areas, as the continuation downward of the Calciferous, and to consider these two members as constituting the basal portion of the Cambro-Silurian system. No defined break between the Calciferous limestone and the Potsdam sandstone has yet been observed in Canada."

The map shows the railways and roads as well as the topographical features. This renders it exceedingly interesting, as a glance at any familiar locality or line of travel shows at once the geological formations to be seen.

Thus, in crossing the St. Lawrence Valley from St. Jerome to Montreal by the Canadian Pacific Railway, and thence to West Brome by the Central Vermont R.R., the chief geological formations of the Cambro-Silurian system are found.

After leaving the Laurentian, about a mile south of the village of St. Jerome, the Potsdam sandstone is crossed for about an equal distance, when the Calciferous is reached. This extends to the Ste. Rose River. The Chazy formation reaches from this river to Outremont, where it it is succeeded by the Trenton, which continues to the St. Lawrence.

The former of these includes the limestones seen at Sault au Recollect, the latter those of Mile End and the City of Montreal. From the western abutment of Victoria bridge the Utica shales pass under the St. Lawrence River, and extend a few miles east of St. Lambert. Here the Hudson River, or Lorraine, formation is met. This is the highest horizon in the geological column that is represented on this map, with the exception of the limestones of St. Helen's Island and Lake Memphremagog of Lower Helderberg (Silurian) age and the small areas of Devonian, both of which have been previously mentioned.

The Hudson River shales and sandstones extend to the vicinity of Farnham, whence the remainder of the section to Sweetsburg is occupied by the Trenton and Chazy formations respectively, their approximate point of division being East Farnham.

From Sweetsburg to West Brome only the Cambrian is found, but from the latter point the Huronian extends to the vicinity of the mountains on the west of Lake Memphremagog.

These formations, or their equivalents, may be seen in passing across the St. Lawrence Valley by any of the other usual lines of travel.

On 'the line of the Canadian Pacific Railway between Montreal and Ottawa the Potsdam sandstone is first found at Ste. Scholastique, and on the line of this railway running from Montreal to Toronto it is met at Ile Perrot, which consists wholly of this formation.

The Utica fringes either shore of the St. Lawrence from Laprairie to Vercheres, whence, after forming the western portion of Ile Bouchard, it passes beyond the north shore and along the course of the Canadian Pacific Railway towards Quebec. The Richelieu River flows through strata of the Utica horizon from Lake Champlain to Chambly, and thence to its mouth through the Hudson River formation, which, from Ile Bouchard northwards, appears on both sides of the St. Lawrence.

Passing southward, the Grand Trunk Railway lies wholly on the Utica formation from the Victoria Bridge to St. Johns, and thence to Rouse's Point, while towards the east the Hudson River, which is met a short distance east of St. Lambert, gives place to the Trenton formation near the junction with the Drummond County Railway.

This, after enclosing a band of Sillery (Cambrian) slates, is succeeded by the lower Cambrian, and this in turn by Huronian a few miles west of Richmond.

It has been already stated that the Huronian formation here comprises the ridges known as the Stoke Mountains and the Sutton Mountain Anticlinal. The age of these rocks has been the subject of much geological controversy, and their establishment in the Huronian system is one of the most important changes from the last map of the district, which was issued in 1866.

Sir William Logan, in the earlier days of the Geological Survey, determined the age of this series to be Silurian, and believed that the strata, now regarded as part of the

Trenton formation, were the oldest members of what was known as the Quebec Group.

This view was subsequently opposed by Dr. Sterry Hunt, and also by Dr. Selwyn, soon after his appointment to the directorship of the Geological Survey, who advanced the theory that the Trenton is the most recent instead of the oldest formation here found, and that the other members of this series are older than the Quebec Group, and are of Huronian age.

In support of his earlier views, Logan, after having retired from the Survey, spent several seasons in a re-examination of the disputed ground, studying chiefly the townships of Melbourne, Cleveland and Shipton, which he considered to give the key to the structure of the Quebec Group. He had these townships topographically surveyed at his own expense, and proceeded to prepare a geological map of the district in considerable detail. Having all but completed the work which he considered necessary for the vindication of his position, he died without making public any results of his work, nor have they since been published. Entirely apart from any controversial interest, it is much to be regretted that the result of what was, perhaps, the most complete geological investigation that has ever been made of any area of equal complexity, size and importance in Canada, should not have been made known.

The task of elucidating this tangled question was, however, reserved for Dr. Ells, whose work appears in the reports of 1886 and 1896. Beginning at the Vermont boundary line, he traced the Sutton mountain ridge in a north-easterly direction, and by a very extensive series of observations arrived at conclusions essentially similar to those of Dr. Selwyn, viz.; that the chief rocks of this range are of Huronian age.

The intrusive rocks in this sheet, exclusive of the Laurentian, comprise the line of volcanic mountains which crosses the map from east to west. They include Two Mountains, Mount Royal, Montarville, Belœil, Rougemont, Yamaska and Shefford, with Mount Johnson, the mountains about Lake Memphremagog and the Serpentines, so important from their production of asbestos.

The other economic products mentioned are iron, copper, slate, lime, building-stone, whetstones, brick, and mineral waters.

The exceeding brevity of this report (92 pp.) is unfortunate. This precludes the giving of detailed information, and tends to render the descriptions less definite, or even obscure in places.

It presents a concise compilation of the work hitherto published and a rather brief statement of the important researches more recently made.

It would probably have been better to quote from the "Geology of Canada" than to refer to it for important descriptions, since that work has been so long out of print as to have become difficult of access to many of the reading public.

The report, nevertheless, presents much that is of great value and interest to the student of local geology.

Another welcome aid to local study is the appendix by Dr. H. M. Ami, Assistant Palæontologist of the Geological Survey. This contains a list of the organic remains found in the different strata. The fossils are classified, first, according to the formations in which they occur, and then in each group they are arranged according to their zoological affinities. They embrace the collections of different workers in this field, notably those of Billings, Whiteaves, Ells, Ami, Weston and Deeks, and furnish the data for the determination of most of the chief formations. This appendix is of inestimable value to the investigator of the fossiliferous rocks of this area.

The chapter on the Laurentian district in the northwestern part of the sheet is regarded by the author, Dr.

F. D. Adams, rather as preliminary to a more detailed report to be issued later. It is a somewhat general description of a small part of the Laurentian area whose north-western extension beyond the limits of this map has been more minutely studied.

About half of the Laurentian area shown on this map consists of Anorthosite. This rock was formerly regarded by Logan, Hunt and other early investigators as a sedimentary deposit, and was called the Upper Laurentian or Norian formation.

An elaborate study of this and other occurrences was made by Dr. Adams, the result of which was to establish the fact that Anorthosite is an igneous rock which has been intruded through the Laurentian prior to the deposition of the overlying Palæozoic strata.

The Laurentian system here, as in many other places, has been found to consist of two parts, an upper series which is sedimentary in part at least, and is highly metamorphosed, and an underlying mass of altered igneous rock which constitutes the lowest known member of the earth's crust.

The former of these, which is known as the Grenville series, has been much altered by igneous intrusions. It contains almost all the mineral wealth of the Laurentian.

The underlying mass is commonly designated as the Fundamental Gneiss. From recent researches it seems probable that it represents the downward extension of its original crust of the Earth, into which when subsequently softened by heating, the Grenville series has sagged down. If so, it has probably been the chief agency in the metamorphism of the Grenville series. The prominently petrographical character of this chapter and the absence of structural details may somewhat lessen its popular, though not its technical, interest. This is, however, amply compensated for by the admirable description of the area which introduces the chapter.

This chapter is one which cannot fail to be extremely interesting as well as instructive, especially to all members of the Natural History Society who have enjoyed any of the field days in the Laurentian country.

The investigation of these older parts of the earth's crust is of great scientific interest and economic importance, especially in Canada, where the Laurentian system has its greatest development, and from which it has even derived its name.

In writing of the importance of the study of Archean (Laurentian) geology in Canada, Dr. J. E. Wolff, Professor of Petrography in Harvard University, Mass., recently said: "Dr. Adams, indeed, deserves the greatest credit for his work on the Archean of Canada. One great problem, that of the anorthosites, he has surely settled, and his careful work in the field, combined with a thorough knowledge of laboratory methods, is bearing fruit in the attempt to solve some of the other problems connected with the Archean generally and that of Canada in especial. When one considers that this formation covers much more than two million square miles in North America, its importance as a field of investigation is apparent, while the difficulty of the problem is evident from the small progress made in fifty or so years in solving some of its obscure features.

I am convinced, by my own experience, that patient detailed work will alone yield answers, and that much which is unexpected can be obtained in this way; we must look to the stratigraphic relations for new discoveries, and here there is still a great field."

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY.

MONTREAL, June 1st, 1896.

The annual meeting of the Society was held this evening at eight o'clock, the President, Rev. Robert Campbell, D.D., in the chair. There were also present—Hon. Mr. Justice Wurtele, J. A. U. Beaudry, C.E., John S. Shearer, Edgar Judge, F. W. Richards, J. B. Williams, A. F. Winn, E. T. Chambers, Geo. Sumner, Dr. Stirling, James Gardner, J. Stevenson Brown, H. H. Lyman, Dr. Adams, A. Holden, Hon. J. K. Ward, Capt. Wm. Ross, Geo. Kearley, Joseph Fortier, the Recording Secretary and others.

The minutes of the last annual meeting, of the last monthly meeting, and of the Council were all read and adopted.

On report of the Council, the following members were, on motion (the rule being suspended) elected: A. O. Granger as ordinary and Mrs. A. O. Granger associate member.

The following members were elected, the Secretary casting the ballot:—As ordinary members—James Rodger, proposed by Jno. S. Shearer, and seconded by Geo. Sumner; W. A. Stephenson, proposed by A. Holden, seconded by J. Fortier; Alfred Joyce, proposed by A. Holden, seconded by John S. Shearer; Fred. Joyce, proposed and seconded by the same; James Cayford, proposed by F. W. Richards, seconded by A. Holden; and Miss Peebles as associate member, proposed by F. W. Richards, and seconded by A. Holden.

The Annual Report of the Chairman of Council was read by the President of Council, Geo. Sumner, and, on motion, received.

The Treasurer's report was also read by F. W. Richards, showing a small balance on the right side.

The House Committee report was given verbally by John S. Shearer, the principal matter arising out of this report being the need of a new roof to the building and a new floor in the main hall.

The reports of the Curator and Library Committee were read and, on motion, accepted.

The President then gave his annual address, which was listened to with great interest.

Moved by John S. Shearer, and seconded by J. Stevenson Brown, that a special vote of thanks be given to J. B. Williams, E. T. Chambers, the Librarian and the Treasurer for the very effective work done during the past year. Carried.

John S. Shearer referred to the matter of the windows on the north side of the hall next to Kearney's being closed from light. The matter, on motion of Judge Wurtele, seconded by J. A. U. Beaudry, was referred to the incoming Council.

A vote of thanks was passed, on motion of J. Stevenson Brown, seconded by James Gardner, to the Editing Committee (Prof. Adams, Chairman), for their very efficient conducting of *The Record of Science.*

Albert Holden and F. W. Richards were appointed scrutineers.

The election of officers then took place in the usual manner, and resulted as follows:—

President—Rev. Robt. Campbell, D.D., by acclamation.

First Vice-President—John S. Shearer, by acclamation.

The following were balloted for and duly elected:—

Vice-Presidents—Dr. Wesley Mills, Sir Donald A. Smith, G.C.M.G., B. J. Harrington, Ph.D., F.R.S.C. Geo. Sumner, Hon. Justice Wurtele, J. H. R. Molson, Prof. John Cox, M.A., Frank D. Adams, Ph.D., F.R.S.C., J. Stevenson Brown.

Hon. Recording Secretary—Chas. S. J. Phillips.

Hon. Corresponding Secretary—John W. Stirling, M.B., Edin.

Hon. Curator—J. B. Williams.

Hon. Treasurer—F. W. Richards.

Members of Council—Geo. Sumner, Chairman; Albert Holden, G. P. Girdwood, M.D., C. T. Williams, James Gardner, Joseph Fortier, Hon. J. K. Ward, Walter Drake, J. H. Joseph, Edgar Judge.

Editing and Exchange Committee—Frank D. Adams, Ph.D., F.R.S.C., Chairman; G. F. Matthew, F.R.S.C., St. John, N.B.; J. F. Whiteaves, F.R.S.C., Ottawa, Ont.; Prof. Goodwin, Rev. Robt. Campbell, D.D., M.A., N. N. Evans, M.A.Sc., Carrie M. Derick, M.A.

After some discussion as to the improvements and the best way of obtaining more funds for the furtherance of the work of the Society, a vote was offered to the retiring officers on the motion of Edgar Judge, seconded by A. F. Winn. Carried.

MONTREAL, Oct. 26th, 1896.

The first monthly meeting of the Society for the session of 1896–97 was held this evening in the Library, the President, Rev. Robt. Campbell, D.D., in the chair.

There were also present—Edgar Judge, J. A. U. Beaudry, F. W. Richards, J. B. Williams, Walter Drake, E. T. Chambers, Geo. Kearley, Albert Holden, Capt. W. Ross, A. F. Winn, Jas. Gardner, C. T. Williams, Prof. Adams, Dr. Girdwood, Rev. G. Colborne Heine, Hon. Mr. Justice Wurtele, over fifteen ladies and gentlemen.

Minutes of meeting of April 27th last were read and confirmed.

DONATIONS.—The following donations have been made to the Museum since our annual meeting in June last, and are now exhibited on the table:—

From J. Broughton, Esq., late of the G. T. R. Co., 2 Tortoise Shells from the East Indies, Pipes, Bows, a Spice Holder, a curious Painting on glass, Sawfish Heads, Shells, Geological Specimens and a Snake Skin.

From E. D. Wintle, Esq., a Drawing of the Great Auk's Egg.

From J. A. U. Beaudry, Esq., an Aquarium Tank and Stand.

From H. J. Tiffin, Esq., a Scorpion.

From J. J. McBrien, a Specimen of the Stick Insect.

From E. C. Greenwood, Esq., Ellstree, Herts, England, a Collection of British and Foreign Butterflies.

From Robt. W. Chase, Esq., Birmingham, Eng., nineteen British Birds and three Nests and Eggs of British Birds.

From J. B. Williams, Esq., the Hooded Crow.

From the Zoological Gardens and Museum, London, England, a number of live Reptiles received in exchange, the most interesting of these being a young Crocodile from West Africa and a Puff Adder from the Cape of Good Hope.

From the Mason College, Birmingham, in exchange, an Apteryx from New Zealand, and nine other small birds.

On motion of J. Stevenson Brown, seconded by Walter Drake, a hearty vote of thanks was given to the donors of the beautiful specimens.

NEW MEMBERS.—On motion, Miss Elizabeth Whitney was elected an Associate Member.

The President then gave his communication on "Some Additional Flora of the Island of Montreal," exhibiting at the same time a great number of mounted specimens which he intended donating to the Society.

The thanks of the meeting were cordially extended to Dr. Campbell for his excellent communication, on motion of Walter Drake, seconded by Jas. Gardner.

The Curator, J. B. Williams, communicated to the Society some recent additions to the Museum, explaining and describing the various donations as above detailed.

It was moved by J. A. U. Beaudry, and seconded by

J. Stevenson Brown, that we put on record our appreciation of the labor and pains Mr. Williams has taken in collecting the many specimens and the information he has imparted to us, and

It is with deep regret that we have to record since our last meeting the death of a much-respected member and at one time officer of this Society, the Rev. W. J. Smyth, M.A., B.Sc., Ph.D.

It was moved by the Rev. G. Colborne Heine and seconded by Walter Drake, that the Society take this opportunity of placing on record their deep and sincere regret at the decease of the Rev. W. J. Smyth, M.A., B.Sc., Ph.D., for so many years a member and at one time an officer of this Society, and one who took a lively interest and an active part in all its proceedings. He had won the respect and regard of those with whom he had come in contact with, also that the Society wish to express their cordial sympathy with the widow of Dr. Smyth in this her heavy affliction, and order that a copy of this resolution be sent to Mrs. Smyth. Carried.

The resolution was feelingly spoken to by the mover, seconded by the President, J. A. U. Beaudry and others.

On motion the meeting then adjourned.

MONTREAL, Nov. 26th, 1896.

The second monthly meeting of the Society was held this evening at the usual hour, Dr. Wesley Mills, Vice-President, in the chair. There were also present—J. A. U. Beaudry, J. B. Williams, Geo. Kearley, Capt. W. Ross, E. T. Chambers, A. Holden, H. McLaren, Miss Howard O'Keefe, A. F. Winn, Prof. J. T. Donald, W. M. Knowles, Capt. R. C. Adams, Edgar Judge, and the Recording Secretary and a number of friends, in all 46.

Minutes of last monthly meeting were read and confirmed.

The report of the Council was read and accepted.

DONATIONS TO THE MUSEUM.—A Duck Hawk (immature female), presented by Romouald Martin, Chasseur St. Valentine, per E. D. Wintle, Esq.

A Swainson Hawk, taken near Montreal in 1894 (purchased). Thanks voted to donors.

E. T. Chambers gave a verbal report from the Library Committee.

Dr. Mills then vacated the chair, and delivered his very interesting paper on the "Development of Animal Intelligence."

After a few interesting comments and questions upon this excellent paper, a vote of thanks was unanimously passed, after being moved by Edgar Judge, seconded by E. T. Chambers.

The meeting then adjourned.

MONTREAL, Jan. 25th. 1897.

The second monthly meeting of the Society was held this evening at eight o'clock, the meeting being called to order by Dr. Frank D. Adams, one of the Vice-Presidents. There were present—Sir J. W. Dawson, J. A. U. Beaudry, J. B. Williams, F. W. Richards, Dr. Deeks, E. T. Chambers, the Recording Secretary and four visitors, one of whom was Major-General Donald Roderick Cameron, who was introduced by Sir Wm. Dawson.

Minutes of previous meeting were read and, on motion, received and confirmed.

The report of Council was read (of 18th Jan.), the Museum Committee reporting thereon that the Saturday afternoon talks to young people would be given during February and March.

DONATIONS.—The following were donated to the Society's Museum :—

Red-winged Black Bird, a live Screech Owl, David Denne, 100 St. Francois Xavier street.

Egg of Sharp-skinned Hawk, egg of Black-crowned Night Heron, specimen of King Crab, W. Mackay, 31 Bishop street.

Illustration of all the British Butterflies, R. Brainard, 171 Drummond street.

Pair of Scallop Shells, illustration of Leaf Butterfly, Alfred Griffin.

Sir J. Wm. Dawson then read his highly interesting communication to the Society, "On Some Ancient Canadian Fossils and their Allies Abroad." The paper was listened to with intense interest, Dr. Adams remarking upon the ease with which Sir William makes very abstruse plain to ordinary listeners.

Dr. Deeks exhibited a lower jaw of a Hippopotamus dredged out of the bottom of the river opposite the city.

An interesting discussion ensued as to how it came to be there, but no satisfactory decision was arrived at.

Hearty votes of thanks were then given to Sir William Dawson and also to Dr. Deeks, with the regret that there was such a small attendance.

NEW MEMBERS.—Peter Lang was, on the recommendation of the Council, proposed as an ordinary member; being moved by Jas. Gardner, and seconded by T. E. Hodgson, was elected on vote, the usual rule in such cases being suspended.

The meeting then adjourned.

Book Notice.

The Earth and its Story: a First Book on Geology.—By Angelo Heilprin; pp. 267. Silver, Burdett & Company, New York, Boston and Chicago, 1896.

The story of our earth and the wonderful processes by which the story is carried forward must, we think, have an increasing interest for all thinking persons, as time goes on and the details of this wonderful history are more and more clearly revealed. And this interest finds its cause not only on the fact that we, "Man, His last work," forms, as it were, the *denouement* of the geological story, but also in the vastness of the subject presented for consideration; for "Geology," as was well said by Herschel many years since, "in the magnitude and sublimity of the objects of which it treats, undoubtedly ranks in the scale of sciences next to astronomy." As the modern science of chemistry grew upon and out of the quaint and curious experiments and speculations of the astrologers, so geology had its foundation chiefly in the speculations of the Italians of the 16th and 17th centuries, put forward to account for two very remarkable facts; first, namely, that the ocean has undoubtedly in former times covered great tracts of country now high above sea level, and secondly, that there exist in the rocky strata of the earth's crust what are to all appearances the remains of animals and plants.

Looking back from the heights to which we have now attained these curious speculations are full of interest. We feel that we have really made some progress on finding the fossils of the earth's crust variously explained as curious imitative forms produced by the influence of the stars, as the products of a species of fermentation set up in the earth's crust, or, finally, as the abortive and unsuccessful attempts on the part of the Creator to fashion worlds, which as yet from lack of practice He was unable to bring forth in beauty and perfection.

As a science Geology can hardly be said to have existed more than a century. It may be said to have really come into existence when the truth of Hutton's fundamental principle became recognized that, "In examining things present we have data from which to reason with regard to what has been and from what actually has been we have data for concluding with regard to that which is to happen hereafter"; a principle which, when grasped and realized, afforded a key by which the wonderful story of our planet could be deciphered with clearness and certainty, and which also gave us for the first time some idea of the immense æons represented by the stratified rocks of the earth's crust. For if, to take a single example, in the Carboniferous system of Nova Scotia there is a thickness of three miles of strata, piled up upon one another in regular order by the same processes which are now in operation along the Atlantic coast, and which accomplish so very little in the course of a human lifetime, it is evident that an enormous length of time was required for the accumulation of these strata, and when it is learned that this system is but one of a dozen or more which succeed one another in their order, and whose complete sequence is required to unfold the story of the earth, we apprehend in some faint way the abyss of geological time, which in its turn is a nothing compared with the former time when the planets of our solar system were being brought forth in their order, but the earth as yet was not.

It is the aim of this little book of Professor Heilprin's to present briefly and in popular form the main outlines of the earth's history and to explain the play of the forces by which this history has been recorded. It is quite elementary in character, being intended, as the preface informs us, "for classes in high schools and colleges, and also for the large increasing number of lay readers who are desirous of knowing more about the formation, structure and development of the earth on which they live."

The earlier chapters describe a few commonest rocks which make up the earth's crust, consisting of the igneous rocks, which owe their origin to fire, and the aqueous or sedimentary rocks, which are produced through the agency of water; the latter, in their fossil ripple marks, raindrop markings and impressions of footprints, presenting striking testimony to the similarity of ancient conditions of deposition to those which obtain along the sea-coasts of the present world.

The lessons taught by the mountain chains of the earth's crust, with their bent and dislocated strata, their deeply cutting streams and slowly creeping glaciers, are then explained, and a chapter is devoted to volcanoes and the causes of volcanic action, a class of phenomena which, although often local, have in some parts of the earth's surface a wide-reaching influence, as in Idaho and the adjacent states, where floods of lava, welling up through fissures, have covered a region equal in area to France and Great Britain combined, or in India, where, in the Deccan, an area of 200,000 square miles is covered with lava flows having in places an aggregate thickness of 6,000 feet; or in what is perhaps a still more remarkable district, namely, East Africa, where similar enormous lava plains are cut across by faults or dislocations, giving rise to precipices in some cases a thousand feet or more in height, and which along one line result in the formation of an enormous rift valley, a southerly continuation of that in which lies the River Jordan and the Dead Sea.

Corals and coral islands form the subject of another chapter, a subject with which will always be associated the names of the two great naturalists, Darwin and Dana, and one upon which Professor Heilprin's studies in Florida and the Bermudas enable him to speak with authority.

The treatment of these subjects leads naturally to the following chapters on Fossils, their nature and mode of occurrence, and the gradual unfolding of the tree of life, from lowly forms of the earlier geological systems to the highly organized and specialized forms of the modern world.

The book concludes with a brief description of some of the more common rocks and minerals of economic importance, with explanations of the uses to which they are put.

The Story of the Earth, as told by Professor Heilprin in this useful little work, is all the more readily understood from the presence of the abundant illustrations, in the form of half-tone cuts, which the book contains, many of which are quite new to geological text-books. The book wiil be welcomed by many readers who wish to obtain some knowledge of the history of the earth on which they live,--a history not finished and completed, but which is still being written in the rocky strata, now in course of deposition in all the great waters of the world.

FRANK D. ADAMS.

ABSTRACT FOR THE MONTH OF DECEMBER, 1896.

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

DAY.	THERMOMETER. Mean.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. Range.	BAROMETER. Mean.	BAROMETER. Max.	BAROMETER. Min.	BAROMETER. Range.	†Mean pressure of vapor	‡Mean relative humidity.	Dew point.	WIND. General direction.	WIND. Mean velocity in miles perhour	SKY CLOUDED IN TENTHS Mean.	SKY CLOUDED IN TENTHS Max.	SKY CLOUDED IN TENTHS Min.	Percent. of possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY
1	16.83	20.7	8.8	11.9	30.3265	30.448	30.235	.213	.0743	79.3	11.7	S.W.	14.46	5 0	9	0	42	....	0.0	0.00	1
2	4.17	6.7	— 0.8	7.5	30.5612	30.634	30.477	.157	.0408	77.8	— 1.3	N.W.	7.87	0.0	0	0	84	....	....	....	2
3	11.97	20.2	3.5	16.7	30.3112	30.410	30.226	.184	0637	83.2	8.2	S.E.	9.17	4.7	10	0	1	....	0.6	0.06	3
4	17.62	29.0	7.3	21.7	30.1565	30.339	29.892	.447	.0848	82.8	13.5	S E.	10.04	7 7	10	0	0	....	0.5	0.05	4
5	30.97	36.0	21.1	14.9	29.9947	30.096	29.869	.227	.1542	87.8	27.7	S.W.	17.88	9.8	10	9	0	....	.01	0.01	5
SUNDAY........6	.....	40.1	18.0	22.1	....	......	......	....	.....	...	...	S.W.	18.21		...	...	0	....	1.2	0.12	6............ SUNDAY
7	30.37	22.7	28.3	4.4	30.1532	30.232	30.072	.160	.1222	71 8	22.7	S.W.	12.50	6.2	10	0	54	....	0.0	....	7
8	30.15	34.0	23.6	10.4	30.1513	30.281	29.896	.385	.1440	85.7	26.3	S.W.	8.75	8 3	10	0	9	....	0.0	0.03	8
9	31.43	34.0	28.0	6.0	29.4920	29.691	29.362	.329	.1597	90.0	28.8	N	16.79	9.5	10	7	9	....	3.0	0.30	9
10	32.18	35.2	29.5	5.7	29.6590	29.824	29.463	.361	.1457	79 2	26.3	S.W.	14.82	9.7	10	8	5	....	0.0	0.00	10
11	28.27	30.6	26.0	4.6	30.0138	30.096	29.917	.179	1322	85.0	24.5	N.	9.21	10.0	10	10	0	....	....	....	11
12	33.87	37.4	31.0	6.4	29.8810	29.943	29.751	.192	.1700	87.0	30 5	S.W.	13.71	5.0	10	0	5	....	....	....	12
SUNDAY 13	.....	42.0	29.2	12.8	......	......	.....	....	..	...	....	S.	22.75	....	....	...	13	....	0.0	0.00	13..........SUNDAY
14	17 50	25.2	11.4	13.8	30.1550	30.344	29.861	.483	.0780	78.3	12.2	N.W.	19.12	0.0	0	0	93	....	....	....	14
15	8.33	14.6	4.5	10.1	30.3503	30.419	30 277	.142	0520	82.7	3.8	N.E.	18.75	2.2	10	0	71	....	....	....	15
16	13 35	17.2	7 1	10.1	30.2005	30.228	30.172	056	0615	76.8	7.8	N.E.	23.54	7.2	10	0	3	....	....	....	16
17	15.05	20.9	8.2	12.7	30.2863	30.333	30.239	.094	.0613	71.3	7.5	N.	6.71	1.3	6	0	79	....	....	....	17
18	23.05	31.9	13.5	18.4	29.9035	30.204	29 607	.597	.1095	82.3	18.8	S E.	11.58	10.0	10	10	0	....	1.7	0.14	18
19	13.32	32.9	4.5	28.4	29.9345	30.103	29.591	.512	.0713	83.3	9.5	W.	31.62	5.7	10	0	12	....	2.8	0.24	19
SUNDAY 20	.....	8.1	— 0.1	8.2	......	.....	......	....	....	....	....	S.W.	17.42	...		..	39	....	....	....	20...........SUNDAY
21	0 83	2.9	— 1.4	4.3	30.0600	30.166	30.010	.156	0375	84.0	— 3.0	N.	7.37	2.2	6	0	71	....	....	....	21
22	— 1.22	3.1	— 6.9	10.0	30.0527	30.076	30.009	.067	0377	92.0	— 3.2	W.	5.67	2.5	6	0	45	....	....	...	22
23	— 1.23	3.3	— 4 8	8.1	30.2102	30.324	30.134	.190	0345	85.2	— 4.8	N.	15.08	2 0	5	0	59	....	....	....	23
24	— 1.70	2.3	— 6 2	8 5	30.3953	30.414	30.374	.040	0367	91.2	— 4.0	W.	20.21	5.0	10	0	52	....	0.0	0.00	24
25	11.25	26.3	0.2	26 1	30.3183	30.466	30.045	.421	.0628	81.5	7.3	S.	17.42	8.8	10	0	7	...	0.5	0.05	25
26	16.05	29.2	— 1.4	30.6	30.1742	30.602	29.885	.717	.0842	83.5	11.8	N.W.	29.42	4 3	10	0	56	....	0.4	0.04	26
SUNDAY........27	.....	4.0	— 6.3	10.3	....	......	...	....	.....		..	S.W.	9.42	..	......	..	73	....	....	....	27.......... SUNDAY
28	13.23	22.9	1.0	21.9	30.6478	30 848	30 428	.420	.0593	73.8	6.2	S.	14 04	1.0	3	0	85	...	....	....	28
29	29.93	35.3	21.5	13.8	30.3065	30.345	30.271	.074	.1503	87.8	27.0	S.W.	20.75	8.3	10	0	0	0.08	....	0.08	29
30	36.35	39.5	33.2	6.3	30.1215	30.327	29 970	.357	.1922	89.2	33.5	S.W.	24.71	9.5	10	4	0	....	....	....	30
31	18.23	36.9	12.5	24.4	30.5155	30.693	30.202	.491	.0745	71.5	10 8	N.W.	13.67	0.5	3	0	92	...	....	....	31
Means	17.78	24.36	11 10	13.26	30.1605	30.2921	30.0087	.2834	0924	82.37	13.34	S. 69½° W	15.57	5.25	8.1	1.8	34.1	0.08	10.8	1.09	... . Sums.
22 Years means for and including this month......	18.90	26.06	11 69	14.35	30.0308	......	......	.295	.0996	82.6	...	......	§16.60	6 89	....	..	¶29.95	1.27	22.8	3.51	22 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	1216	1035	81	361	1455	4433	1350	1654	
Duration in hrs..	107	48	12	44	103	214	101	113	2
Mean velocity....	11.36	21.56	6.75	8.20	14.12	20.71	13.36	14.64	

Greatest mileage in one hour was 42 on the 19th.

Greatest velocity in gusts, 50 miles per hour on the 19th.

Resultant mileage, 4910.

Resultant direction, S. 69½° W.

Total mileage, 11585.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 15 years only.

The greatest heat was 42°0 on the 13th; the greatest cold was —6.°9 on the 22nd giving a range of temperature of 48.°9 degrees.

Warmest day was the 30th. Coldest day was the 24th. Highest barometer reading was 30.935 on the 27th. Lowest barometer was 29.362 on the 9th, giving a range of 1,573 inches. Maximum relative humidity was 98 on the 5th, 8th and 18th. Minimum relative humidity was 55 on the 17th.

Rain fell on 1 day.

Snow fell on 14 days.

Rain or snow fell on 15 days.

Auroras were observed on 1 night on the 3rd.

Lunar halos on the 18 h and 22nd.

Lunar corona on the 20th and 23rd.

Fog on 1 day on the 13th.

Meteorological Abstract for the Year 1896.

Observations made at McGill College Observatory, Montreal, Canada.—Height above sea level 187 ft. Latitude N. 45° 30′ 17″. Longitude 4^h 54^m $18{\cdot}67^s$ W.

C. H. McLEOD, *Superintendent.*

Month.	Thermometer. Mean.	¶ Deviation from 21 years means.	Max.	Min.	Mean daily range.	* Barometer. Mean.	Max.	Min.	Mean daily range.	† Mean pressure of vapour.	‡ Mean relative humidity.	Mean dew point.	Wind. Resultant direction.	Mean velocity in miles per hour.	Sky clouded per cent.	Per cent. possible bright sunshine	Inches of rain.	Number of days on which rain fell.	Inches of snow.	Number of days on which snow fell.	Inches of rain and snow melted.	No. of days on which rain and snow fell.	No. of days on which rain or snow fell.	Month.
January	12.36	+ 0.42	35.3	— 21.2	10.83	30.1906	30.675	29.431	.222	.0742	88.5	9.4	N. 20° W.	14.5	60	39.4	....	..	20.7	17	2.11	..	17	January
February	14.75	— 0.59	41.5	— 23.4	14.76	29.8314	30.601	28.786	.339	.0915	90.3	12.4	N. 30¾° W.	20.0	60	40.7	0.35	1	25.9	17	3.34	..	18	February
March	19.65	— 4.42	45.6	— 3.2	14.96	29.9339	30.682	29.039	.295	.0995	84.5	15.5	N 51½° W.	19.2	55	41 0	2.18	7	39.5	18	6.97	4	21	March
April	41 48	+ 1.41	77.0	17.6	16.92	30.0685	30.586	29.419	.157	.2008	74.6	33.1	S. 44¾° W.	18.2	47	55.3	0.85	12	3.2	6	1.20	2	16	April
May	57.66	+ 2.92	88.7	36.0	20.10	29.9588	30.408	29.493	.199	.3319	67.2	45.9	S. 33¾° W.	11.5	44	59.5	2.74	16	....	..	2.94	..	16	May
June	64.59	— 0.42	86.4	44.2	17.73	29.9208	30.276	29.478	.154	.4031	65.7	52.3	S. 63½° W.	12.0	32	64.6	4.06	11	....	..	4.06	..	11	June
July	68.57	— 0.17	89.3	51.3	16.03	29.9323	30.338	29.458	.183	.5182	73.6	59.5	S. 55¼° W.	13.0	49	57.2	4.84	21	....	..	4.84	..	21	July
August	66.75	+ 0.04	89.7	47.8	16.32	29.9841	30.300	29.646	.139	.4759	71.5	56.6	S. 56¾° W.	11.5	43	64.6	5.35	14	...	..	5.35	..	14	August
September	56.81	— 1.71	83.8	34.3	14.55	29.9923	30.312	29.489	.205	.3718	78.1	49.7	S. 73¾° W.	12.4	52	52.5	3.11	17	....	..	3.11	.	17	September
October	43.07	— 2.18	58.3	21.6	12.24	30.0033	30.638	29.523	.195	.2279	79.3	36.5	N. 50° W.	12.6	64	37.8	2.48	17	Inap.	3	2.48	2	18	October
November	34.79	+ 2.23	57.6	8.8	13.85	30.1077	30.774	29.398	.313	.1760	80.6	29.4	S. 45° W.	15.6	76	22.2	3.48	18	5.9	12	4.19	3	27	November
December	17.78	— 1.12	42.0	— 6.9	13.26	30.1605	30.935	29.362	.283	.0873	82.4	13.3	S. 69½° W.	15.6	53	84.1	0.08	1	10.8	14	1.09	..	15	December
Sums for 1896	...	...	....	....	....	....	....	....	....	....		....		....	....	....	29.47	135	106.0	87	41.68	11	211	Sums for 1896
Means for 1896	41.52	—0.299	....	....	15.13	30.0070	....	....	.2237	.2548	78.03	34.47	N. 84¾° W.	14.68	52.9	47.41	....	....	....	..	3.47	..	17	Means for 1896
Means for 22 years ending Dec. 31, 1896	41.82	....	....	....	....	29.9795	....	....	....	.2521	74.88	....	....	*a* 15.13	60.6	§45.75	28.23	133	117.6	78	39.77	16	200	Means for 22 years ending Dec. 31, 1896.

* Barometer readings reduced to 32° Fah. and to sea level. † Inches of mercury. ‡ Saturation 100. § For 15 years only. ¶ "+" indicates that the temperature has been *higher*: "—" that it has been *lower* than the average for 22 years inclusive of 1896. The monthly means are derived from readings taken every 4th hour, beginning with 3 h. 0 m. Eastern Standard time. The anemometer and wind vane are on the summit of Mount Royal, 57 feet above the ground and 810 feet above the sea level. *a* For 10 years only.

The greatest heat was 89.7° on August 11: the greatest cold was 23.4° below zero on February 18. The extreme range of temperature was therefore 113.1. Greatest range of the thermometer in one day was 39.6° on November 19; least range was 2.8° on February 6. The warmest day was August 11, when the mean temperature was 81.15°. The coldest day was February 17, when the mean temperature was 16.02° below zero. The highest barometer reading was 30.935 on December 27, Lowest barometer reading was 28.786 on February 7, giving a range of 2.149 inches for the year. The lowest relative humidity was 28 on May 1. The greatest mileage of wind recorded in one hour was 66 miles per hour on February 11, and the greatest velocity in gusts was at the rate of 90 miles per hour on February 11. The total mileage of wind was 126,550. The resultant direction of the wind for the year is N. 84¾° W., and the resultant mileage was 41.780. Auroras were observed on 17 nights. Fogs on 8 days. Thunder storms on 15 days. Lunar halos on 8 nights. Lunar coronas on 9 nights. Solar corona on 1 day. Mock suns on 1 day. The sleighing of the winter commenced in the city on November 23. The first appreciable snowfall of the autumn was on November 15.

NOTE.—The yearly means of the above, are the averages of the monthly means, except for the velocity of the wind.

ABSTRACT FOR THE MONTH OF JANUARY, 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 perhour	SKY CLOUDED IN TENTHS. Mean.	Max.	Min.	Per cent. of possible sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	12.90	18.5	6.4	12.1	30.6428	30.720	30.526	.194	.0663	83.5	8.8	N.E.	10.50	6.5	10	0	48	....	0.0	Inap.	1
2	30.47	37.2	20.1	17.1	30.4260	30.507	30.330	.177	.1558	90.0	28.0	S.	13.62	9.5	10	7	00	0.07	....	0.07	2
SUNDAY........3	.....	43.6	33.5	10.1	......	......	......	....	.....	....	....	S.	15.58	....	....	....	84	....	....	....	3............ SUNDAY
4	42.85	47.5	38.7	8.8	29.9473	30.126	29.736	.390	.2500	90.7	40.2	S.	20.33	5.5	10	0	11	....	....	....	4
5	34.40	43.4	30.0	13.4	29.6320	29.732	29.575	.157	.1782	88.0	31.3	S.W.	24.25	8.3	10	0	00	0.20	0.3	0.26	5
6	25.00	28.0	20.5	7.5	29.6835	29.774	29.646	.128	.1082	80.3	20.2	W.	25.08	6.8	10	0	07	....	6.6	0.06	6
7	13.00	21.5	8.9	12.6	30.2722	30.456	30.017	.439	0553	70.5	6.5	W.	11.12	2.3	10	0	93	....	....	...	7
8	11.53	16.7	6.0	10.7	30.4897	30.558	30.397	.161	.0530	86.3	8.3	N.E.	12.46	0 0	0	0	76	....	....	....	8
9	12.90	17.6	6.0	11.6	30.1088	30.486	29.756	.730	.0695	88.7	10.2	E.	4.50	5.8	10	0	36	....	1.5	0.13	9
SUNDAY.......10	.....	26.9	16.8	10.1	......	......	.....	....	....	...	....	W.	17.67	....	...	....	67	....	0.9	0.09	10..........SUNDAY
11	17.13	20.9	13.0	7.9	29.7670	29.789	29.751	.038	.0793	83.5	13.2	W.	7.00	7.7	10	0	12	....	0.2	0.02	11
12	3.50	12.1	−2.1	14.2	30.0430	30.257	29.834	.423	0438	82.8	−0.7	W.	16.37	3.5	10	0	58	....	0.8	0.08	12
13	−4.48	−0.6	−8.3	7.7	30.3537	30.405	30.283	.117	.0322	91.3	−6.5	S.W.	8.68	1.5	5	0	72	....	....	....	13
14	1.15	7.6	−7.1	14.7	30.3300	30.375	30 242	.133	.0398	86.8	−1.8	N.E.	5.55	1.5	9	0	75	....	....	....	14
15	7.35	14.3	0.1	14.2	30.2750	30.377	30.129	.248	.0517	83.8	3.8	N.	10.92	3.7	10	0	92	....	....	....	15
16	25.02	31.9	15.[illegible]	16.9	30.1363	30.178	30.089	.089	.1270	90.0	22.7	S.W.	12.54	10.0	10	10	00	....	0.6	0.06	16
SUNDAY.......17	.....	37.6	31.2	6.4	......	......	.....	....	....	....	....	S.	23.50	....	....	....	00	0.09	0.0	0.09	17..........SUNDAY
18	16.83	40.4	−10.4	50.8	29.6915	30.151	29.321	.830	.1017	84.7	13.5	N.W.	36.82	6.8	10	0	57	0.05	....	0.05	18
19	−12.70	−7.1	−19.2	12.1	30.4172	30.493	30.287	.206	.0210	87.2	−15.2	W.	24.17	1.5	7	0	90	....	....	...	19
20	4.58	16.1	−7.8	23.9	30.3635	30.511	30.150	.361	.0455	82.8	0.3	S.	9.17	7.0	10	0	31	....	0.1	0.01	20
21	19.17	23.7	11.8	11.9	29.6690	29.983	29.514	.469	.0965	91.7	17.0	N.	12.96	10.0	10	10	00	....	13.2	1.32	21
22	18.55	23.5	14.9	8.6	29.6043	29.687	29.446	.241	0885	87.0	15.8	N.	7.2[illegible]	9.2	10	5	23	....	1.1	0.11	22
23	14.03	23.5	2.9	20.6	29.6455	29.844	29.479	.365	.0710	83 5	10 2	S.W.	20.42	8.2	10	0	09	....	1.2	0.12	23
SUNDAY.......24	.....	1.0	−13.5	14.5	....	......	......	....	.....	....	....	S.W.	21.62	....	......	...	76	....	....	....	24.......... SUNDAY
25	10.37	4.3	−23.5	27 8	29.6080	29.851	29.363	.488	.0265	87.3	−12.5	S.W.	37.50	8.0	10	0	21	....	1.2	0.12	25
26	12.05	17.2	6.0	11.2	29.5378	29.724	29 394	.330	.0585	76.8	6.3	S.W.	43.54	8.8	10	3	13	....	0.5	0.05	26
27	15.85	18.6	11.4	7.2	29.8952	29.943	29.836	.107	.0733	81.7	11.7	W.	13.12	8.8	10	3	25	....	....	....	27
28	15.68	19.2	11.8	7.4	29.6640	29.845	29 572	.273	0822	92.7	14.0	S.W.	28.30	8.3	10	0	00	....	3.9	0.39	28
29	16.17	19.1	10.5	8.6	29.9742	30.250	29.693	.557	.0720	79.0	10.8	S.W.	28.12	4.8	10	0	55	....	....	....	29
30	9.27	13.1	2.3	10.8	30.5243	30.688	30.[illegible]8	.350	.0532	80.5	4.7	S.W.	13.21	0.0	0	0	99	....	....	....	30
SUNDAY.......31	.....	17.5	−0 1	17.6	....	......	......	....	.....	....	....	S.W.	13.50	....	....	....	90	....	....	....	31.......... SUNDAY
Means	13.54	21.12	7.28	13.84	30.0269	30.1812	29.8735	.3077	.0812	85.04	10.03	S. 67¼° W.	17.72	5.92	8.9	1.5	42.6	0.41	26.1	3.03	....Sums.
23 Years means for and including this month	12.01	20.36	4.25	16.10	30.0582	......	......	323	.0727	81.7	....	......	§16.77	6.3	....	..	¶31.6	0.79	28.6	3.52	22 Years meansfor and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles	1537	775	203	225	1467	5448	2331	1199	
Duration in hrs..	107	59	27	25	96	238	120	57	15
Mean velocity...	14.36	13.14	7.52	9.00	15.28	22.89	19.43	21.04	

Greatest mileage in one hour was 56 on the 26th.

Greatest velocity in gusts, 66 miles per hour on the 26th.

Resultant mileage, 6620.

Resultant direction, S. 67¼° W.

Total mileage, 13185.

Average velocity, 17.72 m. p. h.

*Barometer readings reduced to sea-level and temperature of 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 47°5 on the 4th; the greatest cold was 23.°5 below zero on the 25th giving a range of temperature of 71.°0 degrees.

Warmest day was the 4th. Coldest day was the 19th. Highest barometer reading was 30.720 on the 1st. Lowest barometer was 29,321 on the 18th, giving a range of 1,399 inches. Maximum relative humidity was 98 on the 4th, 8th and 9th. Minimum relative humidity was 41 on the 7th.

Rain fell on 4 days.

Snow fell on 15 days.

Rain or snow fell on 18 days.

Lunar halos on 1 night.

Lunar corona on 2 nights.

ABSTRACT FOR THE MONTH OF FEBRUARY, 1897.

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

DAY.	Thermometer. Mean.	Thermometer. Max.	Thermometer. Min.	Thermometer. Range	Barometer. Mean.	Barometer. Max.	Barometer. Min.	Barometer. Range.	†Mean pressure of vapor.	Mean relative humidity.	Dew point.	Wind. General direction.	Wind. Mean velocity in miles per hour	Sky Clouded in Tenths. Mean.	Sky Clouded in Tenths. Max	Sky Clouded in Tenths. Min.	Per cent. of possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	14.32	21.7	8.4	13 3	30.3990	30.587	30.205	.382	.0723	87.3	11.2	S.W.	8.08	4 0	10	0	70	....	....	....	1
2	17.28	25.5	8.0	17.5	30.1128	30.199	30.050	.149	.0848	88.3	13.8	N.E.	14.79	4.5	10	0	16	....	....	...	2
3	17.07	20.9	10.0	10.9	30.1345	30.210	30.080	.130	.0787	82.9	13.2	N.E.	28.55	2.2	7	0	89	....	....	....	3
4	12.33	17.9	5.5	12.4	30.3543	30.419	30.278	.141	.0693	90.2	10.0	N.E.	13.87	0.5	3	0	94	....	....	....	4
5	12.50	19.2	0.1	19.1	30.4282	30.513	30.318	.195	.0605	79.0	7.3	E.	9.75	3.7	10	0	83	....	....	....	5
6	30.97	35.7	20.0	15 7	30.1043	30.253	29.893	.360	.1388	77.7	24.8	S.E.	18.92	10.0	10	10	00	0.02	0.0	0.02	6
Sunday. 7	.....	37.7	33.0	4.7	......	......	......	....	.....	....	....	N.	13.08	.	......	..	00	0.45	0.2	0.47	7... ...... Sunday
8	33.22	35.1	30.2	4.9	29.8322	29 862	29.799	.063	.1617	85 0	29.5	S W.	16.33	10.0	10	10	00	0.00	....	0.00	8
9	25.28	28.3	20.5	7.8	30.0145	30.073	29.922	.151	.1140	83.8	21.2	W.	17.02	5.2	10	0	69	....	0.0	0.00	9
10	7.35	10.6	2.5	8.1	30.3457	30.394	30.224	.170	.0477	78.0	2.2	N.W.	10.17	0 0	0	0	100	....	....	....	10
11	1.78	6 2	— 2.9	9.1	30.3940	30.452	30.333	.119	.0355	78.5	— 4.2	N.E.	6.54	0.0	0	0	94	....	....	....	11
12	13.88	10.9	— 2.2	13.1	30.0303	30.265	29.878	.387	0382	74.2	— 2.8	N.	21.07	10.0	10	10	00	....	0.0	0.00	12
13	11.43	16.8	4.9	11.9	30.1693	30.235	30.025	.210	.0502	68.0	2.8	S.W.	15.08	0.7	4	0	100	....	....	....	13
Sunday.. 14	.....	22.3	3.4	18.9	......	.....	.....	....	.....	....	....	N.	11.92	...	...	...	34	....	0.3	0.02	14 ....Sunday
15	28 63	32.6	23.7	8.9	29.8512	29.916	29.762	.154	.1292	81.8	23.8	S.W.	17.55	6.0	10	0	67	....	0.0	0.00	15
16	26.90	31.8	19.0	12.8	29.7702	29.821	29.747	.074	.1295	88.3	23.8	N.	7.92	5.3	10	1	61	....	....	...	16
17	27 92	31.2	22.4	8.8	29.7508	29.865	29.649	.216	.1433	93.0	26.3	S.W.	13.20	7.7	10	0	00	....	2.5	0.25	17
18	31.78	35.4	26.5	8.9	29.7737	29.910	29.608	.302	.1570	87.5	28.3	S W.	18.37	7.7	10	0	14	....	0.1	0.01	18
19	20.47	25.3	15.9	9.4	30.1483	30.256	29.989	.267	.0855	79.3	14.8	S.W.	19 54	3.3	10	0	97	....	0.2	0.02	19
20	22.05	25.7	16.2	9.5	30.2123	30.379	29.840	.539	.0995	83.5	18.0	S.E.	12.17	5.0	10	0	71	....	0.0	0.00	20
Sunday........21	.....	38.7	24.2	14.5	.....	.....	.....	....	....	....	....	N.W.	25.42	....	..	...	32	0.01	4.6	0.47	21..........Sunday
22	12.08	17.7	7.9	9.8	30.1157	30.253	29.844	.409	.0645	84.2	8.3	N.E.	21.21	8 2	10	0	00	....	2.5	0.25	22
23	23.10	26.5	15.9	10.6	29.6115	29.668	29 514	.154	.1095	87.8	20.3	S.W.	13.75	10 0	10	10	05	....	5.8	0.58	23
24	21.25	27.3	16.5	10.8	29 9573	30.067	29.720	.347	0927	81.3	16.5	S.W.	23.71	3.5	10	0	77	....	0.3	0 00	24
25	23.32	32.9	12.6	20.3	29.9782	30.092	29 906	.186	.1063	83.7	19.3	S.	18.75	8.8	10	6	15	....	0.2	0.02	25
26	1.30	5.4	— 5.3	10.7	30.2702	30.319	30.186	.133	.0337	74.3	— 5 8	S.W.	12.87	2.7	9	0	71	...	....	....	26
27	8.65	16.1	0 1	16.0	30.3147	30.357	30.282	.075	.0472	74.0	1.8	S.W.	18.00	3.8	10	0	70	....	0 1	0.01	27
Sunday........28	.....	14.0	— 0.2	14.2	....	......	......	....	.....	....	....	N.W.	19.12	...	....	...	96	...	....	....	28.......... Sunday
29	.....	....	....	....	....	......	......	....	.....	....	....	......	.....	...	..	....	....	...	....	....	29
30	.....	....	....	....	....	......	......	....	.....	....	....	......	.....	....	....	...	....	...	....	....	30
31	.....	....	....	....	....	......	......	....	.....	....	....	......	.....	....	.	....	....	...	....	....	31
Means	18.12	23.91	12.03	11.88	30.0864	30.1819	29.9605	.2214	.0896	82.11	13.52	S. 81½° W.	15.99	5.12	8.45	1.95	51.2	0.48	16.5	2.12	... .Sums.
23 Years means for and including this month	15.46	23.61	7.02	16.59	30.0293	......	......	.301	.0827	79.9	....	......	§18.26	5 9	.....	...	¶42.2	0.75	22.4	2.92	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	1251	2018	582	487	303	4473	494	1129	
Duration in hrs..	95	111	44	30	24	263	39	64	2
Mean velocity....	13.17	18.18	13.23	16.23	12.63	17.01	12.67	17.64	

Greatest mileage in one hour was 38 on the 3rd.
Greatest velocity in gusts, 48 miles per hour on the 3rd.

Resultant mileage, 4265.
Resultant direction, S. 81½° W.
Total mileage, 10737.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only.

§ 11 years only.

The greatest heat was 37°7 on the 7th: the greatest cold was —5.°3 on the 26th giving a range of temperature of 43.°0 degrees.

Warmest day was the 8th. Coldest day was the 26th. Highest barometer reading was 30.587 on the 1st. Lowest barometer was 29.514 on the 23rd, giving a range of 1,073 inches. Maximum relative humidity was 100 on the 1st. Minimum relative humidity was 53 on the 6th.

Rain fell on 4 days.

Snow fell on 16 days.

Rain or snow fell on 16 days.

Auroras were observed on 2 nights, on the 9th, 25th.

Lunar halos on 2 nights.

Lunar coronas on 2 nights.

Mock Suns on 17th.

ABSTRACT FOR THE MONTH OF MARCH, 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	6.45	21.7	—9.7	31.4	30.4878	30.839	29.947	.892	.0583	88.5	3.7	S.E.	16.83	7.3	10	0	25	....	1.4	.14	1
2	20.48	32.3	16.0	16.3	30.2336	30.334	29.982	.352	.0858	75.7	14.3	S.W.	11.79	7.7	10	0	74	....	2.5	.25	2
3	19.53	26.7	11.5	15.2	29.7675	30.063	29.579	.484	.0998	93.2	17.8	N.E.	11.33	8.3	10	0	00	.29	1.7	.46	3
4	20.33	26.1	14.5	11.6	30.2325	30.391	30.036	.355	.0883	80.5	15.3	S.W.	18.42	1.5	8	0	90	....	....	....	4
5	27.20	35.3	13.2	22.1	29.8980	30.328	29.497	.831	.1328	84.2	23.2	S.E.	21.25	8.3	10	0	00	.22	0.3	.25	5
6	19.13	42.0	12.8	29.2	30.3308	30.706	29.651	1.055	.0820	69.3	10.8	N.W.	18.00	.8	5	0	97	.02	....	.02	6
SUNDAY.......7	.....	14.8	1.4	13.4	......	......	......	....	.....	...	...	N.E.	5.04	..	......	..	98	....	....	...	7........SUNDAY
8	13.70	21.3	2.0	19.3	30.4502	30.646	30.260	.386	.0762	87.2	10.8	N.E.	7.71	8.0	10	0	04	....	2.5	.25	8
9	29.20	34.9	19.9	15.0	30.0225	30.209	29.782	.427	.1458	89.3	26.5	N.E.	6.58	10.0	10	10	00	.32	0.0	.32	9
10	35.57	39.8	32.0	7.8	29.5957	29.765	29.470	.295	.1975	94.7	34.3	S.W.	22.42	6.7	10	0	07	.27	....	.27	10
11	31.47	36.0	27.1	8.9	29.8967	30.006	29.834	.172	.1468	82.7	26.8	S.W.	22.67	2.5	7	0	88	....	0.0	.00	11
12	33.22	39.7	24.8	14.9	29.6137	29.978	29.377	.601	.1653	86.8	29.7	S.W.	22.25	7.8	10	0	06	.16	1.6	.32	12
13	11.97	21.0	5.5	15.5	30.1283	30.429	29.660	.769	.0597	78.8	6.0	W.	30.08	2.7	10	0	96	....	....	....	13
SUNDAY.......14	.....	29.0	5.2	23.8	......	.....	.....	....	....	....	....	N.E.	23.84	...	.		00	....	6.0	.50	14........SUNDAY
15	13.28	17.7	7.8	9.9	30.2373	30.380	30.047	.333	.0630	77.8	8.0	S.W.	28.50	0.0	0	0	98	....	....	....	15
16	7.92	13.5	1.1	12.4	30.5850	30.629	30.488	.141	.0468	77.0	1.8	W.	19.48	0.0	0	0	98	....	....	....	16
17	17.40	26.4	7.0	19.4	30.4258	30.553	30.286	.267	.0815	81.3	12.7	S.W.	16.16	4.0	10	0	35	....	0.0	.00	17
18	25.20	31.6	13.0	18.6	30.0225	30.243	29.830	.413	.1142	80.5	20.3	N.	8.54	8.0	10	0	26	....	....	....	18
19	34.33	39.0	31.0	8.0	29.7495	29.816	29.665	.151	.1817	91.3	32.0	S.	6.25	10.0	10	10	00	.04	....	.04	19
20	35.20	38.0	32.0	6.0	29.5607	29.587	29.547	.040	.1938	94.2	33.7	N.E.	15.83	10.0	10	10	00	.40	....	.40	20
SUNDAY.......21	.....	40.2	35.5	4.7	.....	.....	......	....	.....	....	...	S.W.	22.50	....	..	...	00	.03	....	.03	21........SUNDAY
22	37.48	42.0	34.0	8.0	29.8865	29.941	[illegible]	.112	.1860	82.8	32.8	S.W.	13.45	8.2	10	2	08	.00	....	.00	22
23	38.35	41.8	35.9	5.9	29.8410	29.892	29.756	.136	.1652	70.8	29.7	N.E.	7.92	9.7	10	5	28	...	....	....	23
24	31.70	33.5	29.8	3.7	29.3373	29.640	29.124	.516	.1640	91.7	29.8	N.E.	19.04	10.0	10	10	00	.04	3.9	.41	24
25	32.47	37.7	30.4	7.3	29.1923	29.350	29.076	.274	.1698	92.3	30.7	N.	11.54	10.0	10	10	00	.01	3.3	.34	25
26	31.73	37.1	26.6	10.5	29.5593	29.684	29.429	.255	.1517	84.3	27.8	N.W.	12.12	8.2	10	2	45	....	0.4	.04	26
27	33.23	38.1	30.4	7.7	29.8005	29.920	29.726	.194	.1398	73.7	26.0	W.	7.75	9.2	10	3	04	....	0.1	.01	27
SUNDAY.......28	.....	40.1	29.3	10.8	......	.....	.....	....	.....	....	...	N.W.	11.00	.	......		82	....	....	....	28........SUNDAY
29	36.73	42.0	30.5	[illegible]	30.2592	30.305	30.232	.073	.1290	58.0	23.7	S.W.	14.46	1.0	5	0	98	....	....	....	29
30	39.45	46.2	32.0	14.2	[illegible]	30.333	30.218	.115	.1113	45.3	20.5	N.W.	12.00	1.3	8	0	87	....	....	....	30
31	35.47	42.4	29.0	13.4	30.4010	30.470	30.352	.118	.1033	50.2	19.2	N.	18.29	0.2	1	0	96	....	....	....	31
Means	26.60	33.19	19.76	13.43	29.9922	30.1643	29.8030	.3613	.1237	80.08	21.03	S. 68¼° W.	15.58	6.01	8.3	2.3	41.61	1.80	23.7	4.05	....Sums.
23 Years means for and including this month	24.17	31.51	16.59	14.70	29.9682	......	......	.268	.1089	76.5	...	......	§17.88	6.0	...	..	¶46.4	1.03	23.6	3.41	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	1049	1646	268	797	847	4276	1410	1299	
Duration in hrs..	78	130	32	49	53	202	90	98	12
Mean velocity....	13.45	12.66	8.38	16.26	15.98	21.16	15.67	13.26	

Greatest mileage in one hour was 47 on the 6th.

Greatest velocity in gusts, 60 miles per hour on the 6th and 13th.

Resultant mileage, 3605.

Resultant direction, S. 68¼° W.

Total mileage, 11592.

*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.

& 11 years only.

The greatest heat was 46°2 on the 30th; the greatest cold was 9.°7 below zero on the 1st giving a range of temperature of 55.°9 degrees

Warmest day was the 30th. Coldest day was the 1st. Highest barometer reading was 30.857 on the 7th. Lowest barometer was 29.076 on the 25th, giving a range of 1,781 inches. Maximum relative humidity was 99.0 on the 8th and 12th.

Minimum relative humidity was 33 on the 30th.

Rain fell on 12 days.

Snow fell on 14 days.

Rain or snow fell on 20 days.

Auroras were observed on 2 nights, 4th and 25th.

Lunar coronas on the 13th, 15th, 16th 17th.

Fog on 3 days, the 1st, 19th, 22nd.

Earthquakes on 23rd and 27th.