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INCLUDING THE PROCEEDINGS OF

THE NATURAL HISTORY SOCIETY OF MONTREAL,

AND REPLACING

THE CANADIAN NATURALIST.

VOL. VII. (1896-1897.)

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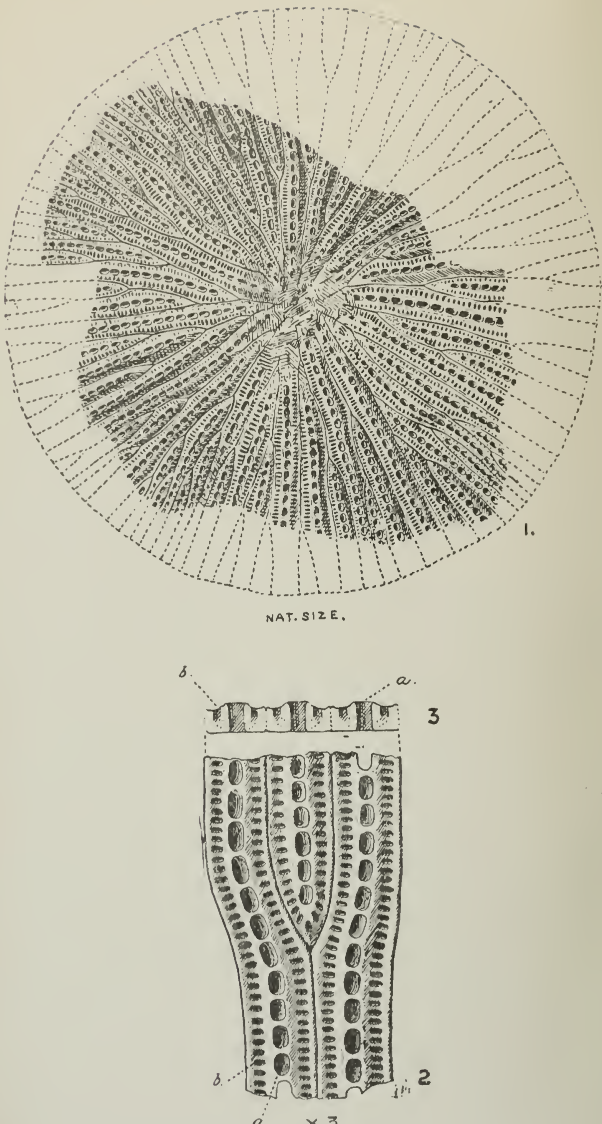

L. M. LAMBE, Del.

Astroporites Ottawaensis.

THE

CANADIAN RECORD

OF SCIENCE.

VOL. VII. JANUARY AND APRIL, 1896. Nos. 1 and 2.

Description of a supposed new genus of Polyzoa from the Trenton limestone at Ottawa.[1]

By Lawrence M. Lambe, F.G.S.

(With Plate I.)

Astroporites. (Gen. nov.)

Zoarium flat or slightly infundibuliform, circular, thin, composed of perforated and poriferous, closely connected segmentary divisions which radiate from a central point and are added to by the intercalation, at intervals, of new divisions as the distance from the nucleus increases.

Astroporites Ottawaensis. (Sp. nov.)

Zoarium forming a flat or slightly concave expansion about 80 mm. in diameter, 3 mm. thick near the centre and thinning toward the edge. It is divided radially into narrow divisions, from 3 to 4 mm. broad, which increase in breadth from their pointed proximal ends for a distance of about from 4 to 10 mm. and then remain of about the same breadth throughout their length. Fresh divisions are added by intercalation as they become necessary for the preservation of the disc-like form of the expansion.

[1] Communicated by permission of the Director of the Geological Survey of Canada.

Two keels extend the entire length of each division, and between them is a single row of perforations piercing the zoarium in a direction at right angles to the plane in which it lies; these perforations are circular, oval or oblong at the surface, from 0.5 to 1 mm. in diameter or length, and are separated by raised margins on a level with the keels. On either side of the elevated central portion of the divisions is a depressed marginal area occupied by a row of circular or oval pores which vary in diameter or length from 0.2 to nearly 1 mm., and when oval have the major axis at right angles to the direction of the divisions. From six to twelve perforations occur in a length of 1 cent, and from sixteen to forty pores in the same distance. In transverse sections the perforations are seen to extend through the thickness of the zoarium and to be of the same width throughout their length, but the pores after extending inward parallel to the direction of the perforations for a distance nearly equal to the thickness of the zoarium appear to enter the perforations from either side by an abrupt turn. The connection of the pores, however, with the perforations, if any, has not been ascertained with any degree of certainty.

The specimen figured was collected by the writer from the Trenton limestone at Hull, P.Q., near Ottawa, in 1890. It is calcareous and is preserved in a thin layer of black shale lying on a dark grey limestone. Only one side of the fossil has been seen, and at the centre of the disc the surface is abraded and the structure obliterated. At a later date Dr. H. M. Ami obtained a fossil, from the same locality, which is thought by the writer to belong to the same species; it does not show the details of structure preserved in the first mentioned specimen, but in it the thin edge of the organism is preserved showing the circular outline.

This organism appears to belong to the Polyzoa, but is different from any genus known to the writer, nor is he able to refer it without some hesitation to any particular family of this large and variable class, although in structure, it seems to approach most closely to the *Fenestellidæ*. The difficulty felt in referring it to any genus of the *Fenestellidæ* has compelled the writer to suggest a new genus for its reception in the hope that when fresh knowledge of its structure shall be obtained its position in the animal kingdom may be more clearly defined.

EXPLANATION OF PLATE I.

Fig. 1. View of a specimen of *Astroporites Ottawaensis* shewing the divergence of the divisions from the centre, the mode of intercalation of new divisions and the disposition of the openings of the pores and perforations at the surface. Natural size.

Fig. 2. Portions of three divisions showing the single rows of perforations and double rows of pores: three times the natural size.

Fig. 3. Cross section of the same divisions with the perforations (*a.*) and the pores (*b.*); the former pass through the zoarium, but the direction of the latter has not been ascertained with certainty. Enlarged three times.

NOTES UPON THE FLORA OF NEWFOUNDLAND.

By B. L. ROBINSON AND H. VON SCHRENK.

Perhaps no region of equal size and ease of access in temperate North America has received less botanical exploration than Newfoundland. This island, although 350 miles long and 130 miles in average breadth, embracing an area nearly as large as Ohio, is settled only on or very near the coast. The only inland town is Whitbourne; and this is almost within sight of salt water, being only seven miles from Trinity Bay. The vast uninhabited interior of the island is covered in great part by sombre forests of fir and spruce, interrupted at intervals by moors or boggy places, sterile rocky hills, or desolate "burns," and studded with lakes and ponds too numerous to find place upon maps. Indeed it has been stated that more than half the surface of Newfoundland is under fresh water. Although, through the activity of the Geological Survey, the topography of the interior is known in some detail, many parts have never been visited for scientific purposes; and it is said that the island has not been traversed at its widest part since an intrepid Scotchman named William Cormack crossed from Trinity Bay to St. George's Bay, in 1822, with a Micmac Indian. Cormack was a shrewd observer, and something of a botanist, and although exposed in his perilous journey to great and almost fatal hardships he managed to make a small collection of plants, which he sent to his friend Professor Jameson, of Edinburgh. A list of these plants, which has hitherto furnished almost the only information as to the interior flora of the island, was published by Cormack in an account of his journey.[1]

The others who have collected plants upon this island have, so far as can be learned, confined their attention to the vicinity of the coast, having been unable to penetrate far inland. It is said that John Fraser collected in Newfoundland in the years 1780 to 1784, but no list of his plants from the island appears to have been published, nor are his specimens cited in systematic works. In 1816 and 1819 Newfoundland was visited by La Pylaie, but his attention was largely devoted to the cryptogams, especially the algæ. Such of his phænogamic specimens as are preserved in the Gray Herbarium are not only

1 This interesting paper, issued doubtless in small edition, is very scarce. Realizing its historic value, Dr. M. Harvey, of St. John's, had it reprinted in 1873 from Cormack's original manuscript. Unfortunately, the reprint is also scarce, and in it there are many typographical errors—due, doubtless, to the crabbed and obscure handwriting from which it was set.

rather fragmentary, but are in most cases so immature as to indicate that he was too early for the proper collecting season. The island was also visited by Banks and by Lambert, a few of whose specimens are cited by DeCandolle in the *Prodromus*, and by Torrey and Gray in their *Flora*. In more recent times, a number of collections—mostly of small extent and covering a very limited range—have been made at different points upon the coast, the most noteworthy by Henry Reeks, John Bell, Rev. Arthur C. Waghorne, Dr. Morison, Miss Brenton, Dr. Roland Thaxter, and Dr. Robert Bell. Mr. Reeks spent two years upon the island, chiefly at Cow Head upon the west coast, and although suffering from ill health, and much of the time confined to his bed, prepared the most extensive list of flowering plants of the island yet issued. Unfortunately, his determinations, while doubtless correct in the main, were made without access to extensive literature, and confessedly often from too fragmentary specimens, and under too adverse circumstances, to inspire much confidence—especially as the specimens were not preserved and verification is now impossible. John Bell, who collected upon the west coast, also published a considerable list.[1] Dr. Robert Bell made a small collection of plants upon the south-east coast, and his specimens were carefully identified by Professor John Macoun.[2] The only resident botanist who has published to any extent upon the flora of Newfoundland is the Rev. Arthur C. Waghorne, who, in his missionary work, has travelled extensively along the coast of the island and in Labrador, thus having exceptional opportunities of collecting at many different points. Mr. Waghorne has published a list of the berries of Newfoundland, and has issued several lists of mosses and lichens without habitats. He is now preparing a catalogue of the flowering plants of Newfound-

[1] Canad. Nat., New Series, IV., 256-263; V., 54-61.

[2] Ann. Rep. Geol. Surv. Canada, I., 1885, 21DD-25DD.

land, Labrador, and the French Islands,[1] the first fascicle —including the Orders from the *Ranunculaceæ* to the *Leguminosæ*—having been already issued.[2] Besides these papers, Mr. Waghorne has published a number of popular articles in the daily journals of St. John's, chiefly upon the common plants of the islands.

The phænogamic flora of Newfoundland has been scarcely represented in the leading herbaria of Europe and America, and in none better than by fragmentary sets of Banks and La Pylaie. With a hope of securing a number of uniform sets for general distribution, to form a basis for a fuller and more accurate knowledge of the flora, the writers visited the island in the summer of 1894, spending there the last days of July and nearly the whole of August. While the time was much too limited to permit anything like thorough exploration of so extensive a territory, no less than seven localities were visited, and, with the exception of the mosses, larger fleshy fungi, and fresh-water algæ, practically all species of plants seen were secured, so that the collections—which in gross amounted to nearly 8,000 specimens—are without doubt representative of the general flora, even if far from being complete.

The first week was spent in collecting about St. John's, from which it was possible to visit, by short excursions, points differing much in exposure and moisture, and of corresponding diversity of vegetation. The tourist reaching St. John's is at once struck with the rugged scenery of the coast at this point. The deep harbour is shut in by precipitous rocky hills, from five to seven hundred feet in height, whose tops are too often buried in fog.

[1] The flora of the French Islands has been carefully studied and well recorded by Bachelot de la Pylaie—Flore de l'île de Terre-Neuve et des îles Saint Pierre et Miclon, 1829, and Ann. Sci. Nat., IV., 174-184. 1824; E. Bonnet—Flornle des îles Saint Pierre et Miquelon, 1888 (Jour. de Bot., I); and E. Delamere, F. Renauld. and J. Cardot—Flora Miquelonensis, 1888.

[2] Trans. Nova Scotian Inst. Sci., Ser. 2, I.

Although these hills from a distance appear very sterile, they prove much better collecting ground than could be anticipated. Exposed and storm-swept as they are, they have frequent little springy hollows, where, in dense mats of sphagnum, a considerable number of *carices, eriophora, junci,* and even the smaller orchids are to be found. Aside from these, the hill vegetation is largely composed of a variety of shrubs, of which the most abundant are *Alnus viridis, Viburnum pauciflorum, Cornus stolonifera,* and *Ribes prostratum*, together with a number of species of *Rubus* and *Vaccinium* as well as *Empetrum nigrum* and *Potentilla tridentata.*

Back of these exposed hills the country is more protected, and covered in part by forests of fir and spruce. Here the best collecting ground was found to be the rocky banks of small streams, which, in this part of Newfoundland, flow chiefly across strongly tilted strata, giving their beds and banks much irregularity—favouring the peculiar vegetation attracted by crevices of moist rocks near running water. One of these small water-courses, called Rennie's River, about twenty minutes walk from St. John's, was most frequently visited, and, beside many other species, furnished *Triodia decumbens, Nardus stricta,* and in a neighbouring pool the natant form of *Juncus supinus,* all of which are exceptional in their American occurrence.

The chief fresh-water vegetation of the region was secured at Quiddy-Viddy Lake, near the city. Perhaps the most noteworthy plant found there was *Ranunculus hederaceus,* which carpets considerable patches of the shores. Professor Britton queries whether it may not be indigenous here, which is very possible, although evidence for such a view is not easy to furnish, and it must be remembered that the occurrence is near a prominent port. Mr. Waghorne has collected the species also, at New Harbour, far up the east coast. Virginia Water, an attractive lake several miles away, was also visited, but was chiefly interesting for the surrounding moist and mossy woods, which furnished a number of lichens and fungi. Good specimens of the Newfoundland bog vegetation were secured at what is known as Bally Haily Bog, a rich peaty swamp but a mile or so from St. John's.

The city streets and roadsides furnished, of course, their quota of introduced weeds, which also have their individuality, as no two ports seem to attract just the same class of these undesirable immigrants. Among those of St. John's, perhaps the most notable seen was *Lamium incisum,* of which only a single specimen was found. So far as learned, this species has only once been accredited to America, namely, by Bentham, in DeCandolle's *Prodromus,* who speaks of its collection in Newfoundland by La Pylaie. That the single plant now secured should be a second introduction of this unusual immigrant to just the same part of the coast seems rather improbable, but it is also difficult to conceive of the species as having persisted in the same locality for eighty years without becoming more abundant.

On leaving St. John's the writers visited Manuels, on Conception Bay, collecting for some distance along the rocky Manuels River as well as in the adjacent clearings and marshy ground. Then, through the courtesy and cordial hospitality of Messrs. W. D. and H. D. Reid, contractors for the Newfoundland Northern and Western Railway, an opportunity was afforded to visit the end of this new line. The Newfoundland Northern Railway extends up the eastern coast for a distance of about two hundred and fifty miles from St. John's and then turns inland. At the time of our visit the headquarters of construction was at the confluence of the Exploits River and Badger Brook, between thirty and forty miles from the coast. The interior region thus gained, although considerably north of St. John's, possessed a richer and heavier vegetation, showing not only a milder climate but a deeper soil, and plants of the same species were in several cases found to be in a more advanced state than at the more southern stations on the coast.

In the Exploits Valley, so far as seen, there is an alternation of woodland and moist moors. The forests are chiefly of fir and spruce, with a moderate mixture of white pine and paper birch, most of the trees being of moderate or small size. This region proved to have a flora almost identical with that of Northern New England; indeed the only plants which suggested a more boreal climate were the attractive little *Betula nana*, var. *flabellifolia,* and *Thalictrum alpinum.* The question which at once presents itself is, why such a region is entirely unused when portions of Canada of much higher latitude and similar native flora have been successfully cultivated. From a botanical standpoint the vegetation presented but little novelty, perhaps the most interesting finds being the terrestrial state of *Subularia aquatica, Litorella lacustris,* and *Carex miliaris,* with its var. (?) *aurea,* which, as now secured in mature fruit, appears specifically distinct.

The remainder of the time upon the island was divided between Whitbourne, Holyrood, Placentia, and Salmonier, in different parts of the peninsula Avalon, each place possessing a certain individuality of vegetation. In a small sphagnum bog near Holyrood a rare and poorly understood *Bartonia* (*Centaurella Moseri*, Steud. & Hochst., at least in part) was found. Few phænogams could be more inconspicuous than this, with its naked filiform stem, and one to five small pinkish-white flowers, just the colour of the surrounding sphagnum. It required nearly an hour's searching upon hands and knees to secure the desired sixty or eighty plants.

The maritime vegetation of the eastern part of the island appears to be very scanty. Although a considerable extent of coast was visited at various points, only two distinctly maritime phænogams were found, namely, *Plantago maritima* and *Ligusticum Scoticum.* This noteworthy paucity of shore vegetation is doubtless due to the generally precipitous coast. The only beaches visited (at Manuels and Placentia) were composed of coarse pebbles, and entirely sterile.

The following is a list of the phænogams and vascular cryptogams secured on the island. The plan of collection was to take all indigenous and noteworthy introduced plants in considerable quantity for some twenty sets, and these plants were regularly numbered. The commoner introduced plants were taken in small quantity, merely to show distribution, and, as well as some of the rarer plants not found in sufficient quantity to be incorporated in the regular sets, were not numbered.

Most of the plants have been determined by the staff of the Gray Herbarium, but several specialists have most obligingly rendered important assistance in their particular groups: Prof. Franz Buchenau and Mr. F. V. Coville in the *Junci;* Prof. L. H. Bailey in the *Carices;* and Prof. Lamson-Scribner in the *Gramineæ.* The cellular cryptogams have not as yet been fully determined, and cannot be included in this list.

Species and varieties marked with an asterisk appear not to have been hitherto recorded from Newfoundland, although several of them have been discovered upon the French Islands, St. Pierre and Miquelon. Plants from the Exploits River were collected within ten miles of the mouth of Badger Brook, a considerable tributary from the north.

Aconitum napellus, L. Borders of fields, St. John's; not abundant.

Coptis trifolia, Salisb. Common in fir woods, Whitbourne (27).

RANUNCULUS ACRIS, L. Abundant about St. John's, but occurring only on roadsides and in pastures, as though introduced there as elsewhere in America. Nothing was seen to confirm Dr. Gray's supposition that this species might be indigenous in Newfoundland.

*R. AQUATILIS, var. TRICHOPHYLLUS, Gray. In Quiddy-Viddy Lake and Exploits River.

*R. FLAMMULA, var. INTERMEDIUS, Hook. Abundant about St. John's, in moist meadows and upon the shores of Quiddy-Viddy Lake (30). More slender forms, with narrower leaves, were occasionally detected, showing transitions to the following:—

R. FLAMMULA, var. REPTANS, E. Meyer. Abundant upon the rocky banks of Rennie's River (50).

R. REPENS, L. Moist ground, Placentia (238, distributed as *R. Macounii*), also near Salmonier.

THALICTRUM ALPINUM, L. Moor near Exploits River.

T. POLYGAMUM, Muhl. St. John's (187), Colinet, Exploits River.

*NUPHAR ADVENA, var. MINUS, Morong. Whitbourne.

*NYMPHÆA ODORATA, var. MINOR, Sims. Whitbourne (114).

SARRACENIA PURPUREA, L. Whitbourne (64). The more slender green state was found on the Exploits River.

FUMARIA OFFICINALIS, L. Ploughed ground, St. John's.

CAPSELLA BURSA-PASTORIS, Mœnch. St. John's.

CARDAMINE PENNSYLVANICA, Muhl. Whitbourne; appearing introduced.

ERYSIMUM CHEIRANTHOIDES, L. St. John's (228).

*HESPERIS MATRONALIS, L. Streets of St. John's; infrequent.

NASTURTIUM OFFICINALE, R. Br. Brooksides, St. John's.

*N. TERRESTRE, R. Br. Exploits River.

*N. SYLVESTRE, R. Br. St. John's.

Raphanus Raphinastrum, L. Fields near Quiddy-Viddy.

Senebiera pinnatifida, DC. Streets of St. John's; abundant.

*Subularia aquatica, L. The terrestrial form; Exploits River (7), and around a pond near Whitbourne.

Viola blanda, Willd. Rocky banks of Rennie's River (189).

V. palmata, var. cucullata, Gray. St. John's (188), and on Exploits River.

*V. tricolor, var. arvensis, DC. Rocky hills near the harbour, St. John's.

Arenaria lateriflora, L. Bottom lands of the Salmonier River.

Cerastium vulgatum, L. St. John's.

Sagina procumbens, L. Apetalous form; abundant in low meadows, St. John's (218).

Spergula arvensis, L. Fields, St. John's; common.

*Spergularia rubra, Presl. St. John's.

Stellaria graminea, L. Borders of fields, St. John's.

S. longifolia, Muhl. Grassy bottom lands of Salmonier River.

S. media, Cyril. St. John's.

*S. uliginosa, Murr. Moist shaded cliffs, Placentia (33).

Montia fontana, L. Ditches, Holyrood (48).

Elodes campanulata, Pursh. Bally Haily Bog (149).

Hypericum Canadense, L. St. John's (185).

H. mutilum, L. St. John's (186).

*Malva rotundifolia, L. St. John's.

*Geranium Carolinianum, L. Railway ballast near Placentia Junction.

Impatiens fulva, Nutt. Whitbourne.

Nemapanthes fascicularis, Raf. Along the banks of Badger Brook (83).

Acer rubrum, L. Exploits River.

A. spicatum, Lam. Rocky banks, Manuels River.

Medicago lupulina, L. Roadsides, St. John's.

Pisum sp. (indeterminate state). Exploits River; probably introduced by lumbermen or campers.

*Trifolium hybridum, L. Whitbourne and Virginia Water; frequent.

T. pratense, L. Whitbourne.

T. repens, L. St. John's, Whitbourne, etc.

Viccia Cracca, L. Borders of fields, St. John's.

V. sativa, L. Cultivated fields, St. John's; infrequent.

Amelanchier Canadensis, Medic. In two forms, growing together, in woods, St. John's:—

(1) Nearly typical; tall shrub, with leaves oblong, short-acuminate, rounded at base; fruits three or four together, in loose naked raceme, small, red (53).

(2) Arborescent shrub, fifteen feet high; leaves large and subcuneate at base; fruits axillary and solitary, or terminal in pairs, larger, greenish (237). The latter form does not fall satisfactorily in any of the described varieties.

Fragaria vesca, L. Manuels and Holyrood.

Geum rivale, L. Woods near Salmonier (80) and Exploits Rivers.

Potentilla Anserina, L. Placentia (42).

P. fruticosa, L. Manuels (20).

P. Norvegica, L. Railway ballast, Whitbourne (84).

P. tridentata, Ait. Rocky hills, St. John's; common (23).

Poterium Canadense, Benth. & Hook. Along Manuels (25) and Exploits Rivers.

Prunus Pennsylvanica, L. f. Salmonier River (74).

P. Virginiana, L. Salmonier River (75).

Pyrus arbutifolia, L. f. Rocky hills, Quiddy-Viddy (51), and on Exploits River.

*P. sambucifolia, Cham. & Schlecht. Whitbourne.

*Rosa humilis, Marsh. St. John's.

R. nitida, Willd. St. John's.

Rubus Canadensis, L. Whitbourne (235).

R. Chamæmorus, L. Whitbourne, etc.

R. strigosus, Michx. Very abundant, especially on recently burned land, said to be the first growth after forest fires. Whitbourne (66).

R. strigosus, var. caudatus, n. var. Leaves more divided; leaflets narrow, lanceolate, caudate-attenuate; those of the sterile shoots cleft nearly or quite to the base. Rocky hills south of harbour, St. John's, August 1.

R. triflorus, Richards. Along Manuels and Exploïts Rivers.

Spiræa salicifolia, L. Abundant about St. John's (22).

Mitella nuda, L. Exploits River.

Ribes prostratum, l'Her. Rocky hills, St. John's (113).

Drosera rotundifolia, L. Quiddy-Viddy (144).

*D. intermedia, var. Americana, DC. Sphagnum bogs, Manuels (145) and Exploits Rivers.

*Callitriche verna, L. Muddy shores of Quiddy-Viddy Lake (229).

*C. heterophylla, Pursh. Whitbourne (215) and Exploits River.

Hippuris vulgaris, L. Exploits River (119).

*Myriophyllum alterniflorum, DC. Whitbourne (169.)

M. tenellum, Bigel. Quiddy-Viddy Lake (16). There is scarcely a doubt that this is the *M. denudatum* which

La Pylaie mentions, without any proper description, in Ann. Sci. Nat., Ser. 1, IV., 176.

CIRCÆA ALPINA, L. Manuels (6).

*EPILOBIUM ADENOCAULON, Haussk. Near streams, St. John's (195) and Holyrood.

E. ANGUSTIFOLIUM, L. Burned regions, etc.; abundant; St. John's (143).

E. PALUSTRE, L. St. John's.

*E. PALUSTRE, forma LABRADORICA, Haussk. Moist places on rocky hills, St. John's (194).

ARCHANGELICA ATROPURPUREA, Hoffm. Exploits River.

*CARUM CARUI, L. Chance escape, St. John's.

*CONIOSELINUM CANADENSE, Torr. & Gray. Exploits River; infrequent.

LIGUSTICUM SCOTICUM, L. Cliffs of Placentia Bay.

SANICULA MARILANDICA, L. Exploits River.

*SIUM CICUTÆFOLIUM, Gmelin. Whitbourne.

ARALIA HISPIDA, Vent. Frequent about Manuels and on barrens near Exploits River (183).

A. NUDICAULIS, L. Rocky hills, St. John's.

CORNUS CANADENSIS, L. Very common, St. John's, Whitbourne (49), and Salmonier, showing great variability in foliage, especially in woodland forms, which differ greatly in the number and arrangement of the leaves, the sterile shoots being often branched and having opposite, not whorled, leaves upon the branches. A striking anomalous form was seen several times in which a second whorl of leaves formed above the main whorl was connate in a cup.

C. STOLONIFERA, Michx. Common, and widely distributed upon the island; St. John's (217).

DIERVILLA TRIFIDA, Moench. St. John's (10); common.

LINNÆA BOREALIS, L. St. John's (55).

Lonicera cærulea, L. Whitbourne (11).

Viburnum cassinoides, L. St. John's (191); very abundant.

V. Opulus, L. Exploits River; much less frequent than the other species.

V. pauciflorum, La Pylaie. Common about St. John's, Manuels (192), etc. The fruit is collected and made into an excellent preserve under the name of "squash-berry," a designation said to allude to the flat seeds, which are thought to resemble those of the squash.

Galium asprellum, Michx. Whitbourne (179).

*G. Mollugo, L. Ploughed ground, St. John's (38).

*G. trifidum, var. latifolium, Torr. Open woods, St. John's (214).

*G. trifidum, var. pusillum, Gray. Sunny banks of lake, Whitbourne (213).

*G. triflorum, Michx. Exploits River (32).

Achillea Millefolium, L. St. John's.

Anaphalis margaritacea, Benth. & Hook. St. John's and Holyrood; especially abundant in burned ground.

Antennaria plantaginifolia, Hook. Holyrood.

*Anthemis Cotula, DC. Clode's Sound.

*Arctium Lappa, L. In leaf only, but probably var. minus. Holyrood.

Aster nemoralis, Ait. St. John's (177).

A. Novi-Belgii, L. Exploits River.

A. puniceus, L. River banks; common; Salmonier (73).

A. radula, Ait. Salmonier and Manuels Rivers (175). Forms passing into the following were collected near St. John's:—

A. Radula, var. strictus, Gray. Exploits River (176).

A. umbellatus, Mill. Common, especially along streams; Manuels, Holyrood (54).

CENTAUREA NIGRA, L. Fields, St. John's.

CHRYSANTHEMUM LEUCANTHEMUM, L. Common; St. John's.

*CICHORIUM INTYBUS, L. St. John's; infrequent.

CNICUS ARVENSIS, L. St. John's.

*C. LANCEOLATUS, L. Recent clearings, Manuels.

C. MUTICUS, Pursh. Marshy ground, Exploits River (69).

EUPATORIUM PURPUREUM, L. Salmonier River (40). A form passing to var. AMŒNUM, Gray, was collected on the Manuels River.

GNAPHALIUM ULIGINOSUM, L. In the slender uliginous form in marshy meadows near Quiddy-Viddy Lake (181) and in the bushy branched form very abundant in burned regions, Holyrood (108).

HERACLEUM LANATUM, Michx. Banks of the Salmonier River.

*HIERACIUM CANADENSE, Michx. Rocky river banks, Manuels, etc. (173).

*H. VULGATUM, Fries. Less frequent than the preceding, and occurring in crevices of rocks by swift streams and waterfalls; Holyrood, and the cataracts of the Rocky River (227). To all appearances indigenous. The leaves are nearly always mottled.

LEONTODON AUTUMNALIS, L. St. John's; a common weed.

MATRICARIA INODORA, L. Only on rubbish heaps, St. John's.

*PRENANTHES SERPENTARIA, var. NANA, Gray. St. John's (47) and Holyrood. Six inches to $2\frac{1}{2}$ feet high.

*RUDBECKIA HIRTA, L. Fields, Holyrood (178) and St. John's; not yet abundant.

SENECIO AUREUS, L. Salmonier, and near Placentia Junction.

S. AUREUS, var. BALSAMITÆ, Torr. & Gray. Exploits River and Holyrood.

*S. JACOBÆA, L. Roadsides, St. John's. Noticed to be very abundant in Northern Nova Scotia.

*S. SYLVATICUS, L. Railway ballast, Whitbourne; abundant.

S. VULGARIS, L. St. John's.

*SOLIDAGO MACROPHYLLA, Pursh. St. John's (52).

*S. RUGOSA, Mill. Holyrood (172). A smoothish form was collected in open wood near St. John's.

S. TERRÆ-NOVÆ, Torr. & Gray. Whitbourne. Clearly a more corymbosely branched form of *S. uliginosa*, toward which intergradations were found near the Exploits River.

S. ULIGINOSA, Nutt. Exploits River (210), etc.

SONCHUS ARVENSIS, L. Gravel banks in Salmonier River (164). Exclusively with native plants, as if indigenous.

S. OLERACEUS, L. Fields, Placentia.

TARAXACUM OFFICINALE, Weber. St. John's, etc.

CAMPANULA ROTUNDIFOLIA, L. Cliffs on the north side of the harbour, St. John's (71).

LOBELIA DORTMANNA, L. Quiddy-Viddy Lake (56).

ANDROMEDA POLIFOLIA, L. Exploits River and near Whitbourne (8).

CASSANDRA CALYCULATA, Don. Low, peaty ground, St. John's (58), and Exploits River.

CHIOGENES SERPYLLIFOLIA, Salisb. Moist places upon rocky hillsides, abundant; St. John's (28), etc. The fruit, under the name of "capillaire-berry," is collected in sufficient quantity to make a preserve, which is justly esteemed a special delicacy. It is said that the crops of this, to us, rare berry vary much, being often good and poor in alternate seasons. The reason assigned was, the difficulty of picking the fruit without tearing and injuring the plants, which require a year or so to recover from the rough treatment.

Gaylussacia dumosa, Torr. & Gray. Whitbourne (201).

Kalmia angustifolia, L. St. John's (41); common.

K. glauca, Ait. St. John's (9), Whitbourne, etc.; common.

Ledum latifolium, Ait. St. John's (13).

Moneses grandiflora, Salisb. Whitbourne; rare.

Monotropa Hypopitys, L. Fir woods near Exploits River.

M. uniflora, L. Virginia Water. In woods near the Exploits River a small form was found, which, although agreeing as to anthers and stigma with *M. uniflora*, had flowers in size just intermediate between this and *M. Hypopitys.* In drying, also, these plants have assumed an intermediate color between the black of the former species and the tawny color of the latter.

Pyrola chlorantha, Swartz. St. John's.

P. rotundifolia, L. Manuels.

P. secunda, L. Near St. John's (37).

Rhododendron Rhodora, Don. St. John's (14) and Exploits River; abundant.

Vaccinium Oxycoccus, L. St. John's (12).

V. Pennsylvanicum, Lam. Very abundant, especially upon burned tracts.

V. Pennsylvanicum, var. angustifolium, Gray. Rocky hills, Placentia; infrequent.

V. uliginosum, L. St. John's and Holyrood; less plentiful than the other species.

V. Vitis-Idæa, L. Exposed hills, abundant, St. John's (15), etc.; locally called "partridge-berry."

Lysimachia stricta, Ait. Whitbourne (118).

TRIENTALIS AMERICANA, Pursh. St. John's (17).

*APOCYNUM ANDROSÆMIFOLIUM, L. Exploits River (96).

BARTONIA, SP. (*Centaurella Moseri*, Steud. & Hochst., acc. to Griseb., in DC. Prodr. ix. 121.) A plant which appears to represent, at least in part, this rare and poorly understood species, was discovered in a small bog near Holyrood (5). The species was first described from specimens collected by Moser at Salzburg, Pa., and Drummond at Covington, La. In his treatment of the genus in DeCandolle's Prodromus, however, Grisebach includes in it, with the mark of affirmation, a specimen collected by La Pylaie in Newfoundland. As the present plant agrees with Grisebach's description as regards alternate leaf-scales and in having the corolla twice as long as the calyx, there can be little doubt that it is the plant of La Pylaie. It is, however, of lower growth, less branched, and less numerously flowered than Drummond's specimen—differences perhaps wholly due to the climate. The flowers, also, are mostly larger and solitary, on peduncles which are often 6 to 9 lines long. From *B. tenella*, the Newfoundland plant differs in its alternate leaf-scales, loose few-flowered raceme, and relatively larger corolla, which in the fresh state is pinkish; also in its purplish anthers. More perfect material of the United States form of *Centaurella Moseri* is much to be desired.

HALENIA DEFLEXA, var. BRENTONIANA, Gray. Hillsides and pastures, St. John's (180).

MENYANTHES TRIFOLIATA, L. Pools near Exploits River.

*MYOSOTIS ARVENSIS, Hoffm. St. John's (203); appearing as if introduced.

M. LAXA, Lehm. Manuels.

SYMPHYTUM OFFICINALE, L. St. John's.

*SOLANUM DULCAMARA, L. St. John's.

Chelone glabra, L. Whitbourne (211) and Exploits River.

Euphrasia officinalis, L. St. John's (102).

*Limosella aquatica, var. tenuifolia, Hoffm. (?) Sterile, and accordingly doubtful, specimens collected upon precipitous cliffs of Placentia Harbour.

*Linaria striata, DC. St. John's, on Rennie's River, but near waste heaps; doubtless a waif.

*L. vulgaris, Mill. St. John's.

*Pedicularis palustris, L. Moist meadow, St. John's (82). The typical form of this does not appear to have been heretofore recorded in America. It differs from the var. Wlassoviana, Bunge (generally distributed in British America), conspicuously in the form of the corolla, and has also been collected in Labrador by Mr. J. A. Allen.

Rhinanthus Crista-Galli, L. St. John's (101) and Exploits River.

*Veronica agrestis, L. St. John's (151).

*V. officinalis, L. St. John's.

V. scutellata, L. Whitbourne (95).

Utricularia cornuta, Michx. Whitbourne (90) and Exploits River.

U. intermedia, Hayne. Brooks, Placentia (19).

U. vulgaris, L. Whitbourne and Exploits River.

Brunella vulgaris, L. Common; Salmonier River (72).

*Calamintha linopodium, Benth. Rich bottoms, Salmonier River (91).

Galeopsis tetrahit, L. St. John's (104).

*Lamicum amplexicaule, L. Ploughed ground, St. John's.

L. incisum, Willd. St. John's; a single specimen by roadside.

*Lycopus sinuatus, Ell. Gravel beds, Salmonier River (106).

L. Virginicus, L. Rennie's River (105).

*Mentha arvensis, L. Manuels (230); common along streams.

Nepeta Glechoma, Benth. St. John's.

Scutellaria galericulata, L. Manuels (103).

Stachys palustris, L. St. John's.

*Litorella lacustris, L. Exploits River (1).

Plantago lanceolata, L. St. John's.

P. major, L. St. John's.

P. maritima, L. Placentia (70).

Atriplex patulum, var. hastatum, Gray. St. John's.

Chenopodium album, L. St. John's.

Polygonum aviculare, L. St. John's.

*P. Convolvulus, L. Whitbourne.

P. Hydropiper, L. Whitbourne (36).

*P. lapathifolium, L. Near Quiddy-Viddy Lake.

*P. Persicaria, L. St. John's.

P. sagittatum, L. Gravel beds, Salmonier River (92) and St. John's.

Rumex acetosa. L. St. John's.

R. Acetosella, L. St. John's.

*R. Britannica, L. Whitbourne.

Comandra livida, Richards. Dry woods, St. John's (152), and Exploits River.

Urtica dioica, L. St. John's.

U. urens, L. Quiddy-Viddy.

Myrica Gale, L. St. John's (29).

Alnus incana, Willd. Exploits River (35).

A. viridis, DC. St. John's (24); abundant.

*Betula nana, var. flabellifolia, Hook. Moors near Exploits River (3).

B. PAPYRIFERA, Marshall. Manuels (139) and Exploits Rivers.

B. PUMILA, L. Moors near Exploits River (2).

[QUERCUS PEDUNCULATA, L. Cultivated near St. John's. Trees a foot in diameter, and evidently sixty or eighty years old, are interesting, as showing that the climate is not too severe for the genus, although it is entirely unrepresented in the native flora.]

POPULUS TREMULOIDES, Michx. Virginia Water, near St. John's.

*SALIX BALSAMIFERA, Barratt. Virginia Water (140).

*S. HUMILIS × DISCOLOR, Bebb. Manuels River.

S. LUCIDA, Muhl. Exploits River.

EMPETRUM NIGRUM, L. Abundant on rocky hills, St. John's (150).

COROLLORHIZA MULTIFLORA, Nutt. Deep mossy woods, Salmonier River.

CYPRIPEDIUM ACAULE, Ait. Near St. John's.

*GOODYERA REPENS, R. Br. Woods, Whitbourne and Salmonier.

HABENARIA BLEPHARIGLOTTIS, Torr. Holyrood (111).

H. DILATATA, Gray. Exploits River (110), Holyrood, Manuels, etc.; common.

*H. FIMBRIATA, R. Br. Exploits River.

*H. LACERA, R. Br. Holyrood.

H. OBTUSATA, Rich. Whitbourne.

H. ORBICULATA, Torr. Moist woods, Whitbourne. An unusually large-flowered form, the same as collected by Robbins on Lake Superior, but appearing to pass insensibly into smaller-flowered forms.

H. PSYCHODES, Gray. Wet meadows, Placentia (165), and on Manuels River.

H. TRIDENTATA, Hook. Manuels (167).

Listera cordata, R. Br. Whitbourne (168) and Exploits River.

Microstylis ophioglossoides. Nutt. Manuels (68).

Pogonia ophioglossoides, Nutt. Manuels and Whitbourne (166).

Spiranthes Romanzoffiana, Cham. Holyrood (128), Exploits River, etc.: common.

Iris versicolor, L. St. John's.

Sisyrinchium anceps, Cav. Salmonier River.

*S. angustifolium, Mill. With the last, and not satisfactorily distinguishable from it. Doubtless Dr. Morong was quite right in uniting them as *S. Bermudiana*, L.

Clintonia borealis, Raf. Virginia Water (45) and Exploits River.

Maianthemum Canadense, Desf. St. John's (62), etc.

Smilacina trifolia, Desf. Whitbourne (44).

Streptopus amplexifolius, DC. Manuels River; infrequent.

*Tofieldia glutinosa, Willd. Holyrood (39).

*Xyris flexuosa, var. pusilla, Gray. Holyrood (153).

*Luzula campestris, var. multiflora, Celakovsky. Whitbourne (86) and Placentia, also in more exposed places upon rocky hills about St. John's (85) a smaller form with darker flowers (distributed as *L arcuata*, Mey).

Juncus articulata, L. St. John's (163).

J. Balticus, var. littoralis, Engelm. Placentia (142).

J. bufonius, L. St. John's; in two forms, one slender and erect, 6 to 8 inches high (160); the other spreading and more flexuous, 3 to 4 inches high (161).

J. Canadensis, J. Gay. Whitbourne and Holyrood.

J. Canadensis, var. coarctatus, Engelm. St. John's (162).

*J. EFFUSUS, in colour approaching var. BRUNNEUS, Engelm. Placentia. The true var. *brunneus* is of the far west.

*J. EFFUSUS, probably of the formal var. COMPACTUS, Lej. et Courtois (132); distributed as var. *conglomeratus.*

*J. EFFUSUS × LEERSII. Bottom lands of the Salmonier River (131). distributed as *J. effusus.*

*J. FILIFORMIS, L. Shores of Quiddy-Viddy Lake (138) and Exploits River.

*J. LEERSII, Marsson. Near the railway track, Whitbourne (133), and north of Placentia Junction. Hitherto known in America only from doubtful specimens collected in Pennsylvania by Sartwell (see Buchenau Monog. Juncac. 234).

J. PELOCARPUS, E. Mey. St. John's (141).

J. STYGIUS, var. AMERICANUS, Buchenau. Marshes, Holyrood.

*J. SUPINUS, Moench. Near St. John's, in two very different forms: one reddish, and with elongated stems, floating in shaded pools, near Rennie's River (234); the other, green, sub-erect, 2 to 4 inches high, growing upon muddy banks of small streams; heads viviparous (233). The occurrence of this species in America has until recently rested exclusively upon immature and doubtful specimens collected in Newfoundland by La Pylaie. Through Mr. Coville we learn that it was re-discovered some time ago by Mr. Waghorne.

J. TENUIS, Willd. Beaten paths, Virginia Water (130).

J. TRIFIDUS, L. Crevices of precipitous rocks, Helmet Mt., Holyrood (158).

SAGITTARIA GRAMINEA, Michx. Whitbourne; rare.

*SPARGANIUM SIMPLEX, var. ANDROCLADUM, Engelm. Virginia Water (200).

*POTAMOGETON HETEROPHYLLUS, Schreb. Whitbourne (231).

*P. HETEROPHYLLUS, var. GRAMINIFOLIUS, Wats. & Coult. Exploits River (232).

*P. PENNSYLVANICUS, Cham. Exploits River.

*P. PERFOLIATUS, L. Holyrood (207).

ERIOCAULON SEPTANGULARE, Withering. Quiddy-Viddy Lake (112) and Exploits River.

*CAREX ADUSTA, Boott. North of Placentia Junction, on railway ballast (93).

*C. RAEANA, Boott. (*C. miliaris*, var. *aurea*, Bailey.) Marshy ground by the Exploits River (236). Abundant fruiting material of this attractive sedge leaves no doubt of its distinctness from *C. miliaris*, and makes it more than probable that it represents the true *C. Raeana*, apparently a good species. Before its affinities were thoroughly traced it was distributed as *C. Baileyi*. The same plant has been collected in Maine by Prof. Porter and by Mr. Fernald, and is said to extend westward to North Michigan.

C. CANESCENS, var. VULGARIS, Bailey. St. John's (124).

C. CRINITA, var. GYNANDRA, Schweinitz & Torr. Manuels River (99) and St. John's.

*C. DEBILIS, var. RUDGEI, Bailey. St. John's (122).

C. EXILIS, Dew. Holyrood.

*C. FŒNEA, Willd. A peculiar form, resembling the *C. festiva*, Dew, at least appearing identical with specimens from Greenland generally referred to that species.

*C. FLAVA, var. GRAMINIS, Bailey. Rocky banks, Manuels River (98).

*C. FLAVA, var. VIRIDULA, Bailey. Rennie's River (97), Holyrood, and Exploits River.

C. FOLLICULATA, L. St. John's (76).

C. INTUMESCENS, Rudge. Between Placentia and Colinet (79).

*C. LAXIFLORA, var. VARIANS, Bailey. Exploits River.

*C. LIVIDA, Willd. Holyrood.

C. MAGELLANICA, Lam. Frequent in sphagnum, St. John's (88).

C. MICHAUXIANA, Bœckl. St. John's (78) and Exploits River.

*C. MILIARIS, Michx. Exploits River (87).

*C. OLIGOSPERMA, Michx. Exploits River (77) and Holyrood.

C. PAUCIFLORA, Lightf. Whitbourne.

C. POLYTRICHOIDES, Muhl. St. John's (89).

*C. RIGIDA, var. GOODENOVII, Bailey. St. John's (123).

C. SCOPARIA, Schkuhr. Whitbourne (94) and near Shoals Harbour.

C. STERILIS, Willd. Rennie's River, near St. John's (125).

*C. STERILIS, var. CEPHALANTHA, Bailey. Marsh near Exploits River.

C. STIPATA, Muhl. Rennie's River, St. John's (81), and Salmonier River.

*C. TRISPERMA, Dew. Virginia Water (100).

*C. UTRICULATA, Boott. Whitbourne (120), St. John's, and Exploits River.

*C. UTRICULATA, var. MINOR, Boott. Bally Haily Bog, St. John's (182), and Exploits River.

*DULICHIUM SPATHACEUM, Pers. Exploits River (46).

*ELEOCHARIS ACICULARIS, R. Br. Shores of Quiddy-Viddy Lake (126).

*E. PALUSTRIS, var. VIGENS, Bailey. Whitbourne (121).

E. TENUIS, Schultes. St. John's (127).

*ERIOPHORUM ALPINUM, L. Bluffs of Manuels River (59).

E. CYPERINUM, L. St. John's (65).

E. GRACILE, Koch. St. John's (60).

E. VAGINATUM, L. Bally Haily Bog, St. John's (117).

E. Virginicum, L. Holyrood (61). In the same locality *E. polystachyon*, L., was seen, but through oversight was not collected.

Rhynchospora alba, Vahl. Manuels (116).

R. fusca, Roem. & Sch. Holyrood (171).

*Scirpus cæspitosus, L. Bally Haily Bog, St. John's (115).

*S. subterminalis, Torr. Exploits River (208).

Agropyrum repens, Beauv. St. John's.

*Agrostis alba, var. sylvatica, Scribner. Field, St. John's.

A. alba, var. vulgaris, Thurb. Whitbourne; in two forms, differing in breadth of leaves.

A. scabra, Willd. Exploits River (220).

Alopecurus geniculatus, L. St. John's (154).

A. pratensis, L. St. John's.

Anthoxanthum odoratum, L. Fir woods, St. John's.

*Brachyelytrum aristatum, Beauv. Exploits River (197).

Bromus ciliatus, L. Manuels and Exploits Rivers.

Calamagrostis Canadensis, Beauv. St. John's (204).

*C. Pickeringii, Gray. Exploits River (205).

Cinna pendula, Trin. Placentia.

Danthonia spicata, Beauv. Quiddy-Viddy (199) and Exploits Rivers.

Deschampsia flexuosa, Trin. St. John's (198).

*Festuca elator, L. Whitbourne.

*F. rubra, L. Placentia (226).

Glyceria Canadensis, L. St. John's (155).

*G. fluitans, R. Br. St. John's (221).

*G. LAXA, Scribner. Whitbourne.

*G. NERVATA, Trin. Shoals Harbour (156), as if introduced.

*HOLCUS LANATUS, L. Whitbourne; rare.

*LOLIUM ITALICUM, A. Br. Introduced about railway station Clode's Sound; distributed as *L. temulentum.*

*MUHLENBERGIA GLOMERATA, Trin. Exploits River (196).

NARDUS STRICTA, L. Well established upon rocky banks of Rennie's River (209). Although forming a turf with native grasses and sedges, the specimens were too near the city of St. John's to argue strongly for an indigenous character. The species, however, is native in Greenland, and might not improbably extend down the north-eastern coast of America. We have been able to find only one previous record of the occurrence of this grass in America, that being by Prof. Edw. Tuckerman, who reported it as present in his lawn in Massachusetts—doubtless introduced in foreign grass-seed.

PANICUM BOREALE, Nash. (Bull. Torr. Club, xxii. 421.). Exploits River (222); distributed as a small-flowered variety of *P. commutatum.*

PHLEUM PRATENSE, L. Cultivated, and often escaping upon roadsides, St. John's.

POA ANNUA, L. St. John's.

P. COMPRESSA, L. On railway ballast, Placentia Junction (225) and Whitbourne.

P. PRATENSIS, L. St. John's (219). With this number a small quantity of another species of *Poa* was inadvertently distributed. It had larger spikelets and white-margined glumes, and is undoubtedly new to the island. Unfortunately, the material is too scanty to permit a satisfactory determination.

P. SEROTINA, Ehrh. Slender, shaded form, in woods, St. John's (224); also a more robust form in dry open ground, Whitbourne (223), and near Northern Bight.

*SPOROBOLUS SEROTINUS, Gray. Exploits River.

*TRIODIA DECUMBENS, Beauv. Rocky banks of Rennie's River (206). A grass not, to our knowledge, heretofore reported from America. Well established, and forming a turf with native grasses.

ABIES BALSAMEA, Mill. Common about St. John's, etc.

JUNIPERUS COMMUNIS, L. (Nearly typical). Rocky hills, Quiddy-Viddy, with, and less frequent than, the following:—

*J. COMMUNIS, var. ALPINA, Gaud. Quiddy-Viddy (67).

J. SABINA, var. PROCUMBENS, Pursh. Marshy moors, Exploits River (34).

LARIX AMERICANA, Michx. St. John's (157).

PICEA ALBA, Link. St. John's. The collection of *P. nigra*, Link, and its var. *rubra*, Engelm., was deferred, and finally, through shortness of time, neglected, so that they can only be reported upon the accuracy of field determinations.

PINUS STROBUS, L. Exploits River, common, and of considerable size; also on the peninsula of Avalon, at Holyrood, but there apparently very scarce.

TAXUS CANADENSIS, Willd. St. John's and Exploits River; frequent.

*EQUISETUM ARVENSE, L. Manuels River.

E. LIMOSUM, L. Exploits River.

E. SYLVATICUM, L. Badger Brook.

*ASPIDIUM CRISTATUM, Swartz. Whitbourne.

A. NOVEBORACENSE, Swartz. In alder thickets, St. John's (107).

A. spinulosum, var. dilatatum, Hook. Placentia.

*A. spinulosum, var. intermedium, D. C. Eaton. Whitbourne.

Asplenium Filix-fœmina, Bernh. Virginia Water and Salmonier River.

Cystopteris fragilis, Bernh. Cliffs, Placentia, and bluffs of Manuels River.

Onoclea sensibilis, L. Whitbourne (63).

Osmunda cinnamomea, L. Whitbourne (57).

O. Claytoniana, L. Holyrood (43) and Exploits River.

O. regalis, L. Holyrood and Exploits River.

Phegopteris Dryopteris, Fée. Salmonier River (147) and Exploits River.

P. polypodioides, Fée. Salmonier River (146).

Polypodium vulgare, L. Helmet Mountain, Holyrood (21).

*Pteris aquilina, L. Holyrood (4).

*Lycopodium annotinum, var. pungens, Spreng. St. John's and Holyrood (216).

L. clavatum, L. St. John's.

L. complanatum, L. Exploits River.

*L. inundatum, L. Bally Haily Bog, St. John's (135), and Exploits River.

L. lucidulum, Michx. Whitbourne (137).

L. obscurum, var. dendroideum, D. C. Eaton. Helmet Mountain, Holyrood (134).

*L. Selago, L. Holyrood (136).

*Isoetes Tuckermani, Braun. In 3 to 6 inches of water, Quiddy-Viddy Lake.

Peculiar Behaviour of Charcoal in the Blast Furnace at Radnor Forges, Que.

By J. T. Donald, M.A.

In October last the Canada Iron Furnace Company sent the writer a sample of what they termed partly consumed charcoal, containing a large percentage of siliceous matter, and which they stated "had been thrown out at the cinder notch of the furnace in large quantities, unconsumed, and showing fibres, or threads, of a yellow colour, and similar to mineral wool." It was further stated that "the coal, which was made from oak, and, apparently, basswood and elm, seems unfit for furnace work." A superficial examination was sufficient to show that this charcoal was very peculiar indeed. Its unusual weight at once challenged attention; and a closer inspection showed in the specimen a framework in the form of a fibrous mass—not unlike a piece of harsh fibred asbestos. Analysis showed that this fibrous matter amounted to no less than 41.16 per cent. of the coal. The question now was, to account for this large percentage of mineral matter. The only explanation I could offer was to suggest that it might be the result of charring wood that had been partially fossilized, for it was well known that such silicified wood is not uncommon. At the same time this suggestion did not satisfy me; it did not, I thought, cover the fibrous or rod-like structure of the mineral matter—for I had never seen a similar structure in silicified wood. I therefore decided to send portions of the sample to Prof. Penhallow, of McGill, and Mr. W. F. Ferrier, of the Geological Survey. These gentlemen are authorities in their own departments—the former as a botanist, and the latter as a mineralogist and lithologist. It appeared to me that the question of the origin of the siliceous matter of this coal was one of either botany or mineralogy, and not of chemistry. Prof. Penhallow, having examined the specimens, reported that "it seems difficult to think that these rods are the result of natural processes of growth." Mr. Ferrier said he thought the siliceous matter had not been present in the original charcoal, but that it was slag that the coal had absorbed in the furnace. Then, next, word came from the furnace at Radnor that similar fibrous charcoal had again been expelled from the slag notch, and this whilst charcoal from a totally different locality was being used in the furnace. The evidence was thus strongly against the view that the siliceous matter was part of the original coal, and in favour of Mr. Ferrier's suggestion. The question was thus again, as it were, thrown back into the sphere of chemistry, and it appeared probable that an analysis of the fibrous matter would settle it. After much care and labour, a quantity of fibre sufficient for analysis—and free from the ash naturally present in the charcoal—was obtained. The difficulty of securing a satisfactory sample lay in the fact that the alkali of the true ash caused the fibres to fuse, forming little glassy globules. It was desirable to avoid these, in order that the analysis might show the composition of the fibre itself. The analysis of the fibre is stated in column 2; column 1 is the partial analysis of a sample of Radnor slag made by myself in January, 1891:—

	(1) p.c.	(2) p.c.
Alumina	13.52	18.15
Ferrous oxide	1.44	.51
Manganous oxide	3.48	Traces
Lime	23.89	25.44
Magnesia	.74	1.47
Sulphuric anhydride	1.52	Traces
Silica	54.00	42.18
Alkalies — Phosphoric anhydride, etc., by diff.	2.41	2.25

It is very evident, then, that the fibrous matter of this charcoal is simply absorbed slag. Two questions of interest then arise. What were the conditions in the furnace that caused charcoal in large quantities to absorb and retain the liquid slag? How did it happen that only on two occasions had the production of this slag-saturated coal been observed?

The following particulars regarding the furnace are data that must be taken into consideration in any theory put forth to explain the peculiar behaviour of the charcoal under consideration:—

Four $3\frac{1}{2}$ inch tuyeres are used.

The average pressure of blast is about $5\frac{3}{4}$ lbs.

The average temperature of blast, 900 degrees Fahr.

The quantity of air, as a rule, is 2,638 cubic feet, but at times it has run to as high as 2,827 cubic feet to the minute.

Cubical contents of furnace, from stock-line down, is 1,264 cubic feet.

Charcoal Impregnated with Slag.

By D. P. Penhallow, M.A.Sc.

On the 8th of October last I received from Prof. J. T. Donald a sample of charcoal, together with some peculiarly fibrous silicious matter, accompanied by the statement that the coal was received from "clients who use charcoal in the production of charcoal iron," and that "when the coal is burned it leaves an ash consisting of long fibres. This material was thrown out at the cinder notch in large quantities unconsumed. The coal was made from oak and apparently bass-wood and elm."

Upon submitting the coal to examination, it became evident that it was derived from the wood of an elm—probably the common white or American elm (*Ulmus* *americana*). The texture was found to be very harsh and rough. A transverse fissure was found to be filled with a somewhat protruding mass of vitreous matter which also extended above and below wherever longitudinal fractures occurred. Upon handling the specimen, small vitreous particles, like small shot, but usually imperfectly rounded and quite glossy, would detach themselves from the mass. Running longitudinally, and clearly lying within the vessels, were to be seen numerous siliceous rods. Where these entered the transverse fissures previously referred to, they, in some cases, presented free terminations, or again were fused together into a more or less continuous mass. The transverse fracture of the coal is somewhat lustrous, and shows numerous short, black and glossy filaments with a lustrous fracture, projecting from the various vessels.

The sample of residue sent me shows that when the coal is consumed it leaves behind a rather compact, fibrous mass of stiff, greyish filaments which, when undisturbed, have the general aspect of a very poor and coarse fibred asbestos. Under a low magnifying glass, the filaments appear as glistening and chiefly transparent or translucent glass rods. They are of very variable size, and in our specimen reach a length of upwards of 30 mm., though there is no reason to suppose that they may not have a greater length. The surface shows conspicuous irregularities, which at once serve to suggest the conformation of the rods to the walls of the vessels in which they occur.

A more critical examination under a compound microscope shows that the filaments measure from 29 μ. to 72 μ. in diameter. For the most part they are perfectly transparent, glass like bodies, or again they assume a yellowish hue, or even become blackish or more or less opaque in consequence of the inclusion of numerous small air bubbles, or of black granules, apparently particles of unconsumed carbon. Chiefly solid, they rarely show a central, longitudinal channel. Sometimes they are full of minute air bubbles which, as they come to the surface, merge into minute but irregular fissures and air cavities, such as we might suppose to be formed by air enclosed in a solidifying mass.

The most interesting aspect, however, is to be found in the surface markings. These take of the form of transverse, often forking striæ, between which may be seen small round pit-like markings, and it requires no very critical inspection to convince one that all these markings are extremely faithful casts of the various structural features of the vessels within which the rods were found. So complete, indeed, are these casts that the terminal walls of the vessels in all their details may be observed.

On the 9th of December a second lot of coal from another furnace, was received from Prof. Donald. This proved, upon investigation, to have been derived from some species of oak. It was very light, but showed numerous rods of silica, completely filling the various vessels. In this, as in the former case, when the rods projected into fissures, they were commonly fused into bead-like terminations, or the whole were joined into a more or less continuous mass. These masses were sometimes transparent, but more often of a greenish color, strongly suggestive of slag. They commonly assumed a nodular form and usually had the aspect of being formed *in situ* by fusion of the extremities where these latter projected into fissures.

The rods themselves were found to be white or glossy, and transparent, rarely green, but often dark from the inclusion of air or of particles of unconsumed charcoal. They were found to measure from 37 μ. to 249 μ. in diameter, and thus to vary much more widely than those from the elm, a fact which is quite in accord with the different dimensions of the vessels in these two woods

—elm and oak. As in the first case, the rods exhibit in a remarkably well defined manner all the structural features of the vessels from which they were derived or within which they were formed.

In the facts thus obtained from a direct examination of the material itself, we have conclusive evidence that

1st. Siliceous matter, either in a molten or a soluble condition, was taken into the vessels of oak and elm wood, or into the charcoal derived therefrom, and eventually deposited there.

2nd. That the volume of material was sufficient to completely fill all the vessels in large pieces of coal or wood, and thus to form complete casts of these structures.

It thus becomes necessary to obtain answers to the following questions :—

1st. Was the silica taken up by the living plants or by the charcoal derived therefrom.

2nd. In what form was the silica taken up ?

3rd. In what way was entrance into the tissues of the coal effected ?

1st. The evidence of the specimens themselves shows beyond question that the silica must have been taken up before the structure of the tissues was destroyed by combustion. It must, therefore, have been taken up by the living plant or by the charcoal before the latter was subjected to a destructive oxidation.

With respect to the first of these alternatives, we fortunately have important guiding data in the known processes of silicification in plants. So far as we know, silica can enter the living plant only through its roots in the form of a soluble silicate. Its final disposition leads not to the filling up of vessels, but to such a distribution within the substance of the walls of tissues as to give to these latter a marked element of mechanical strength. Instances of this kind are familiar in highly silicified hairs of the nettle and squash, as also in the very highly silicified and strongly resistant epidermis of the grasses and Equiseti. The formation of tabashir in the hollow joints of certain bamboos might be held to offer a fair basis for comparison, but all analogy fails when it is recalled that the often large masses of silica thus met with are altogether amorphous and deposited as the residuum of the fluids originally present. In the known deposition of silica in plants, there are, in fact, no grounds for comparison, and, from a botanical point of view, there is no way of reaching an adequate explanation of the presence of such rods of silica in charcoal. It is, in fact, quite within the limits of safety to assert that it would be altogether contrary to normal processes of growth for such deposits to occur in living tissues.

We are thus confronted with the alternative that the silica must have been taken up by the charcoal itself. It is a well known fact that charcoal often retains all the prominent structural features of the original tissues in a remarkable degree, and it thus becomes possible to see how the casts could so completely represent the structure of the vessels.

In whatever form the silica entered the coal, the fact that it later appears as complete casts shows that it solidified within the vessels before the latter were destroyed by combustion.

2nd. The rods have been shown to present a diversity of appearances. They are clear and glass like ; opaque through the inclusion of air or of what seem to be particles of unconsumed carbon ; or they again appear—but more particularly in the massive form—of a greenish white color like slag. Collectively, these appearances point to the view that the infiltrated matter must have entered the coal in a molten state, and that it is in reality slag in which the coal was immersed, a conclusion which is greatly strengthened by Prof. Donald's statement that an analysis of this residue shows it to have the composition of ordinary slag.

3rd. The question as to how such infiltration was accomplished cannot be answered with a full measure of satisfaction. The results of our examination would seem to imply the operation of capillarity as the only process which will offer an adequate explanation of the case. This would certainly account for the entrance of even a dense fluid into the vessels of the coal, and it would find its parallel in the formation of the Kootanie Cannel coals by the infiltration of fluid hydro-carbons into plant tissues.[1] This view, however, does not take account of the special conditions existing in the furnace and under which this infiltration took place, and of such conditions we have no knowledge. Under what peculiar circumstances it is possible for conditions, such as are implied by the facts before us, to exist, it is not within my province to say, but upon a knowledge of them, appears to depend the solution of what must otherwise remain an obscure problem.

Contributions to Canadian Botany.

By James M. Macoun.

IX.

Delphinium simplex, Dougl.

About two miles above the mouth of the Kootanie River, B.C., 1889. (*John Macoun*, Herb. No. 10,597.) New to Canada.

Alyssum calycinum, L.; Macoun, Cat. Can. Plants, Vol. I., p. 53.

Near Blackwell Station, Lambton Co., Ont. (*T. C. Wheatley.*)

[1] Trans. R. Soc. Can. XII. iii. 30.

POLYGALA INCARNATA, L.

Walpole Island, Lambton Co., Ont., 1894. (*C. K. Dodge.*) New to Canada.

POLYGALA SENEGA, L., var. LATIFOLIA, T. & G.

Georgian Bay, Lake Huron, 1889. (*J. M. Dickson.*) New to Canada.

SAGINA DECUMBENS, Torr. & Gray; Macoun, Cat. Can. Plants. Vol. I., p. 79.

Hillsides, Farewell Creek, Cypress Hills, Assa. Herb. No. 11,710.[1] (*John Macoun.*)

DESMODIUM MARILANDICUM, F. Boott.

Near Blackwell Station, Lambton Co., Ont., 1893. (*T. C. Wheatley.*) New to Canada.

DESMODIUM ROTUNDIFOLIUM, DC.; Macoun, Cat. Can. Plants, Vol. I., p. 118.

Niagara Falls, Ont. (*R. Cameron.*) Near Blackwell Station, Lambton Co., Ont. (*C. K. Dodge.*)

VICIA SEPIUM, L.

In ditches in a ravine west of Hamilton, Ont. (*J. M Dickson.*) New to Canada. Introduced.

LUDWIGIA POLYCARPA, Short & Peter.

Since recording in Part I. of these papers the occurrence of this species, at Amherstburg, it has been reported from the vicinity of Sarnia by Mr. Chas. K. Dodge.

EPILOBIUM WATSONI, Barbey.

New Westminster, B.C. (*A. J. Hill. Rev. H. H. Gowen.*) New to Canada.

1 Whenever herbarium numbers are given, they are the numbers under which specimens have been distributed from the herbarium of the Geological Survey of Canada.

LYTHRUM SALICARIA, L.

In No. VII. of these papers, it was stated that this species had not been recorded from Eastern Ontario until found at Ottawa, in 1895, by Mr. Tourchat. This was a mistake. It had been before collected at Ottawa by Mr. William Scott, and was recorded in *Flora Ottawaensis*, p. 32.

PASTINACA SATIVA, L.

Spence's Bridge, B.C.; common in old gardens and waste places on Vancouver Island. (*John Macoun.*) Not recorded west of Manitoba.[1]

PEUCEDANUM EURYCARPUM, C. & R.; Macoun, Cat. Can. Plants, Vol. I., p. 329.

From the east end of the Cypress Hills west to the Rocky Mountains, 1894, 1895. Herb. Nos. 4,963 and 10,692-3-4-5. (*John Macoun.*) Not before recorded east of Rocky Mountains.

PEUCEDANUM TRITERNATUM, Nutt.: Macoun, Cat. Can. Plants, Vol. I., pp. 187 and 536; and Vol. II., p. 329.

Milk River, Assa. Herb. No. 10,688. (*John Macoun.*) Eastern limit.

DAUCUS CAROTA, L.

Common in meadows on Vancouver Island, and apparently naturalized.

CORNUS PUBESCENS, Nutt.; Macoun, Cat. Can. Plants, Vol. I., pp. 191 and 538.

Donald, Columbia River, B.C.; north of Pass Creek, Sproat, B.C. (*John Macoun.*)

CORNUS PUBESCENS, Nutt., var. CALIFORNICA, C. & E.

Woods at Revelstoke, Columbia River, B.C., 1890. (*John Macoun.*) Only Canadian station.

[1] The geographical limits given in these papers refer to Canada only.

NYSSA AQUATICA, L.

N. multiflora, Wang.; Macoun, Cat. Can. Plants, Vol. I., p. 192.

Many fine trees of this species grow at Queenston Heights, and near Niagara-on-the-Lake, Ont., but it has apparently never been recorded from that vicinity.

ADOXA MOSCHATELLINA, L.; Macoun, Cat. Can. Plants, Vol. I., p. 193.

Athabasca River, below the Cascades. (*Miss E. Taylor.*) Athabasca River, Lat. 56°. (*Jas. M. Macoun.*)

SAMBUCUS GLAUCA, Nutt.; Macoun, Cat. Can. Plants, Vol. II.. p. 331.

In woods at Deer Park, Lower Arrow Lake, Columbia River, B.C. (*John Macoun.*) Eastern limit.

VIBURNUM DENTATUM, L.; Macoun, Cat. Can. Plants, Vol. I., pp. 194 and 538.

Foster's Flats, Niagara River, Ont. (*John Macoun.*) Near Sarnia, Ont. (*C. K. Dodge.*)

VIBURNUM OPULUS, L.; Macoun, Cat. Can. Plants, Vol. I., p. 195.

Prof. Macoun, in his Catalogue, makes the Saskatchewan the western limit of this species. We have now specimens from Sproat, B.C.; Sicamous, B.C.; and Agassiz, B.C. (*John Macoun.*)

LONICERA CILIOSA, Poir.; Macoun, Cat. Can. Plants, Vol. I., p. 196.

Woods at Sproat and Deer Park, Columbia River, B.C.; Yale, B.C. (*John Macoun.*)

LONICERA UTAHENSIS, Wats.; Macoun, Cat. Can. Plants, Vol. I., p.540.

Sheep Mountain, Waterton Lake, Rocky Mountains;

Deer Park, Lower Arrow Lake, B.C.; Revelstoke, B.C.; Sicamous, B.C. (*John Macoun.*)

GALIUM APARINE, L.; Macoun, Cat. Can. Plants, Vol. I., p. 200.

The only western station for this plant given by Prof. Macoun is Victoria, Vancouver Island. It has since been found to be of very general distribution in British Columbia. Our specimens are from Elk River Bridge, Rocky Mountains. (*Dr. Geo. M. Dawson.*) Deer Park, Lower Arrow Lake, Columbia River, B.C.; Ainsworth, Kootanie Lake, B.C.; Kamloops, B.C.; Yale, B.C.; Agassiz, B.C.; Lulu Island, B.C.; Salt Spring Island, Gulf of Georgia; common on Vancouver Island. (*John Macoun.*) Specimens from some of the above localities have been distributed as var. *Vaillantii*, Koch, but they are true *G. Aparine.* We agree with Dr. Greene that though this species is "as much at home in our woods and thickets as any indigenous plant, it is probable that it came hither from the Old World within the last two centuries."

SHERARDIA ARVENSIS, L.

In fields, Victoria, Vancouver Island, 1893. (*John Macoun.*) Not before recorded west of Ontario.

ASPERULA ARVENSIS, L.

Edge of a marsh, near Hamilton, Ont. (*J. M. Dickson.*) New to Canada.

LIATRIS SCARIOSA, Willd.; Macoun, Cat. Can. Plants, Vol. I., p. 208.

Near Sarnia, Lambton Co., Ont. (*C. K. Dodge.*) Not recorded from Ontario since collected by Maclagan. Not having seen Maclagan's specimens, Prof. Macoun, when preparing his Catalogue, was of the opinion that Maclagan's stations for *L. scariosa* should be referred to *L. cylindrica.*

Aster concinnus, Willd.

A specimen of this rare *Aster* was sent to our herbarium by Mr. Eugene A. Rau in December, 1890. Thé label reads thus: "Moraviantown (formerly called New Fairfield) near railroad station, Bothwell, Ontario, Canada. Collected by Robert Rau, Sept. 30th, 1872. Identified by Prof. Porter." Specimens collected by Jas. M. Macoun, at Point Edward, Ont., in 1884, have been doubtfully referred here. They differ very slightly from Mr. Rau's specimen, and are not referable to any other species.

Aster conspicuus, Lindl.; Macoun, Cat. Can. Plants, Vol. I., pp. 220 and 544.

In rocky thickets at Sicamous, B.C. (*John Macoun.*) Western limit.

Erigeron armeriæfolius, Turcz; Macoun, Cat. Can. Plants, Vol. I., p. 235.

Additional stations for this species are: Chaplin, Old Wives Lakes, Assa., Herb. No. 10,840; Fort Walsh, Cypress Hills, Assa.; Hand Hills, Alberta; St. Mary's River, Alberta, Herb. No. 10,839; Cave Avenue, Banff, Rocky Mountains; Sicamous, B.C.; Kamloops, B.C. (*John Macoun.*) Not before recorded west of the prairie region.

Erigeron ochroleucus, Nutt.

Summit of Sheep Mountain, Waterton Lake, Rocky Mountains. Herb. No. 10,858. (*John Macoun.*) New to Canada. Flowers purplish, turning to a dirty chrome yellow when the specimens have been badly dried. The description in Torr. & Gray, Fl. II., p. 178, is a much better one than that in Gray's Syn. Flora.

Erigeron strigosus, Muhl.; Macoun, Cat. Can. Plants, Vol. I., p. 234.

Near Belly and St. Mary's rivers, Alberta; Griffin Lake, B.C.; Sproat, B.C.; Ainsworth, Kootanie Lake, B.C.;

Alberni, Vancouver Island. (*John Macoun.*) Not before recorded west of Assiniboia. The Sproat specimens are the var. *discoideus*, Robbins.

Erigeron uniflorus, L.; Macoun, Cat. Can. Plants, Vol. I., pp. 231 and 547.

Summit of Avalanche Mountain, Selkirk Mts., B.C.; Mt. Queest, Shuswap Lake, B.C. Alt. 6,000 feet. (*Jas. M. Macoun.*) Not recorded before from British Columbia. Specimens from Kicking Horse Lake, taken from a land-slide at the foot of a mountain, show a great divergence in habit from those collected at the summit of the same mountain, 3,000 feet higher. These latter are scarcely an inch in height, and have in some cases a barely perceptible stem; the plants from the lower levels are more than a foot high.

Antennaria alpina, Gærtn.; Macoun, Cat. Can. Plants, Vol. I., pp. 236 and 548.

Mountains north of Griffin Lake, B.C.; Revelstoke, B.C.; Spence's Bridge, B.C.; summit of Mount Arrowsmith, Vancouver Island. (*John Macoun.*)

Antennaria Carpathica, R. Br.; Macoun, Cat. Can. Plants, Vol. I., pp. 236 and 548.

Additional stations for this species are: mountains at Roger's Pass, Selkirk Mts., B.C., alt. 6,500 feet; near Ainsworth, Kootanie Lake, B.C.; Spence's Bridge, B.C. (*John Macoun.*) Mount Queest, Shuswap Lake, B.C.; mountains at Griffin Lake, B.C. (*Jas. M. Macoun.*) Sucker Mountain, B.C. (*Jas. McEvoy.*)

Antennaria Carpathica, R. Br., var. pulcherrima, Hook: Macoun, Cat. Can. Plants. Vol. I., pp. 237 and 548.

Guichon Creek, B.C.; mountains south of Tulameen River, B.C. (*Dr. Geo. M. Dawson.*) Spence's Bridge, B.C.; Câche Creek Mountain. B.C. (*John Macoun.*) The Câche Creek specimens were referred to *A. Carpathica* in Prof. Macoun's Catalogue. Not before recorded west of Selkirk Mountains.

ANTENNARIA DIOICA, Gaertn.; Macoun, Cat. Can. Plants, Vol. I., pp. 236 and 548.

Charlton Island. James Bay, Hudson Bay, the var. *parviflora*, T. & G. (*Jas. M. Macoun.*) Our herbarium material shows typical *A. dioica*, Gærtn., to be common from Assiniboia west through the Rocky Mountains to Kamloops, B.C., and north to Fort Smith on Great Slave River. The pink-flowered form is almost as common, but has not been found east of Belly River, Alberta.

GNAPHALIUM DECURRENS, Ives, var. CALIFORNICUM, Gray.

In open woods at Revelstoke, B.C., and at Ainsworth, Kootanie Lake, B.C., 1890. (*John Macoun.*) New to Canada.

GNAPHALIUM MICROCEPHALUM, Nutt.; Macoun, Cat. Can. Plants, Vol. I., p. 548.

Qualicum, Vancouver Island, and Protection Island, Nanaimo, V.I. Herb. No. 430. (*John Macoun.*)

XANTHIUM SPINOSUM, L.

On ballast, Nanaimo, Vancouver Island. (*John Macoun.*) Recorded before only from Ontario.

RUDBECKIA HIRTA, L.

About deserted dwellings, Kicking Horse River, Rocky Mountains. (*J. M. Macoun.*) Revelstoke, B.C.; Griffin Lake, B.C. (*John Macoun.*) Not before recorded west of the prairie region. Probably introduced by means of the railway.

HELIANTHUS DIVARICATUS, L.

Our specimens of this species show a wider range of cauline leaf forms than are included in Gray's descriptions. They vary from the ovate-lanceolate form, deeply and regularly serrate, to ovate with *obtusc* or *rounded* tips, with the serration barely apparent. Specimens collected at The Chats, Ottawa River, by Mr. Cowley, are farthest from typical *divaricatus*—the truncate, sessile, obtuse leaves, not being even divaricate.

HELIANTHUS RIGIDUS, Desf.

In thickets, Revelstoke, B.C. (*John Macoun.*) Not before recorded west of prairie region. Probably introduced from the east along the Canadian Pacific Railway.

BIDENS CERNUA, L.

New Westminster, B.C. Herb. Nos. 457 and 458. (*John Macoun.*) Not before recorded west of Rocky Mountains.

BIDENS FRONDOSA, L.

New Westminster, B.C. Herb. No. 456. (*John Macoun.*) Not before recorded west of Rocky Mountains.

MADIA FILIPES, Gray; Macoun, Cat. Can. Plants, Vol. I., p. 248.

Nanaimo, Vancouver Island, Herb. No. 461; Deer Park, Lower Arrow Lake, Columbia River, B.C. (*John Macoun.*)

ARTEMISIA ABSINTHIUM, L.

Waste places at Medicine Hat, Assa., 1895. (*John Macoun*, Herb. No. 10,980.) Not before recorded west of Ontario.

ARTEMISIA LUDOVICIANA, Nutt.

Along roadsides at Port Arthur, Ont., 1889. (*Dr. and Mrs. N. L. Britton and Miss Timmerman.*) On the Canadian Pacific Railway, near the station at Chalk River, Ont. Herb. No. 10,985. (*John Macoun.*) Doubtless introduced from the west in both cases.

SENECIO FASTIGIATUS, Nutt.

S. megacephalus, Macoun, Cat. Can. Plants, Vol. I., p. 263.

Belly River, Alberta, 1881. (*Dr. Geo. M. Dawson.*) Souris Plain, Assa. (*J. M. Macoun.*) Indian Head, Assa. (*David Macoun.*) Alkaline flats, near Twelve-mile Lake, Wood Mountain, Assa., Herb. No. 11,615. (*John Macoun.*)

SENECIO MEGACEPHALUS, Nutt.

S. amplectans, Macoun, Cat. Can. Plants, Vol. I., p. 264.

South Kootanie Pass, Rocky Mountains, 1881. (*Dr. G. M. Dawson.*) Amongst debris on mountain sides, Sheep Mountain, Waterton Lake, Lat. 49° 05′, Rocky Mountains. Herb. No. 11,631. (*John Macoun.*) New to Canada.

CICHORIUM INTYBUS, L.

Winnifred, Assa. (*W. Spreadborough.*) Sicamous, B.C. (*John Macoun.*) Not before recorded between Ontario and the Pacific Coast.

STEPHANOMERIA RUNCINATA, Nutt.

S. minor, Macoun, Cat. Can. Plants, Vol. I., p. 284, in part.

On a dry clay bank, south of Wood Mountain, Assa., 1874. (*Dr. G. M. Dawson.*) Many Berries Creek, Milk River, Assa. (*John Macoun.*) New to Canada.

ASCLEPIAS PURPURASCENS, L.; Macoun, Cat. Can. Plants, Vol. I., p. 320.

Walpole Island, Lambton County, Ont. (*C. K. Dodge.*)

ASCLEPIAS SULLIVANTII, Engelm.

Walpole Island, Lambton County, Ont. (*C. K. Dodge.*) New to Canada.

GENTIANA PUBERULA. Michx.

On the Humber Plains, near Toronto, Ont., 1895. (*Wm. Scott.*) New to Canada. All the references under *G. puberula*, Macoun, Cat. Can. Plants, go to *G. affinis*, Griseb.

LITHOSPERMUM ANGUSTIFOLIUM, Mx.

Sandy soil at the beach at Hamilton, Ont. (*J. M. Macoun.*) Not before recorded east of Manitoba.

OROBANCHE PURPUREA, Vill.

Found growing on a lawn at Wingham, Ont. (*J. A. Morton.*) Probably introduced in grass seed. New to Canada.

UTRICULARIA RESUPINATA, B. W. Green; Can. Rec. of Science, Vol. VI., p. 204.

On an island near the north shore of Parry Sound, Lake Huron, 1893. (*J. M. Dickson.*) Only authentic record for Ontario.

VERONICA VIRGINICA, L.; Macoun, Cat. Can. Plants, Vol. I., p. 360.

Found by Prof. Macoun near Savanne station on the C. P. Railway, west of Port Arthur, in 1889. Probably introduced at this particular place, but indigenous further west along the railway. Credited to the Winnipeg Valley by Gray, but on what authority is not stated. Walpole Island, Lambton Co., Ont. (*C. K. Dodge.*)

PEDICULARIS SCOPULORUM, Gray.

Summit of Saddle Mountain, Devil's Lake, Rocky

Mountains, alt. 8,000 feet. (*John Macoun.*) New to Canada.

PYCNANTHEMUM MUTICUM, Pers.

Near Hamilton, Ont. (*J. M. Dickson.*) New to Canada.

CAREX FESTIVA, Dew., var. HAYDENIANA, W. Boott.

Borders of coulees, Cypress Hills, Assa., 1894. Herb. No. 7,397. (*John Macoun.*) Not before recorded east of Rocky Mountains.

LYCOPODIUM OBSCURUM, L.; Macoun, Cat. Can. Plants, Vol. II., p. 288.

Near Fort Norman, Mackenzie River, 1892. (*Miss E. Taylor.*) Revelstoke, B.C., 1890. (*John Macoun.*) Not before recorded north or west of the Saskatchewan.

LYCOPODIUM INUNDATUM. L.

Swamp at "The Lake," Stanley Park, Vancouver, B.C., 1893. Herb. No. 527 (*John Macoun.*) Not before recorded west of Ontario.

CURRENTS AND TEMPERATURES IN THE GULF OF ST. LAWRENCE.

By ANDREW T. DRUMMOND, LL.D.

That the cold Arctic or Labrador Current which, in a broad belt, skirts the easterly coasts of Labrador and Newfoundland, sends, when passing the Straits of Belle Isle, a branch westerly into the Gulf of St. Lawrence, influencing thus, the temperature of the water on, not only its northerly coasts, but far up the estuary of the St. Lawrence, has been the hitherto received opinion. This opinion obtained confirmation not only from the presence of icebergs in the Gulf of St. Lawrence 275 miles westerly of the Straits of Belle Isle, but in the low temperature of the water, both at the surface and at the bottom, as far up the northerly side of the River St. Lawrence as at least Murray Bay, seventy miles below Quebec, the general effect of this low temperature on the vegetation of the immediate coasts being seen in the limited distribution of forest trees and the presence of high northern or semi-Arctic plants. That icebergs were not found farther into the Gulf was not an argument against the existence of a branch current, as the milder atmosphere and warmer surface waters of the land-locked gulf during summer, would, naturally, tell rapidly on the masses of ice, however large, once they were carried well into and beyond the Straits of Belle Isle.

Mr. W. Bell Dawson, who has been commissioned by the Dominion Government to make a survey of the tides and currents of the River and Gulf of St. Lawrence, has, in his report for 1894, raised the question whether there is an uniformly inward current at the Straits of Belle Isle, and whether the currents there are not, in reality, fundamentally tidal, though affected considerably by the direction of the wind in the Straits, and by barometric pressure in the Gulf as well as outside.

Apart from the great scientific interest which attaches to it, the proper settlement of this question is important on account of its bearing on the navigation of the Straits where several large steamships have in recent years been lost. Enveloped in fog as these Straits so frequently are, and their surface dotted at certain seasons with icebergs, it is essential that their currents should be carefully examined and thoroughly understood. Whilst, however, Mr. Dawson's investigations into the direction and force of the current have very great value attached to them, are not the tests made too few in number and carried over too limited an area, to, as yet, enable definite conclusions to be drawn? The nearest point in the Straits to the

Labrador coast, at which tests of the currents were made, was three miles distant, and yet the position in which we would expect to find this cold branch current, if it does exist, is comparatively close to this Labrador coast, where the water is colder and deeper.

An instance to some extent parallel to that of the Gulf St. Lawrence and the Atlantic Ocean is the Black Sea in its relations to the Mediterranean Sea. There is a great body of fresh water poured daily into the Black Sea by the Danube, the Dnieper and other rivers, but even after taking into account the enormous evaporation constantly going on over the broad area which the sea presents, there is a slight outward surface current through the Dardanelles. On the other hand, there is also a current inward which is beneath and saline, and which, Dr. Carpenter explains in the Encyclopædia Britannica, is produced by the outward surface current creating downward and therefore lateral pressure on the Mediterranean waters, causing a current inward through the Dardanelles. Dr. Carpenter adds: "We have here a pregnant instance of the slight differences in level and salinity to produce even rapid movements of considerable bodies of water, and a strong confirmation of the doctrine that differences of density produced by temperature are adequate to give rise to still larger though slower movements of the same kind in the great ocean basins."

As bearing on the subject, Mr. Dawson has taken both surface and deep water temperatures at different points on three cross sections of the Straits of Belle Isle and one cross section at Cabot Straits, between Newfoundland and the Cape Breton coast. These temperatures are very interesting and establish the conclusions that the colder waters are always deflected against the Labrador or northern side of the Straits of Belle Isle, and against the Newfoundland or northern side of Cabot's Straits, whilst the warmer waters press against the southern sides in both straits. The cold Arctic current itself, in its onward course southward along the North American coast line, is, as we know, always similarly thrown to the right hand or westward side, and exhibits this distinctive feature even where with a greatly modified temperature at the surface, it somewhat parallels the Gulf stream off the southern United States coast. The details of Mr. Dawson's notes show that on the Labrador side of the Straits of Belle Isle, just inside of Belle Isle itself, the thermometric readings at ten fathoms ranged from 35° to 38° F., whilst on the Newfoundland side of the Straits near Cape Bauld they reached as high as 51°. Again, on the south-west side of Newfoundland, near Cape Ray, at the same depth, they indicated 41° to 46° F., whilst towards the Cape Breton side they were as high as 60° to 64° F. Further, at twenty fathoms, the difference in temperature between the north and south sides of the Straits of Belle Isle was 13°, and between the Newfoundland and Cape Breton sides of Cabot Straits 4°. In some cases the variations were very marked. Proceeding from Cape North on the Cape Breton coast to near St. Paul Island, the temperature at ten fathoms fell 24°. Still further, at forty fathoms the general temperature off the Labrador coasts, in the Straits of Belle Isle, was about 30° F., whilst near Cape Bauld, on the opposite coast line, it rose to 33° F. At the same depth in Cabot's Straits variations in the readings were less marked—the range being on both sides between 33 and 34° F.

The inferences which can be drawn, generally, from these temperatures in connection with other facts is that the colder waters deflected against the northerly sides represent the Arctic Current from the Atlantic Ocean, whilst the southerly deflected warmer waters are to be attributed to the Gulf of St. Lawrence. The higher temperatures of the Gulf waters are traceable to two sources —the land-locked character of this great bay, and the enormous volume of warmer water being daily poured into it by the St. Lawrence and numerous other smaller Canadian rivers. Although the point has not been properly established on both sides of this river's great estuary by thermometric tests, yet it would appear from surface and deep sea readings taken by the writer near Murray Bay on the north coast ($46\frac{1}{2}°$ F. at surface, $38\frac{1}{4}°$ at 17 fms., and $38\frac{1}{2}°$ at 31 fms.—all on 5th August), and from the fact that whilst bathing during the summer season is somewhat exceptional on that side, it is more general on the south coast, that these warmer waters of the River St. Lawrence are also deflected to the southern coast or right hand in their progress towards the sea.

The evaporation over the broad surface of the Gulf must be very great, but does it counterbalance the enormous masses of fresh water which are being constantly poured into it from the Great Lakes and the rivers of Canada ? Whether it does so or not, if there is an outward current of warmer water deflected to the southerly side of these two outlets from the Gulf, there must be some fully compensating inward flow of colder water either reversely parallel to it or underneath, just as in the case of the Black Sea. Although claiming that the current at the Straits of Belle Isle is fundamentally tidal in its nature, Mr. Dawson, nevertheless, admits that under normal conditions and when both surface current and undercurrent in the two directions are taken into account, the difference on the average is in favor of a greater inward flow from the east, and that the actual flow throughout the year appears also, on the whole, to be greater in the inward direction from the east than outward from the west. Between Newfoundland and Cape Breton he, however, finds a current running out of the Gulf on the western or Nova Scotia side, and into the Gulf on the eastern or Newfoundland side.

There are other very important considerations which have also to be taken into account. Wind, as we know, influences currents. On Lake Ontario, it will, when blowing down the lake continuously for some time even pile up the water at the lower end to a height of many inches and create underneath a reverse current. The direct effects produced by winds are, however, not relatively deep, and, therefore, probably hardly have a perceptible influence upon any cold current in the Gulf which underlies warmer waters. Thus in the Straits of Belle Isle, at a depth of thirty to forty fathoms, a high wind from the west may have but little effect on a current from the east. Again, although the great mass of water in the ocean as well as in the land-locked Gulf of St. Lawrence, is swayed backward and forward twice each day, the whole moves together, and it is quite possible to conceive of the currents in these bodies of water maintaining their directions irrespective of the motion of the whole mass, of which these currents form only a part, with different causes for their motion. The rise and fall of the surface, which is the popular notion of the tide, is, Prof. G. H. Darwin has, among other matters, pointed out to me, really the outcome of a small current in the whole fluid, the current being reversed in direction every twelve hours. The subject has an important bearing on the existence of a more or less continuous cold current inwards at the Straits of Belle Isle. The cold current, if it exists at all there, as a definite factor, is to be sought for more as a deep seated than even a surface current, and will be found clinging to the northerly side of the Straits where the deepest channel is also known to exist. How far does the effect of the tide there at forty to fifty fathoms seriously interrupt such a current ? It is in this northern part of the Straits where investigations into the undercurrents are still wanted. Mr. Dawson's observations, where they were made outside of the three miles distance from the Labrador coast, show that some permanent undercurrent does exist, because "during the times that the current ran in fair correspondence with the tides, when the conditions may be considered as normal, the undercurrent was usually stronger than the surface current, when the flow was from the east, and it was always weaker than the surface current, when the flow was from the west." Whatever effect winds and tides do produce at forty fathoms or more would be exerted in favor of this inward undercurrent during a considerable part of the year, since, as a whole, between easterly and westerly influences, that from the east appears to be the stronger of the two throughout the year. As to the relative effects of high pressure areas over the Gulf and over the Atlantic Ocean, off the Labrador and Newfoundland coasts, on the passage of water through the Straits, our information is probably too meagre to enable any opinion as yet to be formed beyond the general fact that for the time a current would be formed.

Another very interesting matter brought to light by Mr. Dawson, and the further investigation of which he recognizes as necessary, is that in the deep sea temperatures, taken on the 16th August, in Cabot Straits, between St. Paul Island and Cape Ray, the temperature—especially towards the former place—which successively fell from 59° at the surface to 31° and 33° F. at fifty fathoms, appeared to rise again to $40\frac{1}{2}$° F. at one hundred and fifty fathoms. Some further careful tests of the density and salinity of these waters as well as further thermometric readings appear to be needed with a view to tracing the influence here of the River St. Lawrence waters. The anomaly can hardly be altogether ascribed to areas of water of different temperatures floating oceanward. In the fresh water of the River St. Lawrence, as it leaves Lake Ontario, where the depth averages about twelve fathoms, there appear in summer to be areas of different temperature, but at any given depth, these areas as they pass the thermometer do not show differences of temperature exceeding 2° to 3°. We must look largely to other causes for such reversals of the temperature as are indicated near St. Paul's Island.

Jan., 1896.

On Certain Birds from the Moluccas, now in the Society's Museum.

By J. B. Williams, Esq., F.Z.S.

The Moluccas form, zoologically, a very peculiar and interesting group of islands. Immediately to the east of them lies the great island of New Guinea, with Australia to the south of it; while on the other side are the Celebes, with the islands of Borneo and Java in close proximity.

It was by the study, especially, of the birds and insects in this Malay archipelago that the celebrated naturalist A. R. Wallace was convinced of the necessity of some theory such as Mr. Darwin's to explain the facts connected with their variation and geographical distribution, noted during a residence of seven or eight years among the various islands.

In Borneo the fauna is altogether Indian, while the Moluccas are, zoologically, closely allied to Australia.

In Borneo some of the commonest birds are Trogons, Woodpeckers, and Barbets. These all disappear in the Moluccas. and the bird families most frequently seen there are Parrots, Kingfishers, Pigeons, and Honeysuckers.

In Borneo we find the Indian elephant and tiger, besides many smaller carnivora, and hosts of monkeys. In the Moluccas there are hardly any mammals except bats, and five or six out of the nine or ten that are there have probably been introduced by the natives. These introduced animals include one monkey and one civet cat, which are confined to two of the smaller islands, and are the only representatives of their respective orders.

This region forms, therefore, a veritable Paradise for birds: no monkeys to steal their eggs—no cats to devour the parents; no wonder that they greatly vary and increase. Of land birds there are about 200 different species (all Europe has only about 250); and of this 200 about 150 are of species *peculiar* to the Moluccas.

Three or four years ago Mr. H. J. Tiffin presented the Museum with two cases of birds, most of which came from the Malay region. These I have lately been re-arranging and naming, and find quite a number of interesting species among them.

Mr. Tiffin tells me that he purchased them at Singapore, about twenty-six years ago, at a large store where they had been taken in exchange from some of the Malay traders.

The Malays go round in their native boats to collect produce from the various islands, and many of these birds must have been procured in Gilolo—the largest of the Moluccas—as they belong to species that are peculiar to that island.

The rarest of these is a specimen of Wallace's Rail (*Habroptila Wallacei*[1]), found only in Gilolo. There are several specimens of this bird in European museums, but few, if any, on this side the Atlantic.

It is allied to the Weka Rail of New Zealand, which in its turn is allied to the Kiwi or Apteryx; so that our Rail forms one of the links that unite the winged with the almost wingless examples of bird life.

As illustrating the opposite extreme in wings, there is a specimen of the Great-winged Swift (*Macropteryx mystacca*), the largest representative of its family, and found only in this region.

The Great Black Pitta (*Pitta maxima*) is one of the

[1] The scientific names are those used in the British Museum Catalogue of Birds.

handsomest of a very beautiful family, and is peculiar to Gilolo.

This pair of dark-throated Sun-birds (*Cinnyris jugularis*) belong to a family which, in the Old World, takes the place that the Humming-birds occupy in the New. This species is found in the Philippines as well as the Moluccas.

There were several Honeysuckers in the collection, but they had been so damaged by insects that their identification was almost impossible. One, however, I recognized as *Melitograis gilolensis.*

This little Kingfisher appears to be an example of *Alcedo Floresiana,* a variety of the common English Kingfisher (*Alcedo ispida*), which only occurs in Flores and the Moluccas.

Of the Moluccan Blue Kingfisher (*Halcyon diops*) we have a young female. In this species, contrary to the usual custom, it is the female that assumes an adult plumage, and the young ones resemble the male bird.

The Racquet-tailed Kingfisher (*Tanysiptera margaritæ*) belongs to a very beautiful group found only in the neighbourhood of New Guinea. There are twenty different species of them, and eight of these are peculiar to the Moluccas. This one is only found in Gilolo and Batchian.

Of Pigeons, Mr. Tiffin's collection contained somewhat damaged specimens of the beautiful little Blue-capped Fruit Pigeon (*Ptilopus monachus*) and Superb Fruit Pigeon (*Ptilopus superbus*). The first of these is peculiar to the Moluccas, the other ranges from the Moluccas to North Australia.

Of Parrots, there are seven different species of Moluccan birds.

The Ceram Lory (*Lorius garrulus*). This specimen had lost nearly all the webs of the feathers, but, fortunately, a few spots of the yellow linings to the wings were left, so that I was enabled to identify him. It is found in Gilolo only.

Great-billed Parrot (*Tanygnathus megalorhynchus*). This handsome species is found on the west coast of New Guinea as well as the Moluccas.

Blue-necked Parrot (*Geoffroyus cyanicollis*). Found only in the Moluccas. We have a male and female.

Grand Eclectus (*Eclectus roroatus*). A male and female, but, like the two preceding species, almost ruined by insects. Found only in the Moluccas. The male has a green plumage, with a red upper and black lower bill, while the plumage of the female is red and the bill entirely black.

Variegated Lory (*Eos ricinata*) belongs to a group of Red Lories which are confined to the Moluccas; this one inhabits Gilolo.

The little Long-tailed Lorikeet (*Hypocharmosyna placens*) is one of the smallest and most elegant of a family that are very numerous in all the islands.

White-crested Cockatoo (*Cacatua alba*) is distinguished from the allied Australian birds by the broad white feathers of its crest—the Australian ones having narrow coloured crests. It is confined almost entirely to the Island of Gilolo.

We have a second specimen of this bird in the Museum, and also a Purple-capped Lory (*Lorius domicella*) which is peculiar to two of the Moluccan islands—Ceram and Amboyna. These two birds we possessed prior to Mr. Tiffin's gift, which includes also several of the Moluccan perchers (Order *Passeres*) that I have not yet identified, and a large series of birds from other parts of the Malay region, a complete list of which it may perhaps be worth publishing in some future number of the RECORD OF SCIENCE.

Anhydrite in Ontario.

By Professor W. Nicol.

Recently, while visiting the dump of the abandoned Foxton Phosphate Mine with a party of students from the Mining School at Kingston, an unfamiliar mineral was picked up. After returning, Mr. Miller, the Lecturer on Geology, subjected the specimen to an examination with the blowpipe, and determined it to be anhydrous calcium sulphate. An analysis was made with the following result:—

CaO	41.72	per cent.
SO_3	57.47	" "
CO_2	.286	" "
SiO_2	.151	" "
Fe_2O_3	.065	" "
Loss on ignition	.26	" "
	99.952	per cent.

The mine is situated in the Township of Loughborough, County of Frontenac, not far from the Village of Sydenham.

The mineral occurs in considerable quantities, closely associated with transparent selenite, gypsum, calcite, and pyroxene. In appearance the mineral somewhat resembles pink fluorite. It shows the three pinacoidal cleavages and the pearly lustre on the basal plane. Between the layers of the mineral, thin flakes of calcite occur in the same way as they do between the foliæ of mica, which is found at the same dump.

The anhydrite from this locality bears a very strong resemblance to that seen in museums from Hall, Tyrol, and labelled "Muriacite."

Laboratory, School of Mining,
Kingston.

Review of the Evidence for the Animal Nature of Eozoön Canadense.

(Concluded.)

By Sir William Dawson, C.M.G., LL.D., F.R.S., Etc.[1]

II. PETROLOGICAL AND CHEMICAL.

Bearing in mind the statements made in the previous note, respecting the stratigraphical relations of the Grenville Series, and referring to the excellent account by my friend Dr. Bonney of his observations at Côte St. Pierre, and to some difficulties stated by him which merit attention, we may sum up the evidence so far, under the following statements:—

1. The limestones included in the Grenville Series and their associated quartzites and schists bear so strong a resemblance in mineral character to metamorphosed Palæozoic calcareous beds of organic origin and their associates, as to warrant at least the careful consideration of any forms apparently organic contained in these limestones.

2. The occurrence in these limestones of nodular silicates, of graphite, of pyrite, and of apatite, affords additional reason to suspect their organic origin.

3. The presence of large beds as well as of veins of graphite and of thick deposits of iron ore in the Grenville Series constitutes an additional analogy with Palæozoic formations holding organic remains.[2]

These facts were adduced by Dr. Sterry Hunt and Dr. J. D. Dana in evidence of the probability of life in the Laurentian period, even before the discovery of Eozoön. Certain particulars connected with them, however, now demand somewhat more detailed attention, in

[1] [Reprinted from the Geological Magazine, Decade IV., Vol. II., October, November, December, 1895.

[2] See papers by the author on the Graphite and Phosphates of the Laurentian Rocks, Quart. Jour. Geol. Soc. London, 1869 and 1876.

connection with that discovery, and with recent objections to the organic nature of Eozoön.

Dolomite or magnesian limestone is a not infrequent associate of Palæozoic fossiliferous limestones; and I have remarked in previous papers on the similarity of the mode of occurrence of silicified Stromatoporæ in the great dolomite of the Niagara formation with that of Eozoön in the Grenville Limestone, in which dolomite occurs in beds, in thin layers, and in disseminated crystals, in a manner to show that it was an original constituent of the deposit. Dolomite is also one of the most common minerals filling the cavities of Eozoön, and especially the finer tubuli. The mode of its occurrence on the small scale may be seen in the following description of a section of a portion of a bed of limestone from Côte St. Pierre, examined under a lens, after being treated with dilute acid. The specimen comprised about six inches of the thickness of the bed :—

Crystalline limestone with crystals of dolomite, constituting about one half (fragments of Eozoön in calcite portion).[1]

More finely crystalline limestone, with rounded granules of serpentine, some of them apparently moulded in cavities of Archæospherinæ, or of chamberlets of Eozoön.

Limestone with dolomite as above, but including a thin layer of limestone with granules of serpentine.

Limestone and dolomite, with a few grains of serpentine and fragments of Eozoön.

Crystalline dolomite with a few fragments of Eozoön, as limestone, with canals in dolomite.

Limestone with fragments of Eozoön, granules of serpentine, and groups of chamberlets filled with serpentine.

We have thus a bed of limestone in which dolomitic

[1] Distinguished by their fine granular texture and canal-systems.

and serpentinous layers appear to alternate, and occasional fragments of Eozoön occur in both, while the smaller forms resembling fossils are, so far as can be observed, limited to the serpentinous layers.

At Arnprior on the Ottawa a portion of the Grenville Limestone presents dark graphitic layers parallel to the bedding, and giving it a banded grey and white appearance which has led to its use as a marble. An analysis by Dr. Harrington shows that the graphitic layers contain 8.32 per cent. of magnesia, the lighter layers only 2.57 per cent., in the state of grains or crystals of dolomite. Associated with the marble there are also beds of brown-weathering dolomite, affording 42.10 of magnesia. The graphite in this marble, under the microscope appears as fibrils and groups of minute clots, and sometimes coats the surfaces of crystals or fragments of calcite, the appearances being not unlike those seen in carbonaceous and bituminous limestones of later date.

In both the above cases the magnesium carbonate is evidently an original ingredient of the bed, and cannot have been introduced by any metamorphic action. It must be explicable by the causes which produce dolomite in more recent limestones.

Dana has thrown light on these by his observations on the occurrence of dolomite in the elevated coral island of Matea in Polynesia,[1] under circumstances which show that it was formed in the lagoon of an ancient coral atoll, while he finds that coral and coral sands of the same elevated reef contain very little magnesia. He concludes that the introduction of magnesia into the consolidating under-water coral sand or mud has apparently taken place—"(1) In sea-water at the ordinary temperature; and (2) without the agency of any other mineral water except that of the ocean;" but the sand and mud were those of a lagoon in which the saline matter was in pro-

1 "Corals and Coral Islands," p. 356, etc.

cess of concentration by evaporation under the solar heat. Klement has more recently taken up this fact in the way of experiment, and finds that, while in the case of ordinary calcite this action is slow and imperfect, with the aragonite which constitutes the calcareous framework of certain corals, and at temperatures of 60° or over, it is very rapid and complete, producing a mixture of calcium and magnesium carbonates, from which a pure dolomite more or less mixed with calcite may subsequently result.[1]

I regard these observations as of the utmost importance in reference to the relations of dolomite with fossiliferous limestones, and especially with those of the Grenville Series. The waters of the Laurentian ocean must have been much richer in salts of magnesium than those of the present seas, and the temperature was probably higher, so that chemical changes now proceeding in limited lagoons might have occurred over much larger areas. If at that time there were, as in later periods, calcareous organisms composed of aragonite, these may have been destroyed by conversion into dolomite, while others more resisting were preserved, just as a modern *Polytrema* or *Balanus* might remain, when a coral to which it might be attached would be dolomitized. This would account for the persistence of Eozoön and its fragments, when other organisms may have perished, and also for the frequent filling of the canals and tubuli with the magnesian carbonate.

The question now arises as to the mineralization of Eozoön with serpentine, and more rarely, especially in the case of its larger and lower chambers, with pyroxene. Connected with this is the alternation, as above described, of serpentinous and dolomitic layers in the limestone, as if in successive times the conditions were alternately favourable to the deposition of magnesium in the form of carbonate and in that of silicate.

[1] Bulletin Geol. Soc. Belgium, Vol. IX. (1895, p. 3). Also notice in Geol. Mag., July, 1895, p. 329.

We learn from the "Challenger" Reports that under certain circumstances the presence of organic matter in oceanic deposits causes an alkaline condition, tending to the solution of silica and the formation of silicates. We also learn that siliceous matter in a state of fine division (*e.g.*, volcanic dust) may afford material for the production of hydrous silicates, either directly or indirectly through the agency of organisms forming siliceous skeletons. The "Challenger" Reports also show that the silicates known under the name of glauconite, and thus deposited, contain several bases to some extent interchangeable. Of these the principal are aluminium, potash, and iron, though magnesia is also present. Some older silicates injecting fossils in the Palæozoic rocks are less complicated, and contain more magnesia: and, as Hunt has shown, there is nothing anomalous in the supposition that in the Laurentian period silicate of magnesium and iron may have acted in this capacity.[1]

It is true that serpentine is now usually regarded as a product of the hydration of olivine and pyroxene; still, even on this supposition, it might be formed from the hydration of fine volcanic dust falling into the sea. Hunt also has shown that the serpentine of the Grenville Limestone differs chemically from those supposed to be of direct igneous origin, in its comparative freedom from iron oxide, in its larger proportion of water, and in its lower specific gravity, besides being a more pure silicate of magnesium. That it can be deposited by water is shown by the chrysotile filling veins, and by my own observations, published long ago, on the serpentine replacing and filling cavities of Cambro-Silurian fossils at Melbourne in Canada, and filling the cells of Silurian corals at Lake Chebogamong.[2]

[1] See Analyses of Glauconites, etc., by Dr. Hunt in "Dawn of Life," p. 126. One tertiary example is silicate of iron and magnesia. See also Hoskins on Glauconite, Geol. Mag., July, 1895.

[2] Quart. Journ. Geol. Soc. 1864, p. 69, also 1879, p. 48, *et seq.*, Memoir on Eozoon in Peter Redpath Museum, 1888, p. 48 *et seq.*

The occurrence of pyroxene in the limestone, and filling some of the chambers of Eozoön, may also be easily explained. Dr. Bonney well remarks that it does not resemble any igneous rock known to him, and it is quite certain from its mode of occurrence that it cannot be directly igneous. Somewhat thick and continuous beds of a coarser-grained but scarcely less pure pyroxene occur in some parts of the Grenville Series, *e.g.*, at Templeton, and I have described them as probably volcanic ash-beds, though the large pyroxene crystals found in the veins of apatite traversing these beds are probably of thermo-aqueous origin.[1] But the limited and irregular masses and concretions of white pyroxene occurring in the limestones are of different texture and colour, and with less iron. They may have resulted from local showers of volcanic ashes drifted by currents into hollows of the Eozoön reefs, and sufficiently fine to fill the chambers of dead specimens, while they might also form a basis for the growth of new individuals. This is, I think, the only supposition on which they can be explained, and it would also explain the difficulty suggested by Dr. Bonney as to the association of the pyroxene with Eozoön.

There seems, however, to be no good evidence that any portion of the pyroxene has been changed into serpentine as a result of metamorphism; and it is evident that if such a change had occurred after the consolidation of the rock, serious chemical and mechanical difficulties would be involved, whereas if volcanic débris, whether of the nature of olivine or pyroxene, became hydrated while the rock was incoherent and in process of formation, this would tend greatly to promote the infiltration with hydrous silicates of any fossils present in the mass.

Assuming the serpentine and pyroxene to have been deposited as above suggested, the remaining objections

[1] In Logan's Geology of Canada, p. 467, Hunt gives the analysis of a bedded pyroxene, at High Falls, on the Madawaska, as—Silica 54.20; lime 25.65; magnesia 17.02; protoxide of iron 3.24.

stated by Dr. Bonney would at once disappear. Specimens of Eozoön or other fossils might be infiltrated or filled with these silicates, and when the latter were superabundant they might form separate concretions or grains, which might in some cases envelop the fossils or be attached to them in irregular forms, just as one finds in the case of the flints in chalk or the chert in some other limestones.[3]

It is scarcely necessary to say that no objection to the organic origin of the Eozoön can be founded on the fact that many of the specimens are fractured, crushed, bent, or faulted, by the movement of the containing rock, or on the circumstance that well-preserved specimens should be rare, and found chiefly in beds containing silicates capable of injecting their cavities. On the other hand, the circumstance that fragments of Eozoön are abundant in the limestone is one of the best possible proofs that we are dealing with a calcareous organism. It would be interesting to describe and figure a number of specimens in our collections illustrating these points; but to do so would require an extensive illustrated memoir, for which neither space nor means are at present available.

I observe, in conclusion of this part of the subject, that in any highly crystalline limestone we can hope to find well-preserved fossils only when their cavities and pores have been filled with some enduring siliceous mineral: but, on the other hand, that porous fossils, once so infiltrated, become imperishable. It still remains to consider shortly new facts bearing on the structure of Eozoön and its possible biological affinities.

[3] It is a curious coincidence that Dr. Johnston-Lavis has described in the July number of this Journal, the aqueous deposition at ordinary temperature of crystals of pyroxene and hornblende, in cavities and crevices of bones included in an ash-bed of recent date, and in presence of calcite. apatite, and fluoride of calcium, as in the Grenville Series. This is a modern instance analogous to that suggested above.

III. STRUCTURAL AND BIOLOGICAL.

In recent years I have been disposed to attach more importance than formerly to the general form and macroscospical characters of Eozöon. The earlier examples studied were, for the most part, imbedded in the limestone in such a manner as to give little definite information as to external form; and at a later date, when Sir William Logan employed one of his assistants, Mr. Lowe, to quarry large specimens at Grenville and Côte St. Pierre, the attempt was made to secure the most massive blocks possible, in order to provide large slabs for showy museum specimens. More recently, when collections have been made from the eroded and crumbling surfaces of the limestone in its wider exposures, it was found that specimens of moderate size had been weathered out, and could, either naturally or by treatment with acid, be entirely separated from the matrix. Such specimens sometimes showed, either on the surfaces or on the sides of cavities and tubes penetrating the mass, a confluence of the laminæ, constituting a porous cortex or limiting structure. Specimens of this kind were figured in 1888,[1] and I was enabled to add to the characters of the species that the original and proper form was " broadly turbinate with a depression or cavity above, and occasionally with oscula or pits penetrating the mass." The great flattened masses thus seemed to represent confluent or overgrown individuals, often contorted by the folding of the enclosing beds. The openings or oscula penetrating some of the larger specimens of Eozoön may perhaps be compared with the central canal in the modern *Carpenteria*.

There are also in well-preserved specimens certain constant properties of the calcite and serpentine layers. The former are continuous, and connected at intervals, so that if the siliceous filling of the chambers could be

[1] Geological Magazine, and Museum Memoir.

removed, the calcareous portion would form a continuous skeleton, while the serpentine filling the chambers, when the calcareous plates are dissolved out by an acid, forms a continuous cast of the animal matter filling the chambers. This cast of the sarcodous material, when thus separated, is very uniformly and beautifully mammillated on the surfaces of the laminæ, and this tuberculation gradually passes upward into smaller chambers, having amœboid outlines, and finally into rounded chamberlets. It is also a very constant point of structure that the lower laminæ of calcite are thicker than those above, and have the canal-systems larger and coarser. There is thus in the more perfect specimens a definite plan of structure on the large scale.

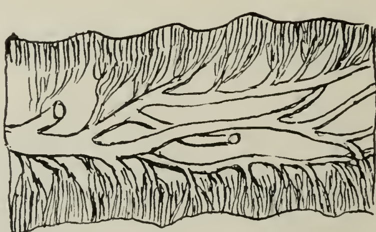

FIG. 6.—Diagram of typical mode of arrangement of canals and tubuli in a lamina of *Eozoön Canadense.* (Magnified.)

The normal mode of mineralization at Côte St. Pierre and Grenville is that the laminæ of the test remain as calcite, while the chambers and larger canals are filled with serpentine of a light green or olive color, and the finer tubuli are injected with dolomite. It may also be observed that the serpentine in the larger cavities often shows a banded structure, as if it had been deposited in successive coats, and the canals are sometimes lined with a tubular film of serpentine, with a core or axis of dolomite, which also extends into the finer tubuli of the surfaces of the laminæ. This, on the theory of animal origin, is the most perfect state of preservation, and it equals anything I have seen in calcareous organisms of later periods. This state of perfection is, however, naturally of infrequent occurrence. The finer tubuli are rarely perfect or fully infiltrated. Even the coarser canals are not infrequently imperfect, while the laminæ themselves are sometimes crumpled, crushed, faulted, or penetrated with veins of chrysotile or of calcite. In some instances the calcareous laminæ are replaced by dolomite, in which case the canal-systems are always imperfect or obsolete. The laminæ of the test itself are also in some cases replaced by serpentine in a flocculent form. At the opposite extreme are specimens or portions of specimens in which the chambers are obliterated by pressure, or occupied only with calcite. In such cases the general structure is entirely lost to view, and scarcely appears in weathering. It can be detected only by microscopic examination of slices, in parts where the granular structure or the tubulation of the calcite layers has been preserved. All palæontologists who have studied silicified fossils in the older rocks are familiar with such appearances.

It has been alleged by Möbius and others that the canal-systems and tubes present no organic regularity. This difficulty, however, arises solely from imperfect specimens or inattention to the necessary results of slicing any system of ramifying canals. In Eozoön the canals form ramifying groups in the middle planes of the laminæ, and proceed at first almost horizontally, dividing into smaller branches, which ultimately give off brushes of minute tubuli running nearly at right angles to the surfaces of the lamina, and forming the extremely fine tubulation which Dr. Carpenter regarded as the proper wall. In my earlier description I did not distinguish this from the canal-system, with which its tubuli are inwardly continuous; Dr. Carpenter, however, understood this arrangement, and has represented it in his figures[1] (see also Fig. 6). It is evident that in a structure like this a transverse or oblique section will show truncated portions of the larger tubes apparently intermixed with others much finer and not continuous with them, except very

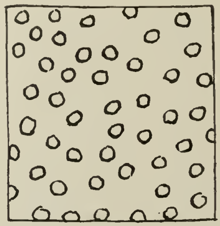

Fig. 7.—Cross section of minute tubuli, about 5 microms. in diameter. (Magnified.)

rarely. Good specimens and many slices and decalcified portions are necessary to understand the arrangement. This consideration alone I think entirely invalidates the

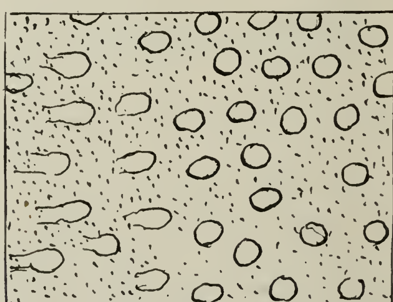

Fig. 8.—Cross section of similar tubuli, more highly magnified, and showing granular character of the test. (From camera tracings.)

criticisms of Möbius, and renders his large costly figures of little value, though his memoir is, as I have elsewhere shown, liable to other and fatal objections.[2]

[1] Ann. and Mag. Nat. Hist., ser. 4, xiii, p. 456, figs. 3, 4.

[2] Museum Memoir, pp. 50 *et seq.*

It has been pretended that the veins of chrysotile, when parallel to the laminæ, cannot be distinguished from the minute tubuli terminating on the surfaces of the laminæ. I feel confident, however, that no microscopist who has seen both, under proper conditions of preservation and study, could confound them. The fibres of chrysotile are closely appressed parallel prisms, with the optical properties of serpentine. The best preserved specimens of the "proper wall" contain no serpentine, but are composed of calcite with extremely minute parallel cylinders of dolomite about five to ten microms. in diameter, and separated by spaces greater than their own diameter (see my comparative figure, "Dawn of Life," p. 106; also Figs. 5. 6). In the rare cases where the cylinders are filled with serpentine they are, of course, still more distinct and beautiful. At the same time I do not doubt that observers who have not seen the true tubulation may have been misled by chrysotile veins when these fringe the laminæ. Möbius, for instance, figures the true and false structure as if they were the same.

Protest should here be made against that mode of treating ancient fossils which regards the most obscure or defaced specimens as typical, and those better preserved as mere accidents of mineral structure. In Tertiary Nummulites injected with glauconite, it is rare to find the tubuli perfectly filled, except in tufts here and there, yet no one doubts that these patches represent a continuous structure.

I have remarked on previous occasions that the calcite constituting the laminæ of Eozoöon often has a minutely granular appearance, different from that of the surrounding limestone. This is, I presume, the "dusty" appearance referred to by Dr. Bonney. Under a high power it resolves itself into extremely minute dots or flocculi, somewhat uniformly diffused. Whether these dots are particles of carbon, iron, apatite, or siliceous matter, or the remains of a porous structure, I do not know; but similar appearances occur in the calcareous fossils contained in altered limestones of later date. Wherever they occur in crystalline limestones supposed to be organic, the microscopist should examine them with care. I have sometimes by this appearance detected fragments of Eozoön which afterwards revealed their canals.

I have not space here to notice late observations on Archæospherinæ and other objects supposed to be organic found in pre-Cambrian rocks in Canada and in Europe. They afford, however, to some extent, corroborative evidence in favour of Eozoön.

Supposing a probability to be established of the animal nature of Eozoön, we should naturally expect to detect links of connection between it and fossils known to us in the succeeding geological formations. We have, however, here to make allowance for the probability that an organism so very ancient may differ materially from any of its successors, and may probably be a synthetic or generalized type, or present embryonic characters. Analogy might also justify the supposition that it might be represented in later times by smaller as well as more specialized forms. In this connection, also, the probable warmth and shallowness of the Laurentian ocean, and its abundance in calcium carbonate and in carbonaceous matter, probably organized, should be taken into account. It should also be noted that the formations next in ascending order are of a character little likely to preserve organic marine forms of the "benthos" or ground-living group. We might thus expect a gap in our record between the fauna of the Grenville Series and that of the next fossiliferous formations.

Logan naturally compared his earlier specimens with the Stromatoporæ so abundant in the Ordovician and Silurian Limestones; and in this he was justified, for, whatever may be the ultimate judgment of naturalists as to these problematical fossils, and whether they are referred to Protozoa or to Hydrozoa, or, as seems more likely, are divided between the two, they resemble Eozoön in general structure and mode of accumulation of calcareous matter, and occupied a similar place in nature. My own conclusion, in discussing the microscopic structures of the specimens of Eozoön, was that they were probably those of Protozoa allied to those Foraminifera with thick supplemental skeleton[1] which had been described by Dr. Carpenter. At the same time, I suspected that those Stromatoporoids, like Cœnostroma, which possesses thick laminæ penetrated by ramifying tubes, might be allied to the Laurentian fossil. Dr. Carpenter regarded the structures as combining in some respects those of Rotaline and Nummuline Foraminifera, and ably, and as I think conclusively, defended this view when attacked.[2] The Rotaline type of Foraminifera has since that time been traced by Cayeux and Matthew far down into the pre-Cambrian rocks. The Nummuline type is not known so early. As to the canal-bearing Stromatoporoids, none of them show the fine tubulation, though some have radiating and branching canals. Recent students of the Stromatoporæ seem disposed to refer them to Hydrozoa,[3] a conclusion probable in the case of some of the forms (especially those spinous ones incrusting shells), but doubtful in the case of others, and more particularly the oldest of all, belonging to the genus Cryptozoön of Hall, and Archæozoön of Matthew,[4] the structure of which seems, so far as known, to consist of very thin primary laminæ with a supplemental tubulated skeleton resembling that of the genus *Loftusia*, and which must, I think, be regarded as foraminiferal. In any case, whether these primitive forms are Protozoa or rudimentary Hydroids, they reach back in time nearly as far as

[1] Calcarina, etc

[2] Ann. and Mag. Nat. Hist., *loc. cit.*

[3] Nicholson, Monographs Palæontographical Society.

[4] Bulletin Nat. Hist. Survey of New Brunswick, 1894-95.

Eozoön, and are equally massive and abundant, and may be regarded as analogous to it in magnitude, habitat, mode of growth, and function in nature.

These later discoveries are gradually widening the horizon of palæontologists in the direction of the dawn of life, and the studies of those who trace backward the history of the Invertebrates of the Palæozoic seas are demanding more and more the discovery of earlier forms than those yet known to complete the chain of life.[1] The field is a difficult one to cultivate, and demands both labour and patience, but it holds forth the prospect of great discoveries, and it has already become the duty and interest of palæontologists to extend their inquiries as far back as the Laurentian in the search for Eozoic life.

In this respect the study and discussion of Eozoön have not been without use, in directing attention to the possibility of finding organic remains in the older crystalline rocks, to the danger of confounding them in their peculiar condition with merely mineral structures, to the state of preservation of organic remains in the older formations, and to the origin and significance of the large deposits of limestone, dolomite, hydrous silicates, iron ore, graphite, and apatite, laid up in certain horizons of the Eozoic rocks. Questions of this kind have been greatly advanced toward their satisfactory solution since the discovery of Eozoön in 1858, and in some degree at least in consequence of the interest excited by that discovery. It is hoped that the present notes may tend in the same direction, and that, whether or not they succeed in removing any existing scepticism in respect to Eozoön, they may help to stimulate and guide the search for those beginnings of life, which there are now the best reasons for believing are to be found far below the base of the Cambrian.

[1] See Dr. Woodward's Address as President of the Geological Society, 1895.

[Additional facts and illustrations, and references to previous papers on the subject, will be found in "Specimens of Eozoön Canadense," pp. 106, published by the Peter Redpath Museum (Notes on Specimens, Sept. 1888), which may be obtained on application to the Museum, or through W. Foster Brown, Bookseller, Montreal. See, also, for a popular summary, Chapters V. and VI. of "Some Salient Points in the Science of the Earth," London, 1893.]

ON A NEW ALKALI HORNBLENDE AND A TITANIFEROUS ANDRADITE FROM THE NEPHELINE-SYENITE OF DUNGANNON, HASTINGS COUNTY, ONTARIO.[1]

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In a paper which appeared in the American Journal of Science for July, 1894, the discovery of a large area of nepheline syenite in the township of Dungannon, in the Province of Ontario, was announced and the geological relations and mineralogical characters of the mass briefly described.

One of the many peculiarities of this rock is the absence from it of the mineral pyroxene, which is usually the chief iron-magnesia constituent in rocks of this class, its place being taken by hornblende and mica, but even these minerals are present in comparatively small amount. Of the hornblende two varieties, occurring in different parts of the mass, were distinguished. The first, from near the York river, has a large axial angle with strong pleochroism in tints varying from pale yellow to deep green, and although containing a considerable amount of soda, probably approaches common green horn-

[1] [Reprinted from the American Journal of Science, March, 1896.]

blende in composition. The second variety, which occurs in a series of exposures about two miles to the east of the village of Bancroft, is quite different in character, having a small axial angle with high extinction and a much stronger pleochroism in the bluish tints suggestive of arfvedsonite.

A number of additional thin sections have been prepared and in the present paper the results of a further investigation of the optical properties and chemical composition of this second variety of hornblende are presented.

Hornblende—The mineral occurs in hypidiomorphic grains, which show the usual hornblende cleavages; it is optically negative, $\mathfrak{a}$ being the acute biseetrix, but the double refraction is weak.

It possesses, as has been mentioned, a strong pleochroism as follows:

$\mathfrak{a}$ = yellowish green. $\mathfrak{b}$ and $\mathfrak{c}$ = deep bluish green.

The absorption is $\mathfrak{c} = \mathfrak{b} > \mathfrak{a}$. $\mathfrak{b}$ and $\mathfrak{c}$, if not quite equal in absorption, are nearly so, hence sections cut at right angles to the acute bisetrix show but little pleochroism and are nearly isotropic. $\mathfrak{c}$ lies nearest the vertical axis, but whether toward the acute angle β or on the opposite side cannot be determined as the mineral does not possess a good crystalline form; it makes with the vertical axis a large angle the extinction amounting to 30°. The plane of the optic axes is the clinopinacoid, and there is a strong dispersion—red greater than violet. What drew especial attention to this hornblende in the first instance was the fact that it appeared to be nearly uniaxial. When a section, cut at right angles to the acute bisectrix, is examined between crossed nicols in convergent light, a black cross is seen somewhat thickened toward the intersection of the arms. This cross, on revolving the stage, divides into two hyperbolas, but these separate from one another but very little, and appear to separate less than they really do, on account of the fact that the low double refraction and deep color of these sections causes the hyperbolas to be ill-defined, while the whole field is very dark. The dispersion, however, makes itself evident in the varying colors on the sides of the hyperbolas. When, however, a gypsum plate giving a red of the first order is inserted above the objective the hyperbolas become a little better defined, although still not sufficiently definite to allow the axial angle to be accurately measured. The axial angle is found to be over 30°, possibly as much as 45°, which, however, is still very small for hornblende, being about one-half the usual value. Our thanks are due to Professor Rosenbusch for his assistance in working out these optical relations.

On examining a large series of thin sections of nepheline syenites representing most of the important occurrences hitherto discovered, only two rocks were found which contain a hornblende at all similar to that above described. The first of these is the nepheline syenite from the Corporation Quarry at Montreal, in which hornblende with the same small axial angle, low double refraction, intense color and pleochroism, large extinction angle and high specific gravity, occurs intergrown with the augite. The second is the hornblende described by Hackman under the name of arfvedsonite and which occurs intergrown with aegerine in the nepheline-syenite from Umptek in the Kola peninsula[1]. This mineral, however, differs from typical arfvedsonite in having an extinction of about 40° as well as in several other important respects. It possesses, moreover, a very small axial angle, although this fact is not noted by Hackman, while in true arfvedsonite the axial angle is very large. This Kola hornblende is much lighter in color than the hornblende from either of the above mentioned Canadian localities.

[1] "Petrographische Beschreibung des Nephelinsyenites vom Umptek," von Victor Hackman. Kuopio, 1894, p. 14.

In order to determine the chemical composition of this somewhat remarkable variety of hornblende from the Dungannon rock, it was decided to separate a portion for analysis. A considerable quantity of the rock was accordingly reduced to powder and passed through a sieve of 43 meshes to the inch—the rock being rather coarse in grain—and after having been freed from dust was treated with Thoulet's solution, having a specific gravity of 3·13, in a large separating funnel. In this way an almost complete separation of the colored constituents was effected. These latter, which sank in Thoulet's solution, were subjected to the action of a bar magnet and then treated with dilute hydrochloric acid, and various impurities thus removed. The purified powder was then treated first with Klein's solution, having a specific gravity of 3·22, and then with methylene iodide, having a specific gravity of 3·323. In both fluids practically everything sank, only a few composite grains floating. A microscopic examination showed the powder now to consist of grains of hornblende and of garnet with some composite grains consisting partly of nepheline. Further separation became difficult since, as was subsequently ascertained, the hornblende had a specific gravity of 3·433, and the specific gravity of the garnet was 3·739, while many composite grains consisting of garnet and nepheline had a specific gravity practically identical with that of the hornblende. As the electro-magnet was found to be useless, both minerals being readily attracted by it, Retger's silver nitrate method was employed.[1] The silver nitrate was fused in a properly arranged test tube, and after the introduction of the powder, potassium nitrate in powder was gradually added to the fused mass until the garnet fell, the whole being frequently stirred and maintained at a temperature of from 200° to 240° C. On

[1] "Ueber Schwere Flussigkeitken zur Trennung von Mineralien." Neues Jahrbuch fur Mineralogie, etc., 1889, ii, p. 190.

allowing the mass to solidify, a portion of the powder was found to have collected at the top of the mass, while the rest was at the bottom, the intervening part being quite free from mineral grains. The solid mass was then cut in two and the salts dissolved by treatment with water. After three successive separations the hornblende was obtained quite free from grains of garnet—the only impurities present being some composite grains consisting of garnet and nepheline. This powder was then placed under a lens and all the composite grains picked out by means of a fine needle. In this way a quantity of pure hornblende sufficient for purposes of analysis was obtained, while the garnet was obtained directly in a state of purity without the necessity of a final separation by hand.

Both minerals were found to be quite fresh and bright and quite unacted upon by the fused salts.

The hornblende[1] was then analyzed by Dr. Harrington with the following results:—

Silica	34·184
Titanium dioxide	1·527
Alumina	11·517
Ferric oxide	12·621
Ferrous oxide	21·979
Manganous oxide	·629
Lime	9·867
Magnesia	1·353
Potash	2·286
Soda	3·290
Water[2]	·348
	99·601
Specific gravity	3·433

[1] We would suggest Hastingsite as a varietal name for this hornblende, connecting it with the region where it occurs.

[2] Loss after igniting for about fifteen minutes. On further ignition the powder gained in weight owing to oxidation of the ferrous oxide.

The atomic and quantivalent ratios deducible from the above analysis are as follows :—

	Atomic.		Quantivalent.	
Si	$570 \times 4 = 2280$			
Ti	$19 \times 4 = 76$	2356	2356	
Al	$226 \times 3 = 678$			
Fe^{III}	$158 \times 3 = 474$	1152		
Fe^{II}	$305 \times 2 = 610$			
Mn	$9 \times 2 = 18$			
Ca	$176 \times 2 = 352$			
Mg	$34 \times 2 = 68$			
K	48			
Na	106	1202	2354	

The ratio of $(R_2O + RO) : R_2O_3 : SiO_2$ is 601 : 192 : 589, or approximately 3 : 1 : 3,, and obviously the mineral is a true orthosilicate agreeing fairly with the formula $(\overset{I}{R}_2\overset{II}{R})_3\ \overset{III}{R}_2Si_3O_{12}$, or, more fully, $(Fe, Mn, Ca, Mg, K_2, Na_2)_3\ (Fe, Al)_2\ (Si, Ti)_3\ O_{12}$—a constitution analogous to that of garnet.

So far as we are aware no other hornblende containing so small a proportion of silica has been analyzed; but the small percentage of silica is explained by the large proportions of ferrous and ferric oxides. This is made plain by the following formulæ and the corresponding percentages of silica deduced from them :

Formula.	P.C. of SiO_2.
$3FeO,\ Fe_2O_3,\ 3SiO_2$	32·19
$3CaO,\ Fe_2O_3,\ 3SiO_2$	35·43
$3FeO,\ Al_2O_3,\ 3SiO_3$	36·14
$3Na_2O,\ Al_2O_,,\ 3SiO_2$	38·38
$3CaO,\ Al_2O_3,\ 3SiO_2$	40·00

The Dungannon hornblende is interesting in connection with the views of Scharizer, who suggested in 1884[1] that many of the aluminous hornblendes might be regarded as molecular compounds of the metasilicate actinolite,

1 N. Jahrb. f. Min., 1884, ii, p. 143.

Ca (Mg, Fe)$_3$ Si_4O_{12}, and the orthosilicate $(\overset{\text{I}}{R}_2\overset{\text{II}}{R})_3\overset{\text{III}}{R}_2Si_3O_{12}$, for which he employed the name syntagmatite, originally given by Breithaupt to a black hornblende from Vesuvius. The hornblende from the Island of Jan Meyen, analyzed by Scharizer,[1] and that from Bohemia, analyzed by Schmidt,[2] agree closely with the so-called "syntagmatite molecule." The Stenzelberg mineral, analyzed by Rammelsberg,[3] also approximatee to it; but these three and the Dungannon hornblende are the only ones yet examined, so far as we are aware, that give at all closely the syntagmatite ratios. The following table gives the analyses of these four minerals and the molecular ratios deducible from them:

	Jan Mayen.	Molec. R.		Bohemia.	Mol. R.		berg.	Mol. R.		Dungannon.	Mol. R.	
SiO_2	39·167	653	653	39·66	661	672	39·62	660	662	34·184	570	589
TiO_2	....	....		0·89	11		0·19	2		1·527	19	
Al_2O_2	14·370	140	218	14·83	145	222	14·92	146	210	11·517	113	192
Fe_2O_3	12·423	78		12·37	77		10·28	64		12.621	79	
FeO	5·856	81		1·97	27		7·67	106		21·979	305	
MnO	1·505	21		....	..		0·24	3		0·629	9	
MgO	10·521	263		14·25	356		11·32	283		1·353	34	
CaO	11·183	200	648	12·74	227	663	12·65	226	685	9·867	176	620
K_2O	2·013	21		1·25	13		2·18	23		2·286	24	
Na_2O	2·478	40		2·47	40		1·12	18		3·290	53	
H_2O	·396	22		....	..		0·48	26		0·348	19	
	99·912			100·43			100·67			99·601		

In all four analyses the ratios for $(R_2O+RO):R_2O_3:SiO_2$ (including TiO_2 when present) are practically 3 : 1 : 3, or, to give the exact figures (excluding water):

	(R_2O+RO)	:	R_2O_3	:	SiO_2
Jan Mayen......	2·87	:	1	:	2·99
Bohemia........	2·99	:	1	:	3·02
Stenzelberg......	3·14	;	1	:	3·15
Dungannon	3·12	:	1	:	3·07

1 loc. cit. 2 Min. Mitth., iv, 23, 1881. 3 Pogg. Ann., 1858, ciii. 454.

The ratio (R_2O+CaO) : (Mg, Mn, Fe)O is, as observed by Scharizer in the case of the Jan Meyen and Bohemian hornblendes, approximately 3 : 4, thus:

	Including Water.			Excluding Water.		
	(R_2O+CaO)	:	(Mg, Mn, Fe)O.	(R_2O+CaO)	:	Mg, Mn, Fe)O.
Jan Meyen.....	3	:	3·87	3	:	4·17
Bohemia	3	:	4·10	3	:	4·10
Stenzelberg	3	:	4·02	3	:	4·38
Dungannon.....	3	:	3·84	3	:	4·11

Scharizer adopts the following ratios (3 : 1 : 3 and 3 : 4) as those of syntagmatite in calculating the composition of hornblendes intermediate between $(\overset{I}{R}_2\overset{II}{R})_3 \overset{III}{R}_2Si_3O_{12}$ and actinolite. He assumes in the first place that all the alumina and ferric oxide belong to the syntagmatite molecule (Σ). The sum of the Al_2O_3 and Fe_2O_3 molecules (from the molecular ratio) multipled by *three*, gives $(SiO_2)^{\Sigma}$ on the one hand and $(R_2O+RO)\Sigma$ on the other. The sum of $(R_2O+RO)\Sigma$ divided in the proportion of 3 : 4 gives $(R_2O+CaO)\Sigma$ and $MgO+FeO)\Sigma$. Subtracting $(MgO+FeO)\Sigma$ from the sum of the corresponding molecules deduced from the analyses gives $(MgO+FeO)_A$—that is the number of molecules of magnesia and ferrous oxide belonging to the actinolite molecule (A)—and $MgO+FeO)_A$ divided by three (see actinolite formula) gives the lime molecules of the actinolite $(CaO)_A$. This value subtracted from the total number of lime molecules gives $(CaO)\Sigma$, and $(CaO)\Sigma$ subtracted from $(R_2O+CaO)\Sigma$ gives the alkali molecules (in some cases including H_2O). Finally $(MgO+CaO)_A$ gives $(SiO_2)_A$. These statements will be made clearer by the following example, one of those selected by Scharizer.

HORNBLENDE FROM EDENVILLE, ANALYZED BY RAMMELSBERG.

Original analysis.		Molec. R. deduced from analysis.	Syntagmatite.	Actinolite.	Calculated composition.	Original analysis calc to 100.
SiO_2	51·67	861	222	609	51·97	52·66
Al_2O_3	5·75	56	56 } 74	...	5·99	5·86
Fe_2O_3	2·86	18	18	...	3·00	2·91
MgO	23·37	584	127	457	24·35	23·82
CaO	12·42	222	70	152	12·96	12·66
Na_2O	0·75	12	12 } 222	...	0·78	0·78
K_2O	0·84	9	9	...	0·88	9.86
H_2O	0·46	25	4	...	0·07	0·47
	98·12				100·00	100·00

Here $(SiO_2)\Sigma = 3(56+18) = 222$

$$(R_2O+RO)\Sigma = 3(56+18) = 222$$

$$(R_2O+CaO)\Sigma = 3\,\frac{(R_2O+RO)}{7}\Sigma = \frac{222\times 3}{7} = 95$$

$$(MgO)\Sigma = 4\frac{(R_2O+RO)}{7}\Sigma = \frac{222\times 4}{7} = 127$$

$$(MgO)_A = 584 - (MgO)\Sigma = 584 - 127 = 457$$

$$(CaO)_A = \frac{(MgO)_A}{3} = \frac{457}{3} = 152$$

$$(CaO)\Sigma = 222 - (CaO)_A = 222 - 152 = 70$$

$(Na_2O + K_2O + H_2O)\Sigma = (R_2O + CaO)\Sigma - (CaO)\Sigma = 95 - 70 = 25$. But $(Na_2O + K_2O)^{\Sigma} = 12 + 9 = 21$

$$\therefore (H_2O)\Sigma = 4$$

Finally $(SiO_2)_A = (MgO + CaO)_A = 457 + 152 = 609$

Having thus deduced the molecular ratios of the syntagmatite and actinolite, the numbers for each constituent are multiplied by the corresponding molecular weights, in order to obtain the theoretical relative weights of the constituents of the mixed hornblende.

Syntagmatite.		Actinolite.	
222 × 60 =	13320	609 × 60 =	36540
56 × 102·6 =	5745	....	....
18 × 160 =	2880	....	....
127 × 40 =	5080	457 × 40 =	18280
70 × 56 =	3920	152 × 56 =	8512
12 × 62 =	744	....	....
9 × 94 =	846	....	....
3 × 18 =	72	....	....
	32607		63332

Then,

$$(32607+63332):(13320+36540)::100:x$$

and $x = 51{\cdot}97$ = p.c. of SiO_2 in the mixed hornblende. And in like manner the percentages of the other constituents are calculated.

But 32607 : 63332 practically as 1 : 2, and therefore the formula of the Edenville hornblende might be regarded as

$$\overset{II}{R}_3\overset{III}{R}_2Si_3O_{12} + 2(Mg_3CaSi_4O_{12})$$

or as Scharizer gives it

$$10(\overset{II}{R}_3\overset{III}{R}_2Si_3O_{12}) + 20(Mg_2CaSi_4O_{12})$$

The analyses selected by Scharizer agree remarkably well with this theory, but there are aluminous hornblendes whose constitution cannot be readily explained in this way and which at the same time cannot be referred to the pargasite orthosilicate.[1]

Garnet.—In the hand specimens the garnet is seen to possess a deep reddish-brown color. In the thin sections it is a paler brown although still deeply colored. It is not found in all parts of the mass and where it does occur is usually present only in small amount. It possesses the usual high index of refraction and is quite isotropic, occurring usually in irregular shaped grains but in some few cases showing distinct crystalline form. It frequently holds a few large inclusions which usually consist of calcite in single individuals, although the garnet

[1] See Scharizer's paper, loc. cit, p. 156.

is perfectly fresh and the calcite shows no distinct evidence of a secondary origin. It moreover sometimes holds inclusions of the hornblende above described, of pyrite, iron ore and even of nepheline. A garnet resembling this occurs in small amount associated with a similar hornblende, as above mentioned, in the nepheline-syenite of the Corporation Quarry at Montreal, and it also contains as inclusions most of the other constituents of the rock. The same is also true of the melanite in the nepheline-syenite of Alnö.[1]

Before analysis the garnet was purified by several separations with fused silver nitrate, and on careful examination with the microscope the grains appeared to be entirely free from foreign matter. With the pycnometer their specific gravity at 16° C. was found to be 3·739. Chemical analysis gave the following results:

Silica	36·604
Titanium dioxide	1·078
Alumina	9·771
Ferric oxide	15·996
Ferrous oxide	3·852
Manganous oxide	1·301
Lime	29·306
Magnesia	1·384
Loss on ignition	·285
	99·577

The atomic and quantivalent ratios deduced from the above analysis are as follows:

	Atomic.		Quantivalent.
Si	610 × 4 = 2440	2492	2492
Ti	13 × 4 = 52		
Al	192 × 3 = 576	1176	2466
Fe^{III}	200 × 3 = 600		
Fe^{II}	53 × 2 = 106	1290	
Mn	18 × 2 – 36		
Ca	523 × 2 = 1046		
Mg	35 × 2 = 70		
H	32 32		

[1] "Ueber das Nephelinsyenitgebiet auf der Insel Alnö," von A. G. Högbom. Geol. Fören. i. Stockholm Förh., 1895, p. 144.

The ratio for $RO : R_2O_2 : (SiTi)O_2$ is 629 : 196 : 623, or, calculating the titanium as Ti_2O_3, 629 : 203 : 610 = 3 : 1 : 3. The analysis therefore accords well with the ordinary garnet formula $3\dot{R}O, R_2O_3, 3SiO_2$ or $\overset{II}{R}_3\overset{III}{R}_2Si_3O_{12}$, and the mineral may be regarded as a titaniferous andradite, with a considerable proportion of the ferric oxide replaced by alumina. In composition it resembles somewhat the brown garnet from the Island of Stokö, analyzed by Lindström.[1]

By way of comparison the analysis of the Stokö garnet and also one of a garnet from the nepheline-syenite of the Island of Alnö[2] are included in the following table.

	Stokö.	Molec.	R	Alnö.	Molec.	R.	Dungannon.	Molec.	R.
SiO_2	36·63	610	610	31·15	519	603	36·604	610	623
TiO_2	....	...	..	6·73	84		1·078	13	
Al_2O_3	9·97	98	182	3·14	31	180	9·771	96	196
Fe_2O_3	13·45	84		23·83	180		15·996	100	
FeO	2·28	32		....	...		3·852	53	
MnO	·63	9		·58	8		1·301	18	
CaO	35·90	641		33·44	597	616	29·306	523	
MgO	·28	7	698	....	...		1·384	35	645
Na_2O	...	...		·68	11		....	...	
Ign	·16	9					·285	16	
	99·30			99·55			99·577		

A Lecture upon Acetylene.[3]

By Prof. J. M. Crafts.

A year and a-half ago, if a chemist had been told that a new illuminating gas could be obtained from the evil-smelling product with which he was only too well acquainted in the laboratory, namely, the acetylene which

1 Zeit. für Kryst. u. Min., xvi, 160, 1890.

2 Sahlbom, in the paper by Högbom already cited.

3 Delivered before the Society of Arts at Boston, January 23, 1896.

forms whenever a Bunsen burner strikes down, he would have said that the idea was absurd. If a physicist had been told that the electric furnace was to be used to produce illuminating gas on a commercial scale he would have said it was quite impossible. But distinguished electricians were explaining that the telephone was impossible, while Graham Bell was inventing that instrument. So that scientific men will be well advised not to utter general opinions about the possibilities of the success of any new enterprise, and I shall endeavour to confine myself to the statement of certain facts and to the description of laboratory experiments, which constitute some new data which can be used to form an opinion regarding at least one side of this subject.

The chemistry of the manufacture of acetylene is very simple. Quicklime is reduced by carbon in an electric furnace to carbide of calcium, and enough carbon is taken not only to combine with the calcium to form carbide of calcium, but also to burn with the oxygen of the quicklime and to remove it as carbonic oxide. The process is represented by the equation : $CaO + 3C = CaC_2 + CO$. The carbide is obtained as a melted mass with crystalline structure, which when brought in contact with water is transformed to slacked lime, and to acetylene which is given off as a gas. The formula for this transformation is : $CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2$. All the alkaline earths and alumina have been subjected to the same treatment, and it has been found that the carbides of barium, strontium and calcium have similar formulæ, and give off acetylene when treated with water. The carbide of aluminum has the formula : Al_4C_3, and evolves marsh gas when treated with water. It may be added that a mixture of silica and carbon yields the carbide of silicon, SiC. The compound is formed when the two boches meet as vapours in the intense heat of the electric furnace and combine as a sublimate of beautiful crystals, now sold under the name of Carborudum. The powdered crystals have sharp cutting edges, hard enough to scratch rubies, and consequently make an excellent polishing and grinding material.

It is to be noticed that this formation of carbides affects the elements which make up by far the larger part of the earth's crust, so that from a geological as well as a chemical point of view these newly discovered transformations are of the utmost importance.

The reduction of these oxides to carbides is only possible at the high temperature of the electric furnace, and it is very interesting to note that at three very different stages of temperature we have such different conditions presiding over the union of the elements that each temperature corresponds to a new chemistry.

The temperature of the electric furnace, which has been estimated to be from 3,500° to 4,000° Cent., may be considered as intermediate between the sun's temperature, estimated by different physicists at 5,000° to 8,000°, and the temperatures of our smelting furnaces, which range from 1,200° to 1,500°. Now, in the sun's atmosphere, spectroscopic observations tell us that the elements exist uncombined, and we can even observe great masses of free oxygen in the presence of heated hydrogen and of metals so transformed in the properties which we are accustomed to recognize that they do not combine, but rise as vapours from the hottest part of the sun, condense and fall back in metallic clouds, which we know as sun spots. Here, then, is a temperature which is too hot for chemistry, if we define chemistry as the science of the combination of bodies.

The next temperature on a descending scale that we have access to is that of the electric furnace; here a partial combination only is possible; much of the oxygen remains free; carbon only burns to the monoxide of carbon, and the carbides and not the oxides of the alkaline earths are the stable forms of combination.

Then, at a lower temperature, the bright red heat of our smelting furnaces, the same carbides formed in the electric furnace, when exposed to free oxygen or to air, burn to oxides and to carbonic acid, and at a still lower temperature these two unite to form carbonates represented by the chalk and magnesian limestone which make so large a part of the earth's crust. Nature has so adjusted her processes that a small residue of oxygen remains, which, mixed with nitrogen, constitutes the vital air of our atmosphere. The carbides of aluminum and silicon burn in a similar way with oxygen, and the stable condition at any temperature lower than a bright-red heat is that of silicates and carbonates which make the chief strata of the earth.

The oxidation of carbides, which became possible when our globe cooled down to a red heat and solidified, has perhaps been a superficial one, and the denser material below the crust may consist of carbides of the alkaline earths and carbides of the heavy metals like iron, and finally the metals themselves.

It is only within the past two years that experiments with the electric furnace have enabled us to study these new transformations at a high temperature, and have given us the means of estimating what must have been the primitive condition of the earth during long geological periods.

Berthelot, Moissan and others have pointed out that the evolution of marsh gas from volcanoes may be an indication of the existence of Plutonic remnants of carbides, dating from a period of higher temperature, and which we now know may give off gas when brought in contact with moisture.

The most important and original experiments made with the electric furnace have been published in the

Comptes Rendus of the French Academy of Sciences by a young chemist, Henri Moissan, who had already distinguished himself by the discovery of fluorine. One of the first results which this new instrument gave in his hands was the artificial production of diamonds made by dissolving carbon in iron, and he then undertook a complete study of the formation of the carbides of the metals. Moissan's paper which interests us most directly was published on the 5th of March, 1894. It contains a full account of the formation of pure crystallized carbide of calcium and of its reactions with oxygen, sulphur, chlorine, etc., and a complete account of the formation of acetylene by the action of water upon the carbide, and nothing of scientific interest has since been added to the chemistry of acetylene, except some few experiments in European laboratories, notably upon its silver compounds.

French physicists have, however, made some very important measures of the thermic conditions which preside over the formation and decomposition of acetylene. They are a continuation of the admirable study of this singular gas, which was begun by Berthelot in 1859, and we shall find them of great value for explaining the properties which make acetylene useful or dangerous as an illuminant. The lecture will be confined strictly to the statement of facts which bear upon the proposed new gas industry, and no place can be given to the long-known laboratory process for making acetylene, and to many experiments which display its general properties.

The idea of using this laboratory product upon a commercial scale originated in the United States, and the merit of it is due to Mr. T. L. Willson and Messrs. Dickerson and Suckert, who have secured patents; but it is important to insist upon the fact that they are not the discoverers of the crystalline carbide of calcium, nor of its transformation to acetylene and to hydrate of calcium. Moissan's publication of March 5, 1894, antedates their patents by many months, and describes completely the whole chemistry of the manufacture of acetylene.

No mention is made of Moissan's work in the reports published by the acetylene company in a lecture by Willson and Suckert before the Franklin Institute, and in a lecture before the London Society of Arts by Prof. Lewes. In these reports Mr. Willson is represented as having discovered the mode of formation of calcium carbide in the electric furnace by the reducing action of carbon upon refractory oxides. It is stated that the experiments were begun by Mr. Willson in 1888.

In such matters dates of discovery can only be established by publications, which in this case are found to be in the Patent Office reports. Mr. Willson took out four patents in 1889–92 for electric smelting processes, and in several of them the use of carbon with refractory oxides is specified. The design seems to have been to make aluminum and its alloys and perhaps other metals. No mention is made in the reports of carbide of calcium nor of acetylene. Dickerson and Suckert, December 31, 1894, nine months after Moissan's publication, patented a process for evolving and condensing acetyline made from the carbide of calcium. And June 18, 1895, is the date of the first patent by T. L. Willson in which the report specifies the production of carbide of calcium.

Many statements have been published concerning commercial aspects of the new enterprise, but it will suffice to say here that it has not yet reached a stage at which the vital question of the cost to the consumer of the carbide of calcium can be fixed by the quotation of a market price. Small quantities can be purchased for experimental purposes in New York at a price of $5 per 100 lbs. But the manufacture in the United States does not exceed one ton per diem and is carried on at Spray, in North Carolina, a somewhat inaccessible place, and no complete account of the process has yet appeared in the best-known scientific periodicals. The commercial carbide, unlike that made by Moissan, probably contains compounds of calcium with the ash of coke, but no complete analysis has been published. Some of the statements made about the number of cubic feet of acetylene are obviously inaccurate, because the figures 5.89 to 6.35 cu. ft. acetylene per 1 lb. carbide are as high or higher than could be obtained if the carbide contained no ash and were absolutely pure.

The accurate measure of the gas given off by the carbide is not easy and requires the construction of a special apparatus. The writer has examined a number of samples of commercial carbide, and found that 70 to 92 per cent. of the theoretical quantity of acetylene could be obtained from them. It appears that the product which can be made to the best advantage is one which contains 84.6 per cent. of pure carbide, and which gives 5 cu. ft. of gas per pound; or, for a ton of carbide, 10,000 cu. ft. acetylene, two-thirds saturated with moisture, and measured at 60° Fahr. and 30 inches barometer. Summer and winter variations of temperature, together with barometric variations, would cause a difference of more than 15 per cent. in the uncorrected measure of the gas, and gas measured in a mountainous region, without correction for the low barometer, would differ far more from the standard amount.

If the acetylene industry shall succeed, the cost of the carbide will have to be adjusted to the price that the consumer may be willing to pay for gas, and it is preferable to treat the subject from this side and to show, as far as laboratory experiments with materials at hand will permit, what will be the probable value to the consumer of acetylene gas.

A very simple experiment illustrates in a beautiful way the ease with which acetylene can be made from the carbide. Direct a small stream of water on a half-pound lump of carbide, ignite the gas and show that the more water is poured on, the more flame is obtained. Various forms of generators can be used for the gas. The simplest one is a bell glass floating on water and containing a few lumps of carbide in a sieve. As soon as the bell glass descends so that the sieve touches the water, a shower of fine sediment of slaked lime can be seen to separate from the carbide and fall to the bottom of the jar, while the gas generated soon causes the bell to rise and removes the carbide from contact with the water. Thus the apparatus can be made to work automatically, generating gas only as fast as it is used; but it is not fitted for permanent use, because the moisture from the water generates gas, even when the contact has ceased, and the bell gradually rises, so that after twenty-four hours gas would escape if it were not used during the interval.

It is in every way preferable to separate the generator and the gas holder, and such arrangements can easily be made automatic.

The acetylene company has patented a tank for generating the gas under sufficient pressure to liquefy itself, and proposes to distribute liquid acetylene in cylinders under a pressure of 600 to 700 pounds to the inch; of this project more is to be said later.

It is certain that a company purchasing the carbide of calcium and using an existing gas plant could generate acetylene and distribute it through mains at a very small expense, and with little skilled labour, so that when a price for the carbide had been established by contract the cost of the gas could be easily estimated; let us see what price such a company could expect to obtain from a consumer.

Value of Acetylene as an Illuminant.

Suppose we take the case of a competition with the gas companies of a large town. At first sight it would seem fair to say we pay for the light gas gives, and if a new gas gives ten times more light we are willing to pay ten times more, particularly if it possesses any other advantages; our gas bill will remain the same.

Here we come upon ground where the facts can be tested by experiments. I have made a large number of measures of illuminating power and find that with a new burner particularly suited to it 5 cu. ft. of acetylene per hour will give 200 candle power; 5 cu. ft. of Boston gas will give a little more than 25 candle power. The Brookline gas is a little brighter. From this point of view alone then we can pay in Boston about $8 per 1000 cu. ft. for acetylene when we pay $1 per 1,000 cu. ft. common gas. But will the gas bills remain the same at this ratio? More light will probably be used and the householder will be led into a more extravagant consumption, and he must decide what he is willing to pay for the new luxury. We must count then with the tastes of the consumer, and these can only be translated into money values after long trial of the new light in many houses.

Besides the question of meeting the desire of the consumer for more or less light is another, which must be taken into consideration depending upon his expertness in burning gas and the care he is willing to take in getting economical results.

No. 1. A Sugg-table fishtail burner is shown, burning just 5 cu. ft. per hour and giving the light of 25 candles. If more or less than 5 cu. ft. of gas is passed through it per hour it gives a lower efficiency and the light costs more. The law in Massachusetts, 1882, requires that the candle power should be tested with the most efficient burners, and I have used the best one for water gas. Coal gas would have given more candle power in an Argand burner. Burning gas economically is an art which is only understood by experts, and here again the habits of consumers disturb calculations; they are not usually willing to take the pains to get the best burners, as the following experiment will show.

No. 2 is a gas burner taken off the pipes in the Technology building and represents the average condition of burners in dwellings. About one-half the illuminating power of the gas is lost in this burner, and few people think of having the burners changed when they become inefficient.

If I put a globe over the burner, about half the light is absorbed, so that with a bad burner and with a milk-glass globe we pay about four times as much as need be for light; but the use of a globe is often necessary for comfort. The acetylene gas gives a different colored light, and I thought it might pass through the globe in larger proportion, but on measuring the candle power I found this was not the case. Perhaps a globe can be found that will especially suit acetylene light.

An important question then is to be answered before we can compare the lighting power of gas and acetylene. Is an acetylene light more tolerant of lack of care in the burners and of variations in the pressure than is the case with common gas? The most superficial observation shows that the two gases must be burnt in a very different way.

Gas burnt in an acetylene jet gives less than one-tenth of its true lighting power, and acetylene burnt in a common gas burner gives a yellow, smoky flame, and when turned down to a small flame it deposits soot on the jet, clogging the burner, if the opening consists of a straight slit. Even the very fine fishtail burners with a straight slit intended for oil gas suffer from this defect when the acetylene flame is turned down.

It appears then from the last experiments that the choice of burner and the mode of using it are very important factors in determining the value of any kind of illuminant, and hundreds of pages have been published on this subject with reference to oil and gas light, and it may be added that the results are not yet concordant.

Acetylene can not well be burnt in an Argand burner nor with the devices that succeed with petroleum lamps. A fishtail flame with a good exposure to the air must be used, and the best form of burner is that which throws the swiftest stream of acetylene into the air in the form of a very thin sheet.

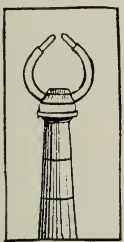
A lava-tip burner has long been used for gas in which the opening is not a slit, but two small holes. The construction of these burners can be well shown by passing gas through two blowpipe jets, and when the two long jets of flame are made to impinge on each other at nearly a right angle they spread out into a fishtail form. Acetylene can be burnt in very small lava tip jets of this class, and gives about 30-candle power, but the light can not be turned low without losing its efficiency and smoking.

An experiment can easily be made which shows how large a quantity of air is required to render acetylene flames smokeless. Mix acetylene gas with measured quantities of air up to $1\frac{1}{2}$ volumes of air and burn the mixtures in a slit fishtail burner. It will be found that the acetylene does not diminish notably in illuminating power. Larger proportions of air begin to destroy the brilliancy of the flame. The same trials with common gas show that a very small proportion of air renders the flame less luminous. Suitable burners must be chosen in each case.

Acetylene can even be burnt mixed with one-third its volume of oxygen, giving a very brilliant flame. These experiments are only of practical value in indicating the kind of burner which should be chosen for acetylene. Another quality of the flame is very instructive from the same point of view. The acetylene flame clings to the burner in an extraordinary way, so that it is difficult to blow it out, and the luminous part of the fishtail flame almost touches the jet, while in a gas flame a large blue zone separates the luminous part from the jet.

By exploring the flame with a bit of platinum wire, it is easy to see, by the intensity with which it glows, which is the hottest part, and also to recognize that the luminous part deposits soot on any cold object.

These experiments led to the idea of constructing a new form of burner for acetylene gas, in which the jets should be very fine and very perfect in form, and which should give the best probable access of air, and which should bring a very small section of metal in contact with the flame in order to avoid smoke and the deposit of soot.



The form eventually chosen is shown by the sketch. The burner is made of brass with nickel or steel tips. The extreme points in contact with the flame may be tipped with platinum or silver, but steel answers the purpose quite well. The most essential feature is that the tips should not be larger than $\frac{1}{16}$ inch in diameter. These burners abstract very little heat from the flame and consequently give more light than the usual form for the same candle power. They do not smoke with any height of flame. They burn acetylene advantageously with the 10- to 20-candle-power light to which we are accustomed. Lava tips are not well suited to such small flames, because the section in contact with the flame is about 20 times larger and abstracts so much heat that the metal setting for several inches in length becomes very hot. Loss of heat occasions loss of light.

It is particularly important in burning acetylene that a large supply of air should be drawn into the flame by the suction of the gas jets which issue from the two orifices of the burner. The steel jets described above provide for this by their perfection of form, as they are bored from their base and have the same proportions, which have been found to throw the swiftest stream under a given pressure with a hose nozzle.

It seems probable, in view of the careless use of burners in the ordinary consumption of gas, that one quality of acetylene will tell in its favor. With a suitable burner acetylene will tolerate greater variations of pressure than common gas. This point was determined by more than 100 measures of the candle power taken with the two gases burning under different pressures.

The smallness of the acetylene flame required to give off a brilliant light is a point in its favour, allowing the use of a great variety of globes and shades for tempering or reflecting the light.

The same quality will be found of advantage when a strong light is to be concentrated as nearly as possible at the focus of a mirror or of a lens, as in locomotive headlights or in lanterns for projections.

It was hoped that the quantity of light given off by duplex or triplex acetylene flames would show a particularly economical consumption, but the results of measures of the candle power of such flames with or without chimneys were disappointing. It appears that defect of air supply with such flames more than counterbalances the effect of the heat which one flame communicates to the other.

It might be desirable to use the existing gas plants and to deliver, as heretofore, a gas of 20-candle power suitable for heating or lighting. Such a project seemed very easy of fulfilment, since it was at first supposed that acetylene could be used to enrich common gas, and in that case no changes would be required in the mode of distribution nor in the form of burners. Experiments have shown that it can be employed to enrich coal gas, but that water gas, which is so largely used in this country, cannot be enriched by acetylene. Water gas has little illuminating power and requires to be enriched by passing petroleum oil into the retorts during the manufacture, and it is only when water gas has already been brought up to a certain candle power that acetylene gas can be mixed with it without losing its effectiveness as an illuminant; so that it cannot be used as a substitute for petroleum to enrich crude water gas.

There is no apparent reason *a priori* why an admixture of a combustible gas should deprive acetylene of its illuminating power, and it is interesting to examine separately the effect of each one of the constituents of water gas to see which one has this property.

Brookline gas, besides 16°/$_{\circ}$ of illuminants derived from oil, contains equal quantities (about 26°/$_{\circ}$) of hydrogen, marsh gas and carbonic oxide. If each one of these is burnt separately with acetylene it appears immediately that it is the carbonic oxide which renders the acetylene non-luminous. Ammonia also has a singular effect upon common gas and upon acetylene, nearly destroying the lighting power and giving a beautiful faint purple flame with curious marked fringes, but ordinarily only traces of ammonia are contained in gas. Nitrogen has much less effect than ammonia or carbonic oxide in destroying the illuminating power of acetylene.

The preceding statements tend to show that a summary of the qualities of acetylene gas, as compared with common gas, must comprise other data beside the measures of candle power, and I have endeavoured to point out some of the peculiar properties of the new light which are advantageous. The price and the taste of the consumers must decide the question of competition.

The gas of small towns is usually poorer in quality and higher in price than in large towns, and perhaps the opportunities for the introduction of acetylene are greatest in this direction. Consumers may be willing to pay

$15 per thousand for acetylene gas where they pay $1.50 for 16-candle water gas or coal gas.

I should expect to see it first introduced to replace the very expensive oil gas used in railroad carriages, and also for special purposes where great brilliancy and concentration are required, like the headlights of locomotives. For such purposes the Welsbach light cannot be used, because it is destroyed by jarring. The adherence of the flame to the burner is an advantage for railroad use, making the flame hard to blow out. For shop-window illumination the Welsbach light, which is very much cheaper than gas burnt in any other way, seems to be beyond the reach of competition ; and the Auer burner, which is similar, is now used for street lighting in Paris, and these incandescent lights work well wherever the light is not shaken, and where the disagreeable green tint is not an objection.

For country houses acetylene light seems well fitted and might replace the very bad illumination of gasolene light.

Much skill and special knowledge are required to run gas works, while the making of acetylene from the carbide or its distribution as a liquid is so simple that acetylene stations could be established in many villages too small to make gas works pay. Moreover the winter consumption of gas is two or three times that of the summer, when the gas plant lies idle in part. With acetylene there is an advantage in this direction, because the value of the plant would be much less.

The whiteness of acetylene light renders it useful for displaying or sorting colours, and some experiments made with Mr. C. R. Walker show that, for photographic purposes, when equal quantities of acetylene light and of water-gas light, measured by candle-power, are compared, the acetylene light has two and one-half the actinic value of the other.

Poisonous Qualities of Gas and Acetylene.

Continuing the comparison of common gas and acetylene, let us see how the case stands from a sanitary point of view. We see reports in the newspapers of deaths and attacks of illness from gas poisoning, the dropping out during the night of the core of a gas cock or a break in a pipe, would often be an accident fatal for the inmate of a small, close bedchamber. Recently persons have been poisoned by a defect in the gas main outside of their houses. Workmen are frequently made ill by a leak in the gas mains while working in a trench, but the officers of the gas companies state that such accidents are very seldom fatal.

There is no question then about the poisonous qualities of common gas and particularly of water gas. Is the new illuminant likely to be less dangerous?

The poisonous constituent of common gas is carbonic oxide. London gas contains 3.2 to 7%; Paris gas 7%; Berlin gas 8%; Boston gas 26%.

Formerly there was a legal limit of 10%, which is now removed, and the introduction of water gas has raised the percentage to this very high and dangerous amount.

Carbonic oxide is not irritating or corrosive, and it seems strange that a compound so nearly allied to carbonic acid, which is innocuous, should act as a rapid poison.

The mode of action is this: Carbonic oxide is absorbed and retained by the blood in a way quite different from other gases. It combines with the red corpuscles, and the compound shows under the spectroscope special absorption bands, which make the recognition of its presence easy.

Blood which has taken up a certain quantity of carbonic oxide no longer is capable of taking up oxygen in the lungs and conveying it through the circulation, and death by suffocation ensues, just as if there were not enough oxygen to breathe.

The blood is so sensitive to carbonic oxide that so little as 0.03% in the air can be shown (Bull. Soc. chem. (6) 663) when a solution of blood is brought thoroughly in contact with a mixture containing carbonic oxide.

The best way to bring a liquid in contact with a large body of air or gas would be to have it circulate by means of minute canals, using a pump to keep the current in motion through the cell walls of a sponge, while the air was continually changed by squeezing and relaxing the sponge. We can find such a little machine in a very perfect form in the body of a small animal, the veins and arteries constituting the canals, the pump being represented by the heart, and the sponge by the lungs.

If we sacrifice a mouse as a martyr to science and enclose him in a tight box containing air with a known percentage of carbonic oxide, and kill him after 3 or 4 hours, we can detect the carbonic oxide absorbed by his blood.

A similar method is best suited to discovering whether acetylene is absorbed by the blood. We might suspect that this would be the case since the two gases have in common the peculiar property of being absorbable by solutions of subchloride of copper.

Grehant (Comptes Rendus, 1895, II., 565) made a careful comparison of carbonic oxide and acetylene in respect to their poisonous qualities upon dogs. He took care to have 20% oxygen always in his mixtures, so as to give it the vital quality of air and not to kill his animals by suffocation. He added 1% carbonic oxide (*i.e.*, enough Paris gas (containing 7% CO) to give 1% carbonic oxide). After 3 minutes the animal suffered; after 10 minutes the dog was very sick and his blood contained 27 volumes per 100 of carbonic oxide. The dog would have soon died if the experiment had been prolonged.

In a mixture containing 20% oxygen and 20% acetylene a dog breathed without inconvenience for 35 minutes.

His blood contained 10% acetylene, less than $\frac{1}{50}$ the rate of absorption of carbonic oxide and not a larger percentage of acetylene than would have been absorbed by water. The mixture contained much more acetylene than could ever get into the air of a room, and in fact in a dwelling house a much smaller quantity would produce an explosion.

A dog was killed by breathing 40% acetylene and 20% oxygen in 51 minutes; another in about 30 minutes by 80% acetylene and 20% oxygen. A guinea pig was *not* killed in 39 minutes by the same mixture.

L. Brociner (Comptes Rendus, 1895, II., 773) had made similar experiments in 1887, and concluded that acetylene was not poisonous. It is not more absorbed by blood than by water. It has *no* specific action on blood. Sulphide of ammonium reduces such blood normally. It has no special absorption band.

Berthelot and Claude Bernard 30 years ago found acetylene not poisonous.

Moissan (Comptes Rendus, 1895, II., 566) says pure acetylene only has an ætheric agreeable odor.

Bistrow and Liebreich in 1868 (Ber. I., 220) pronounced acetylene poisonous, but this opinion is contrary to that of Berthelot and of Claude Bernard, and Berthelot has recently stated anew that pure acetylene is not poisonous, and has pointed out that the old method of preparation of acetylene by means of the acetylide of copper may contaminate the gas with prussic acid (Comptes Rendus, 1895, II., 566). It may be concluded then on the best authority that *pure* acetylene is not poisonous.

The smell of freshly prepared acetylene made with commercial carbide of calcium would lead one to suspect that the gas contained phosphoretted hydrogen and Wellgerodt (Ber. 1895, 2107, 2115) detected its presence in acetylene by passing the gas through nitrate of silver solution. I also got by another method a good molybdate test for phosphoric acid, before I knew of the above publication.

The phosphorus is probably derived from phosphates in the quicklime and in the ash of the coke used for making the carbide of calcium. Moissan used a pure carbon obtained by charring sugar, and his carbide gave pure acetylene free from disagreeable odor. The previous statements that acetylene is innocuous may only apply to pure acetylene, and it is important then to make a special examination of commercial acetylene to see if it contains dangerous constituents. I have only found one statement on this subject, contained in the Electrical Engineer, New York, November 13, 1895, p. 469.

Dr. W. H. Birchmore says that 1 cu. ft. of acetylene in 10,000 cu. ft. of air produces headache in twenty minutes, and that so small a quantity of acetylene is not perceptible to smell.

I have frequently breathed air containing enough acetylene to be very plainly noticeable from its smell, and have not suffered the slightest inconvenience. It seems probable that individuals differ greatly in their susceptibility to poisons of the class to which phosphoretted hydrogen belongs. It is also quite possible that other poisonous gases in very small quantity may constitute impurities of acetylene. Dr. Birchmore performed a single experiment upon an animal and states that one part of acetylene in 10,000 parts of air killed a guinea pig in six hours; sickness came on in ten minutes. The blood lost its power of absorbing oxygen, as in a case of poisoning by cyanhydric acid. He did not examine the blood for acetylene. Experiments of this kind should be repeated by competent physiologists, and the blood should be carefully tested. It is quite certain that in this case the death was caused by some other body present and not by the pure acetylene.

If it is found that phosphoretted hydrogen or some similar impurity is present in dangerous quantity, they can probably be removed by a proper treatment of the gas.

Arsenuretted hydrogen might also be present, but I have failed to find any trace of it in commercial acetylene.

It has been said that acetylene gas could never act as a poison, because an escape from a leaky pipe would attract the attention of a person, even while asleep, by its irritating action upon the throat, producing coughing. The statement is contrary to all my observations.

Further experiments upon this subject are required, but the evidence already accumulated seems to be favourable to acetylene as compared with water gas, and if the new illuminant can be made for a reasonable price and can be quite freed from poisonous impurities it should become a formidable competitor with water gas. On the other side, however, we shall find that the danger from explosion will call for special precautions in the use of acetylene gas.

Danger in Use of Liquefied Acetylene.

There will be an evident advantage, if acetylene gas lighting succeeds, to begin by introducing it without putting down mains and setting down generating houses; this can be done by supplying customers with liquefied gas. A cylinder holding say 1,000 cu. ft. gas compressed in a space of less than 2 cu. ft. can be attached to the gas pipes of a house in place of a meter.

This new gas service is, however, not so simple as would at first appear. Two cylinders must be used at once, or at least a second one must be brought before the first is exhausted to make the supply continuous, otherwise we should have the disagreeable surprise of finding the gas extinguished. A gauge on the cylinders must be watched to see when No. 1 must be cut off and No. 2 turned on.

Neglect in care of this will cause extinction of the gas and discredit of the system. The gas companies have accustomed us to a constant supply through mains at an even pressure and have set a high standard of convenience.

The cylinders contain gas at a pressure of 6 to 700 lbs. A reducing valve, always kept in order, must reduce this pressure to 1 oz. = 2 inches water. The Pintch valve employed on railroad lines is used, but we must ask the question : Will it always keep in order with the care it would get in a private house or tenement house? Then an escape valve is required in case a fault of the Pintch valve throws the whole pressure on the pipes. A mercury seal would answer to empty the gas into the air, and it could be counted on to work satisfactorily, but the gas would be lost each time that the valves got out of order. All this apparatus makes the use of liquefied acetylene somewhat complicated, and in addition to this disadvantage it would present a serious danger in case of fire. The cylinders when strongly heated would be liable to explosion, and it is proposed to guard against this danger by employing a mercury seal to empty them when the pressure exceeds safe limits. This arrangement, even supposing that it always performed its office during a fire, would be open to a serious objection, for if the fire took place in a large building in a town containing, say, 10 cylinders with 5,000 cu. ft. of gas in the 10, this quantity of gas thrown in the air would make an explosive mixture with 20 times its volume of air, or about 100,000 cu. ft. in all, and whether disengaged on the roof or in the street would expose the firemen to a new danger.

If we add to the small annoyances arising from the care of a gas supply which is not constant like that of gas delivered in mains, the danger of explosion of a cylinder weakened by rust or neglect, the danger in case of fire and the very doubtful economy of the systems, the summary seems unfavourable to use of liquefied acetylene, except in places where sufficient space can be had to isolate the cylinders as gasoline tanks are now isolated.

It will be seen later that these cylinders may be exposed to a special danger, although a very improbable one, from the explosive decomposition of acetylene under the impulse of a certain kind of shock.

The Temperature of the Acetylene Flame.

When we compare acetylene and common gas illumination from the point of view of the products of combustion which vitiate the air of a room, or of the heat which is given off, the conclusions are very favourable to acetylene lighting, because ten times as much common gas has to be burnt to obtain the same amount of light as would be given by a unit measure of acetylene. The heating effect, however, is not in the ratio of ten to one. Ten cu. ft. of Boston gas give 2.42 times as much heat as 1 cu. ft. of acetylene.

Prof. Lewes[1] has calculated the amount of carbonic acid given off by different illuminants, and finds, for an equal amount of light,, that coal gas gives off six times as much as acetylene, and he estimates that the heat from acetylene would not be much greater than from the ordinary incandescent lamp.

The true relations are for the same amount of light :—
Heat from incandescent light, 1 ; acetylene, 3 ; water gas, 9.

Prof. Lewes says, in the same connection :—" The flame of acetylene, in spite of its illuminating value, is a distinctly cool flame, and in experiments which I have made by means of the Lechatelier thermo-couple, the highest temperature in any part of the flame is a trace under 1,000° Cent. While coal gas, burning in the same way

[1] A paper read before the Society of Arts, London.

in a flat-flame burner, the temperature rises as high as 1,360 Cent."

It is not an advantage, but a disadvantage, that the fishtail acetylene flame should be cool. Its temperature is lowered by the excessive contact with air required for complete combustion, and, if the flame could be made hotter, more light could be obtained for the same quantity of heat. It is scarcely necessary to add that the temperature of a flame has nothing to do with the heat of combustion. Phosphorus or sodium can be burnt at the ordinary temperature, or at a red heat, and the heat of combustion is the same at either temperature, provided the products of combustion are the same.

Lechatelier,[1] one of the best authorities upon such a subject, does not appear to have measured the temperature of the acetylene flame with his pyrometer, and, in fact, such measurements are very difficult; but he has calculated that acetylene, burned with air, may reach a temperature of 2,100° to 2,400° Centigrade, and, burned with oxygen, 4,000°.

It is easy to melt platinum in a common air blowpipe flame fed with acetylene, but the platinum appears to first form a carbide.

Acetylene, notwithstanding its high cost, may find a restricted use in the laboratory in air or oxygen blast furnaces; it will undoutedly give a higher temperature than gas or hydrogen.

The preceding description has continually held in view the utilitarian side of the question, and it has been thought simpler to enumerate the items in favour of the economical use of acetylene as compared with gas and not to extend the comparison to other forms of illumination, but the following table mostly taken from the most recent book[2] on the subject gives the means of comparing other modes

[1] Comptes Rendus, December 30, 1895.

[2] Julius Swoboda: Petroleum Industrie. Tübingen, 1895.

of lighting. It is to be remarked that authorities differ widely in their estimates, and the cost of gas and electric lighting varies greatly with the locality. Electricity is particularly advantageous when it can be put to other uses during a part of the day.

100 CANDLE LIGHT DURING ONE HOUR.

	QUANTITY.	COST. CENTS.	Heat of combustion. Kilograms of water 1 degree.
Arc light	0.09—0.25E	1—2.5	57—158c
Incandescent lamp	0.46—0.85E	3—5	290—536c
Boston gas, $1 per 1000	20 cu. ft.	2.0	3380c
Acetylene, $10 per 1000	2½ to 3 cu. ft.	2.5—3	1000—1200c
Petroleum lamp	0.62lb.—1.0 lb.	2.0	3360c
Carcel oil lamp	0.9 lb.	8.0	4200c
Paraffine candle	1.7 lb.	28.0	9200c
Spermaceti candle	1.7 lb.	54.0	7960c
Wax candle	1.7 lb.	61.0	8940c
Stearine candle	2.0 lb.	33.0	9700c
Tallow candle	2.2 lb.	32.0	

THE CHEMICAL PROPERTIES OF ACETYLENE.

A series of very simple experiments will illustrate the most important properties of acetylene.

To compare its density and its explosive force with those of common gas take two lamp chimneys closed at the top and bottom with corks, and each fitted with an inlet tube at the bottom and with a large brass tube at the top. Fill one with gas and the other with acetylene and light both gases at the upper tube; then remove the rubber tubes from the inlet tubes. The flames will continue to burn at the upper orifice, because each gas rises, floating on a layer of air, which rushes in from below, and the relative densities of the gases may be estimated from the rapidity with which each flows out. The common gas flows out more rapidly and burns with a higher flame than the acetylene, because it is lighter: (density of Boston gas = 0.607; density of acetylene = 0.91). At the last the flame strikes down into the small residue of each gas, which has become mixed with air in the lamp chimneys, and a slight explosion takes place, which is notably stronger with acetylene than with gas. The greater density of acetylene explains partly why it should have more illuminating power than common gas, since a cubic foot contains more material. As our object is only to examine the properties of acetylene which have a bearing upon its illuminating power, one test of its chemical activity will suffice. Set free a small quantity of hypochlorous acid gas in a tall glass jar and plunge into it a tube from which a stream of acetylene is issuing, this latter will immediately take fire from the great heat evolved by its chemical action upon the hypochlorous acid. If common gas, or almost any other gas, were subjected to the same test, no flame would result.

Acetylene forms peculiar salts with copper, silver and mercury; and these when dry decompose explosively when subjected to a shock or to the action of heat. The silver compound can even be exploded under water and is more dangerous than fulminate of silver.

Explosiveness of Acetylene.

What we have learned concerning the extreme chemical activity of acetylene leads us to expect that it would form more readily than other gases an explosive mixture with air, and this proves to be the case.

Experiments using a piece of two-inch gas pipe as a cannon show that 5–6% of acetylene mixed with air forms an explosive mixture; 10–12% of water gas is required to explode with air.

The heat abstracted by the walls of the iron tube prevents the mixture from obtaining its limit of explosiveness, and a still smaller percentage of either gas mixed with the air of a room would explode. Lechatelier (Comptes Rendus, 1895, II., 1145) gives 2.8°/₀ of acetylene mixed with air as the explosive limit, and it is to be noticed that in a dwelling house the danger from explosion is enhanced by the inequality of such mixtures. A flame spreading from a spot rich in gas would propagate itself explosively through a mixture very poor in gas.

The danger is enhanced in the case of acetylene by the low temperature at which it takes fire, 480° Cent. Most other gases must be treated to about 600° to take fire and marsh gas, the fire-damp of mines, fortunately requires a much higher temperature to ignite, so that a spark from flint and steel does not suffice to cause an explosion. Acetylene burns with greatest increase of volume when the products are carbonic oxide and hydrogen. The violence of combination of acetylene with oxygen can be well shown by igniting equal volumes of the two gases. A quantity equal to 3–4 grains makes a far louder report than the same weight of powder or of nitro-glycerine.

The dangerous properties shown by acetylene need not condemn it, but particular care must be taken to prevent leakage if acetylene gas comes into use; fortunately, small pipes can be used and the gas contains no ammonia, which, in common gas, destroys the grease on the stopcocks and promotes leakage.

If instead of igniting a mixture of air and acetylene, the latter alone is passed through a glass tube heated to dull redness, at first a slight change takes place, and liquid benzene and other products condense in the colder parts of the tube; at a little higher temperature the change goes further—carbon is deposited and hydrogen is set free. If the interior of the tube is carefully watched it will be seen that the decomposition takes place with a dull red flame, as if the acetylene were burning with an insufficient supply of air. No air, however, is in the tube: there is no combustion in the ordinary use of the word, and yet we have in the flame evidence of a sudden disengagement of heat. Here we approach the solution of the problem, regarding the extraordinary chemical activity of acetylene. Acetylene has a supply of heat stored up, which it gives off whenever it is decomposed spontaneously, burnt in air, or excited by any radical chemical change. The sudden evolution of heat manifests itself as light, quickens combustion and promotes all chemical action.

The exact quantity of heat absorbed and stored up by acetylene, when it fs formed by the union of carbon and hydrogen, can be best measured by two experiments. Firstly, burn exactly one cubic foot of acetylene in a calorimetric apparatus, which is merely a device for heating a given weight of water without loss of heat, and find that nearly nine pounds of water can be heated from its freezing to its boiling point. Or, if we take the thermal unit in more general use we find that 407 kilograms of water gain one degree Centigrade in temperature from the heat given off by burning one cubic foot of acetylene gas, measured at 0° Cent. and 76 cm. barometer.

Secondly, take exactly the weights of carbon and hydrogen which correspond to the weight of one cubic foot of acetylene and burn them in the same way under a weighed quantity of water. We shall find that according as we take pure amorphous carbon or diamonds we get a somewhat different quantity of heat. With amorphous carbon and hydrogen 336.5 kilograms of water are raised 1 degree Cent. in temperature. The difference of heating power then between acetylene gas and the same weight of carbon and hydrogen is 71 heat units. The surplus energy stored up in the acetylene and set free when it is burnt becomes evident and is measured, when we find that the acetylene arrangement or combination of carbon and hydrogen atoms is capable of making the elements do more work, that is to heat 71 kilograms more water than when the same elements are free in the state of amorphous carbon and of hydrogen gas.

When the carbon from carbide of calcium and hydrogen from water combine to make acetylene heat is utilized in changing the carbon from the solid and the hydrogen from the liquid form to the form of a gas. Heat is absorbed in this process which imparts a new energy of motion to the atoms, in the same way that heating water separates the particles to two thousand times wider distances from each other and gives them the energy of motion which is apparent in steam. In this case we can measure the amount of heat required for this work and which is absorbed while it takes place. Unfortunately we can not get similar measures with carbon vapour and solid carbon, and we can only measure a total absorption of heat during the generation of acetylene, and we suppose that the total, 71 heat units, may be made up by the absorption of a larger amount of heat in order to change amorphous carbon to the gaseous state, from which must be deducted the heat which is given out when two carbon and two hydrogen atoms combine to make C_2H_2. Benzene which has exactly the same percentage of carbon and hydrogen, but combined into quite a different chemical group, shows that more energy has been expended in bringing about its chemical arrangement. The signs which attest this are greater stability, smaller chemical activity, and above all the fact that when benzene is burnt it gives off much less heat than the same weight of acetylene does, and in fact only 4 heat units more than the same weight of carbon and of hydrogen.

It has seemed necessary to explain fully how quantities of energy, which can usually be measured in terms of heat, preside over the making of different chemical compounds, and how the dormant heat can be made active again when the compounds are excited to chemical change, and how each one is stamped as with a birth-mark by its special heat value.

This peculiar stamp set upon acetylene is at the same time a token of valuable and also of dangerous qualities. Heat is added to the heat of combustion and brings about more sudden changes and plaees acetylene with the class of bodies known as fulminates. These are distinguished from explosives like gunpowder by their capability of suddenly evolving stored-up heat, which causes a great expansion of gaseous products. Berthelot has calculated that fulminate of silver develops a pressure of 600,000 lbs to the square inch in the incredibly short time of one-thirty-millionth of a second. The acetylide of silver has similar properties, and the lightest shock suffices to explode it. It occurred to Berthelot to see whether acetylene gas might not decompose spontaneously into carbon and hydrogen with explosive suddenness. We have seen that it decomposes into these products, *but without explosion,* when strongly heated, and only in one way could it be made to decompose explosively. Berthelot succeeded in detonating pure acetylene by subjecting it to the shock of fulminate of silver.

The danger seems very slight that acetylide of copper or some other metal may form in an acetylene gas holder, and when exploded by friction or heat cause the whole mass of gas or liquid acetylene to explode. The subject, however, is worthy of further study.

As was said in the beginning, the problems which are suggested by this new industry touch on all sides upon some of the most important of the recent discoveries in chemistry and physics, and the ease with which acetylene can be obtained opens the door to many new experiments. Such questions, for instance, as the use of acetylene in gas engines, under special conditions, where the high price would not be prohibitive, would offer a very interesting study. It does not seem impossible that a gas so active and so easily stored might be exploded with air in a pneumatic gun to give an additional impulse to the projectile.

The laboratory experiments which have been described may perhaps serve as a guide in some directions to manufacturers, but they cannot settle the commercial details upon which the success of the new enterprise depends. Much further study and tests upon a larger scale, with the improvements suggested by prolonged trial, can alone decide whether the new illuminant is destined to supplant older industries built up slowly and surely by the persistent efforts of hard-working and skilful men.

Two Shrews of the Genus Sorex, new to New Brunswick.

By Philip Cox, A.B., B.Sc., Ph.D.

It may be of some importance to those interested in the distribution of small mammals to learn that two species of the genus *Sorex* have lately been found in New Brunswick, which are not only new to Provincial lists, but the occurrence of one of them is more than a surprise.

Sorex Richardsoni, Bachman, a boreal form of the North-West and Northern portion of the Central Plain, has not, so far as the writer can learn, been reported east of Northern Minnesota. That it should turn up on the Atlantic side of the continent could hardly have been suspected ; yet the writer collected it here in the winter of 1894-95, Indeed it is by no means rare on the intervales and low forest country adjacent to the St. John River, in Maugerville, Sunbury County.

S. fumeus, Miller, *S. platyrhinus*, Dobson—not *S. platyrhinus*, Baird—another sub-boreal form frequenting to the south the upper parts of mountains, was also collected about the same time in coniferous woods by the banks of a stream in Maugerville. It seems very rare, but one specimen having been taken. Dr. C. Hart Merriam, ornithologist and mammalogist of the Department of Agriculture, Washington, to whose kindness I am indebted in connection with placing the identification of these species beyond doubt, informs me it has never been reported north or east of New Hampshire.

Proceedings of the Natural History Society.

Montreal, Oct. 28th, 1895.

The first monthly meeting was held this evening, the President, Rev. Robert Campbell, in the chair.

Present: J. B. Williams, J. A. U. Beaudry, Geo. Kearley, John S. Shearer, E. T. Chambers, A. T. Winn, Walter Drake, and others—twenty-seven persons in all.

The Curator, J. B. Williams, reported the following donations to the Museum since the last meeting, in May:—

Skull of Albatross—Capt. W. Rome.
Piece of Yucca palm—H. J. Tiffin.
Nest of red-eyed Vireo—P. J. Copland.
Nest of red-eyed Vireo—G. A. Dunlop.
1 Menobranchus—J. B. Williams.
Head of a fossil Whale—Capt. W. Ross.
2 ribs of a Whale—Capt. W. Ross.
1 Rock Bass—E. D. Wintle.

And the following twelve living snakes :—

1 young garter snake—S. W. Boyd.	
1 do do H. Swift.	
1 red-bellied snake 2 Dekay's brown snakes	J. B. Williams.
2 Dekay's brown snakes 1 red-bellied snake	H. Jackson.
1 grass snake—Mrs. H. H. Austin.	
1 young red-bellied snake 1 young grass snake	J. B. Williams.

E. T. Chambers, Chairman of Library Committee, reported having received from the U. S. Geological Survey a copy of the Geological Atlas of the United States.

Moved by E. T, Chambers, and seconded by Walter Drake, That the thanks of the Society be sent to the United States authorities for their donation.—Carried.

Moved by J. A. U. Beaudry, and seconded by J. B. Williams, That the thanks of this meeting be sent to the donors of the different specimens.

The following new members were elected by acclamation on the motion of John S. Shearer, seconded by E. T. Chambers, the rules being suspended for that purpose :—David Robertson, Ald. R. Prefontaine, W. C. McKechnie, A. E. Deeks, M.D., Rev. G. Colborn Heine.

The President then requested the First Vice-President to take the chair that he might read his paper entitled "Some additional Notes on the Flora of Montreal."

Moved by Geo. Kearley, seconded by A. F. Winn, That the thanks of this meeting be extended to Dr. Campbell for his very interesting communication.—Carried.

Mr. J. B. Williams then read his communication entitled "Notes on the Canadian Stick Insect (*Diapheromera femorata*)." Moved by J. A. U. Beaudry, seconded by John S. Shearer, That the thanks of this meeting be extended to Mr. Williams for his intensely interesting and instructive paper.

MONTREAL, Nov. 25th, 1895.

The second monthly meeting of the Society was held this evening, John S. Shearer in the chair.

Present: Messrs. J. B. Williams, Geo. Kearley, Harold B. Cushing, B.A., J. A. U. Beaudry, F. W. Richards, E. T. Chambers, Hon. Mr. Justice Wurtele, A. F. Winn, C. R. Chisholm, Rev. G. Colborne Heine, H. McLaren, Prof. J. T. Donald, Dr. C. W. Wilson, and others.

The minutes of last meeting, October 28th, were read and confirmed.

The report of the Museum Committee was then read and adopted. It contains the following proposal, should the Society approve of the scheme :—To arrange for some short talks or lectures to young people on different objects in the Museum, to be given on Saturday afternoons during the winter months. Such a course of six or seven lectures, it was thought, would interest people in the museum, and help to bring in some young members to the Society.

DONATIONS.

The following donations were reported :—

Nest of Baltimore Oriole—Miss Jackson.
American Merganser—Mr. John Donavan.
5 Lake Urchins—Miss Marion B. Shearer.
Pileated Woodpecker (shot on Mount Royal)—Mr. David Denne.
The Hand-Book of the Flora of New South Wales, by the Hon. Mr. Cheoles, F.L.S., etc., etc.

A vote of thanks to the donors was moved by J. A. U. Beaudry and seconded by H. McLaren.

The following new members were elected by acclamation, the rules being suspended for that purpose :—Capt. W. Ross and Harold B. Cushing, B.A.

Prof. J. T. Donald then read a very interesting communication on "Gold Mining in California, Past and

Present," after which a vote of thanks was tendered to Prof. Donald for his able and excellent paper.

Mr. Harold B. Cushing then read his paper entitled "An Exhibit of Native Ferns of the Island of Montreal."

Moved by E. T. Chambers, and seconded by Geo. Kearley, That a vote of thanks be extended to Mr. Cushing for his very interesting and instructive communication.—Carried.

MONTREAL, Jan. 27th, 1896.

The third monthly meeting of the Society was held this evening at eight o'clock, Rev. Robt. Campbell, D.D., President, in the chair. There were present Sir J. W. Dawson, John S. Shearer, J. A. U. Beaudry, Walter Drake, Fred. W. Richards, Geo. Sumner, Prof. Adams, J. B. Williams, Geo. Kearley, David Robertson, Jas. Gardner, E. T. Chambers, F. D. Reid, M.D., H. McLaren, Hon. Mr. Justice Wurtele, Capt. W. Ross, Miss Howard O'Keefe, and others.

Dr. Campbell reported that the Street Railway Company had withdrawn its application to the City Corporation to build the road through the Mount Royal Park.

There was an informal discussion with regard to the proposed Conversazione.

The following donations were received by the Society :—

Collection of Cocoons and Chrysalides, from A. F. Winn.
Resplendent Trogon (skin) }
Least Bittern (male). . . . } from J. Manghan, jr., of Toronto.
Least Bittern (female) . . }
Virginia Rail, from J. B. Williams.
Long-billed Marsh Wren, from J. B. Fleming, Toronto.
Engraving of Labrador Duck, from E. D. Wintle.
Eider Duck, from John Morris.
Piece of Bermuda Coral, from Dr. Deeks.

It was moved by John S. Shearer, and seconded by Walter Drake, and carried, that they be acknowledged by the Secretary.

On behalf of the Lecture Committee, Dr. Campbell announced that arrangements for the Somerville Course for 1896 were almost completed.

J. B. Williams, the Curator, announced that the Museum Committee had arranged for a series of Saturday afternoon talks, and submitted the programme.

The President then introduced Sir J. W. Dawson, who gave a most interesting paper, "On Some Older Rocks of the Lower St. Lawrence," illustrated by specimens of fossils, drawings, etc. At the close of the paper, Capt. W. Ross gave some facts regarding a specimen of the head of a fossil whale, and asked Sir William Dawson some questions concerning it.

Dr. Adams referred to the obligations the Society were under to Sir William, and also referred to the advantages of careful observation.

A hearty vote of thanks to Sir William was moved by Dr. Adams, seconded by Walter Drake, and carried unanimously.

The question of a petition against a new saloon in the vicinity was discussed, and it was referred to the Council.

MONTREAL, Feb. 26th, 1896.

The fourth monthly meeting of the Society was held this evening at eight o'clock in the Lecture Hall, Hon. Justice Wurtele in the chair. There were also present E. T. Chambers, J. A. U. Beaudry, F. W. Richards, Geo. Kearley, John S. Shearer, J. B. Williams, Prof. Penhallow, Rev. G. Colborne Heine, Miss Howard O'Keeffe, Albert Holden, G. A. Greene, Edgar Judge, Prof. Adams, Jos. Fortier and the Recording Secretary.

Minutes of last meeting read and adopted.

Moved by J. A. U. Beaudry, and seconded by E. T. Chambers, that the rules be suspended, and that the Chairman cast the ballot for the election of Miss Howard O'Keeffe as an ordinary member. Carried. Miss O'Keeffe was then elected.

The following highly interesting and instructive communications were read and discussed :—

"Peculiar Behavior of Charcoal in the Blast Furnace at Radnor Forges," Prof. J. T. Donald.

"Notes on the Silicified Charcoal dealt with in Prof. Donald's Paper" (illustrated by means of the lantern), Prof. D. P. Penhallow.

"The Ornithorhyncus Paradoxus, or Duck-Billed Platypus," Miss Howard O'Keeffe.

A vote of thanks was moved by Edgar Judge, and seconded by Prof. Adams, and carried. The Chairman, in presenting the vote of thanks, expressed the great pleasure the meeting had in seeing Prof. Penhallow present. The following donations were presented to the Society :—

21 specimens of fossil sponges, shells, etc., from the Quebec Group of the Siluro-Cambrian Rocks, from Sir Wm. Dawson.

1 King Eider (female) .... } from W. J. Drayner.
1 King Eider (young male) ...... }

MONTREAL, March 30th, 1896.

The fifth monthly meeting of the Society was held at eight o'clock this evening in the Library, the President, Rev. Robt. Campbell, D.D., in the chair. There were present J. A. U. Beaudry, J. B. Williams, Geo. Kearley, John S. Shearer, E. L. Bond, Miss Howard O'Keefe, the Recording Secretary, and others.

Minutes of last meeting were read and confirmed.

Minutes of Council meeting of March 23rd were read.

The following donations were reported as made to the Museum :—

About 75 eggs of Canadian Birds, by G. A. Dunlop.

16 specimens of Gold, Silver and Lead Ore, from Kootenay Mines, B.C., by Richard Conway, 64 Victoria street, Montreal.

One Kea Parrot, one Owl Parrot, received in exchange from C. Spanner & Co., Toronto.

A vote of thanks to the donors was proposed by John S. Shearer, and seconded by J. A. U. Beaudry. Carried.

On motion the rules were suspended, and the following were elected as ordinary members of the Society :—J. G. Veith and G. E. Drummond.

John S. Shearer then took the chair, and Rev. Robt. Campbell read Mr. A. T. Drummond's paper on "Currents and Temperatures in the Gulf of St. Lawrence."

E. L. Bond, Geo. Kearley and others made remarks on this very interesting paper, and hoped that the Government would take action in the matter of a more thorough survey.

A vote of thanks to Mr. Drummond for his excellent paper was moved by Major E. L. Bond, and seconded by Dr. Campbell.

Mr. Williams then read his communication "On Certain Birds from the Moluccas now in the Society's Museum." A hearty vote of thanks was tendered to Mr. Williams for his paper and also for his care of and arrangement of the birds in the Museum.

MONTREAL, April 27th, 1896.

The sixth monthly meeting of the Society was held in the Library this evening at eight o'clock, the President, Rev. Robert Campbell, D.D., in the chair.

Present: J. Stevenson Brown, Hon. Justice Wurtele, J. B. Williams, C. J. Williams, Jos. Fortier, John S. Shearer, Geo. Sumner, E. T. Chambers, James Gardner, Geo. Kearley, J. A. U. Beaudry, Wm. Jackson, Dr. Stirling, Albert Holden, Prof. Donald, H. B. Cushing, and others.

Minutes of last meeting read and confirmed.

Mr. Shearer, on behalf of the Field-Day Committee, reported progress, and recommended St. Jovite as the objective point.

On motion of J. A. U. Beaudry, seconded by Jos. Fortier, the rules were suspended and Mr. Joseph Haynes was elected, one ballot being cast.

Prof. Adams then read two very interesting papers, entitled "A Visit to the Lake Dwellings at Robenhausen, Switzerland," and "Notes on a Remarkable Deposit of Stalagmite from Gold Hill, Nevada."

A very hearty vote of thanks was tendered to Prof. Adams, on motion of J. Stevenson Brown seconded by J. A. U. Beaudry.

The thanks of the Society were tendered to Sir William Dawson for his kindness in exhibiting the specimen of stalagmite referred to in Dr. Adams' paper, as well as to Mr. Higbich, by whom the specimen was sent to the Peter Redpath Museum.

The meeting then adjourned.

Book Notices.

The History of Mount Mica of Maine, U.S.A., and its Wonderful Deposits of Matchless Tourmalines.—By Augustus Choate Hamlin. Published by the Author; Bangor, Maine, 1895, pp. 72, forty-three colored plates, etc.

This is a memorial volume, dedicated by the author to his father, Hon. Elijah Livermore Hamlin, and his son, Frederick Cutting Hamlin. It gives a history of the development of the locality from the time of its discovery down to the present day, describes the deposits and the mode of occurrence of the tourmalines with a chapter (VII.), giving explanations of a plan of the workings and of the beautiful colored plates. The book is attractive in appearance, and that it is pleasantly written the following extract will suffice to show :—"It (Mount Mica) was discovered in 1820 by two students who had become interested in the study of mineralogy, and who spent much of their leisure time in searching for minerals among the exposed ledges and the mountains around the village. Late in the autumn of 1820, and on one of its clear, calm days, they started out to explore the range of hills which form the eastern boundary of the town, and stretch away to the north-west until lost among the mountains around Molly Ocket. The names of these two students were Elijah L. Hamlin and Ezekiel Holmes. Hamlin was a resident of the village, but Holmes was a visitor, and temporarily a student in the place. They had spent most of the day along the mountain ridge to the southward, and were descending the western declivity on their way home, just as the sun was setting behind the great White Mountain range, fifty miles or more away on the western horizon. At this moment the view of the intervening country, diversified in color and in shade, together with the gorgeous masses of changing clouds in the western sky, formed a picture of great beauty, and young Hamlin, fascinated with the entrancing picture spread before him, halted for a moment on the crest of a little knoll to enjoy the scene. On turning to the eastward for an instant for a final look at the woods and mountains in his rear, a vivid gleam of green flashed from an object on the roots of a tree, upturned by the wind, and caught his eye." Such was the discovery of the first of the matchless tourmalines of Mount Mica. A heavy fall of snow prevented the students from continuing their investigations on the following day, but when the winter's snow had melted they returned to the spot and soon discovered the source from whence the tree-borne fragment had been derived.

The plates are from original drawings by the author, and have been produced in color by the Coloritype Company of New York.

B. J. Harrington.

GEOLOGICAL BIOLOGY, AN INTRODUCTION TO THE GEOLOGICAL HISTORY OF ORGANISMS.—By Henry S. Williams. 8vo. pp. 395. Henry Holt & Co., New York, 1895.

Professor H. S. Williams, of Yale University, has written this book with the view of presenting to college students as well as to the general reader a clear and succinct account of the chief problems in the geological history of plants and animals and of pointing out what progress has been made in solving them by the investigations of Palæontologists in recent years.

The late Professor Huxley once said: "That the primary and direct evidence in favor of evolution can be furnished only by palæontology. The geological record, so soon as it approaches completeness, must, when properly questioned, yield either an affirmative or a negative answer: if evolution has taken place there will be its mark left; if it has not taken place, there will lie its refutation." Dr. Williams, in this book, points out how the study of the geological record shows that evolution has taken place and what the chief facts and factors of this evolution are.

The means of estimating the approximate length of time during which life has existed on the earth are first explained, and the way in which this great length of time may be divided into geological periods is referred to. The teaching of the fossil remains of animals which lived upon the earth during these enormously long periods, and its bearing upon the subject of evolution is then taken up, certain genera of fossils being selected for especial treatment, and the question: "What is a species?" considered and answered. Dr. Williams shows from these studies that the actual facts of the geological history of organisms points unmistakably to a course of evolution by descent in which the progress attained by each succeeding form was a paramount condition of the origin of the next member of the race. Dr. Williams' own investigations have added many important facts to the daily accumulating body of evidence going to establish this important conclusion. He is, however, a firm believer in the divine origin of things. "It has been supposed by many," he writes, "that evolution is intrinsically antagonistic to, and has, in fact, replaced the creational conception of the origin of things in the world. In one respect this is partly true; the new view has fundamentally changed the conception of creation. Evolution has given us another notion of God. In the old conception God was an artificer making organisms out of inorganic matter directly, as one might build up a vessel of clay and then vivify it. The new conception of God, as creator, finds its concrete empirical representation in the act of expressing a thought or purpose into the spoken word. Creation is the phenomenalizing of will, so sublimely described in that ancient formula—*In the beginning God spoke and it* (the whole phenomenal universe) *became.* . . . And the increment to organic structure, expressed by the final bursting into morphological reality, after travelling unobserved, but potential, through the organic matter of countless generations, is as much a result of creative energy as if a new species were to arise out of the dust of the earth."

The book is an excellent one, well printed and fully illustrated, and will prove of great value, especially to University teachers.

FRANK D. ADAMS.

ABSTRACT FOR THE MONTH OF NOVEMBER, 1895.

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	33.87	39.6	30.3	9.3	29.9017	30.176	29.720	.456	.1673	70.3	29.5	W.	22.46	8.5	10	4	23	0.40	....	0.40	1
2	30.32	32.3	27.8	4.5	30.2423	30.292	30.212	.080	.1372	81.3	25.2	N.	7.17	9.5	10	7	00	....	....	....	2
SUNDAY.........3	.....	37.5	26.5	11.0	....	......	......	....	.....	....	....	S.E.	7.46	....	....	..	59	....	....	....	3..........SUNDAY
4	35.07	45.4	27.3	18.1	30.5177	30.594	30.441	.153	.1773	87.0	31 5	S.E.	9.75	4.7	10	0	61	....	....	....	4
5	46.35	57.3	34.1	23.2	30.3960	30.450	30.356	.094	.2263	74.0	37.7	S.W.	17.46	1.0	5	0	96	....	....	....	5
6	47.22	56.4	37.5	18.9	30.3213	30.390	30.247	.143	.2682	82.3	41.8	S.W.	13.83	3.2	10	0	82	....	....	....	6
7	52.43	56.4	47.0	9.4	30.1327	30.247	29.956	.291	.3575	90.0	49.5	S.W.	13.79	9.7	10	2	00	0.09	....	0.09	7
8	53.33	61.3	41.2	20.1	29.9198	30.023	29.872	.151	.3845	92.3	51.0	S.W.	18.08	10.0	10	10	00	0.38	....	0.38	8
9	33.78	41.2	31.2	10.0	29.9340	30.089	29.717	.372	.1862	95.8	32.8	N.E.	28.67	10.0	10	10	00	0.80	....	0.80	9
SUNDAY.........10	.....	34.5	31.1	3.4	....	......	......	....	.....	....	....	W.	12.42	....	......	..	06	0.02	1.0	0.12	10..........SUNDAY
11	28.28	30.1	27.0	3.1	30.3760	30.430	30.292	.138	.1318	84.7	24.2	N.E.	12.46	6.3	10	0	21	....	0.0	0.00	11
12	33.30	35.8	27.5	8.3	30.4128	30.436	30.392	.044	.1612	84.5	29.0	N.E.	4.83	8.3	10	0	00	....	....	....	12
13	35.93	37.8	25.0	2.8	30.4737	30.518	30.411	.107	.1825	86.5	32.2	W.	5.58	8.3	10	0	00	....	....	....	13
14	39.43	45.6	32.4	13.2	30.3430	30.463	30.175	.288	.2075	85.2	35.0	S.E.	14.37	7.7	10	0	06	0.00	....	0.00	14
15	44.08	45.5	41.6	3.9	29.8177	30.060	29.655	.405	.2785	96.0	43.0	S.	14.50	10.0	10	10	00	0.14	....	0.14	15
16	39.93	43.9	36.3	7.6	29.8800	29.951	29.783	.163	.1847	75.2	32.5	S.W.	18.25	4.2	10	0	50	....	....	....	16
SUNDAY.........17	.....	47.3	35.7	11.6	....	......	......	....	.....		....	S.	14.04	....	....	..	32	....	....	....	17..........SUNDAY
18	42.45	45.9	40.5	5.4	29.7662	29.894	29.677	.217	.2443	90.2	39.8	N.	15.29	8.3	10	0	00	0.21	....	0.21	18
19	38.23	41.6	37.0	4.6	29.7755	29.902	29.519	.383	.2303	99.7	38.0	N.E.	9.33	10.0	10	10	00	....	....	....	19
20	36.27	46.2	21.7	24.5	29.2880	29.377	29.248	.129	.2108	94.5	34.7	S.W.	20.87	10.0	10	10	00	0.12	0.0	0.12	20
21	13.25	21 7	10.5	11.2	29.7123	30.244	29.277	.967	0657	82.5	9.0	W.	32.83	7.7	10	0	45	....	3.7	0.37	21
22	15.92	21.5	7.5	14.0	30.5035	30.568	30.391	.177	.8117	89.0	13.0	S.E.	9.71	7.8	10	0	00	....	....	....	22
23	19.78	23.2	16.3	6.9	30.2307	30.550	30.026	.524	.1037	81.5	19.0	N E.	16.42	8.8	10	3	00	....	5.6	0.56	23
SUNDAY.........24	.....	30.4	19.7	10.7	......	......	......	....	.....	....	....	S.	9 08	....	...	.	13	....	0.5	0.05	24..........SUNDAY
25	18.40	35.8	7.8	28.0	30.2327	30.448	29.931	.517	.9867	92.3	16.5	N.E.	14.46	7.5	10	0	00	0.41	1.9	0.60	25
26	40.80	55.6	34.8	20.8	29.6043	29.842	29.401	.441	.2507	96 0	39.8	S.	30.92	10.0	10	10	00	1.23	....	1.23	26
27	28.27	34.8	22.8	12.0	30.3332	30.482	30.060	.422	.1238	79.8	22.8	S.W.	18.65	3.7	10	0	86	...	....	....	27
28	33.37	40.2	27.1	13.1	30.4887	30.555	30.406	.149	.1483	77.2	26.8	W.	17.16	0.2	1	0	91	....	....	....	28
29	35.65	42.2	31.8	10.4	30.1502	30.318	30.033	.285	.1608	77.3	29.2	W.	10.83	6.7	10	0	34	....	....	....	29
30	17.22	37.1	11 2	25.9	30.3598	30.481	30.097	.384	.0785	75.2	10.8	N.	15.12	1.8	10	0	97	....	0.0	0.00	30
....Means	34.34	40.80	28.61	12.19	30.1198	30.2608	29.9731	.2977	.2487	85.40	30.59	S. 45½°W.	15.19	7.07	9.46	2.92	26.7	3.80	12.7	5.07	Sums ....
21 Years means for and including this month......	32.42	38.86	26.49	12.37	30.0124	.....	......	.2644	.1597	79.68	....	......	§16.49	7.37	..	..	¶29.09	2.35	12.78	3.62	21 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	1143	1762	198	933	1598	3353	1861	96	
Duration in hrs..	83	123	20	85	123	162	111	9	4
Mean velocity....	13.77	14.32	9.90	10.97	12.99	20.69	16.77	10.67	

Greatest mileage in one hour was 47 on the 26th.
Greatest velocity in gusts, 60 miles per hour on the 26th.

Resultant mileage, 3,090.
Resultant direction, S. 45½° W.
Total mileage, 10,944.
Average velocity 15.20 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.

¶ 14 years only. § Ten years only.

The greatest heat was 61.3° on the 8th; the greatest cold was 7.5° on the 22nd, giving a range of temperature of 53.8 degrees.

Warmest day was the 8th. Coldest day was the 21st. Highest barometer reading was 30.594 on the 4th. Lowest barometer was 29.248 on the 20th, giving a range of 1.346 inches. Maximum relative humidity was 100 on the 1st, 15th, 19th, 25th and 26th. Minimum relative humidity was 51 on the 5th.

Rain fell on 11 days.
Snow fell on 8 days.
Rain or snow fell on 16 days.
Lunar halos on 3 nights, 4th, 6th and 30th.
Lunar coronas on 1 night, 1st.
Hoar frost on 2 days, 4th and 29th.
Thunder and lightning on 9th.

ABSTRACT FOR THE MONTH OF DECEMBER, 1895.

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
SUNDAY........1	.....	23.9	9.2	14.7	......	......	......	....	.....	....	....	N.E.	7.42	....	....	..	43	....	....	....	1............SUNDAY
2	24.23	27.6	18.3	9.3	29.6845	29.863	29.582	.281	.1298	99.2	23.8	N.	8.54	10.0	10	10	00	inap.	4.6	0.46	2
3	7.58	18.3	3.7	14.6	29.9520	30.108	29.768	.340	.0558	90.5	5.3	S.W.	11.37	3.7	10	0	70	....	1.0	0.10	3
4	6.32	10.7	0.6	10.1	30.2060	30.244	30.148	.051	.0573	98.5	6.0	S.E.	7.37	5.8	8	0	37	....	....	....	4
5	10.67	14.8	5.6	9.2	30.1188	30.202	29.996	.306	.0678	95.7	9.5	N.	7.75	9.3	10	8	18	....	....	....	5
6	13.33	17.8	9.0	8.8	29.9965	30.090	29.927	.063	.0678	85.2	9.8	S.W.	19.79	1.8	8	0	75	....	....	....	6
7	20.47	27.4	10.0	17.4	29.8620	30.093	29.723	.370	.1082	95.2	19 3	S.E.	9.96	10.0	10	10	00	....	5.3	0.53	7
SUNDAY........8	.....	21.8	1.2	20.6	....	......	......	....	.....	....	....	N.	10 71	....	......	..	87	....	0.4	0.04	8............SUNDAY
9	2.08	7.2	—4.9	12.1	30.2793	30.330	30.202	.128	.0453	93.3	0.5	S.	15.00	1.8	10	0	53	....	inap.	inap.	9
10	19.22	26.6	6.0	20.6	30.1010	30.177	30.053	.124	.0927	87.5	16.0	S.	16.12	6.8	10	0	05	....	0.3	0.03	10
11	1.35	8.5	—1.7	10.2	30.1960	30.293	30.137	.156	.0425	93 0	—0.7	N.	28.37	0.5	2	0	92	....	....	....	11
12	—5.02	—0.2	—9.9	9.7	30.4248	30.471	30.338	.133	.0307	89.8	—7.5	N.	18.46	2.5	8	0	65	....	....	....	12
13	—4.25	1.2	—10.3	11.5	30.4162	30.467	30.356	.111	.0387	96 5	—5.0	N.	12.87	0 0	0	0	61	....	....	....	13
14	3.03	9.3	—4.7	14.0	30.2275	30.342	30.120	.222	.0483	94.0	—1.8	N.	9.79	0.2	2	0	67	....	....	....	14
SUNDAY........15	.....	28.4	2.8	25.6	......	......	......	...	.....	....	....	E.	11.54	....	...	..	00	....	....	....	15............SUNDAY
16	17.98	23.5	11.4	12 1	30.6078	30.749	30.390	.359	.0820	83.2	13.8	W.	13.08	0.0	0	0	81	...	....	....	16
17	13.95	29.5	1.4	28.1	30 5665	30.772	30.374	.388	.0742	86.7	10.5	E.	16.00	6.5	10	0	13	inap.	inap.	inap.	17
18	35.40	39.0	29.5	9.5	30.2125	30.353	30.013	.340	.1807	86.3	31.7	S.	21.92	10.0	10	10	00	0.05	inap.	0.05	18
19	38.90	41.8	35.5	6.3	30.1883	30.255	30.136	.119	.2350	99.0	38.5	S.W.	14.50	10.0	10	10	00	0.05	....	0.05	19
20	45.65	48.3	39.5	8.8	30.2162	30.311	30.152	.159	.2775	90.7	42.8	S.	20.67	9.2	10	5	01	....	....	....	20
21	47.07	54.4	39.4	15.5	30.2830	30.395	30.136	.249	.2752	85.2	42.8	S.	16.50	5.5	10	0	79	....	....	....	21
SUNDAY........22	.....	40.4	35.8	4.6	....	......	......	....	.....	....	....	W.	23.37	....	...		00	0.63	....	0.63	22............SUNDAY
23	37.02	38.5	34.3	4.2	29.9455	30.056	29.816	.240	.2027	91.8	34.8	S.W.	11.29	10.0	10	10	00	0.18	....	0.18	23
24	34.37	38.0	32.2	5.8	30.1167	30.210	29.959	.251	.1663	84 0	29.8	W.	10.92	3.7	10	0	73	....	.	....	24
25	38.32	43.9	31.7	12.2	30.0475	30.174	29.982	.192	.2000	85.5	34.2	S.E.	11 12	9.7	10	8	23	0.03	....	0.03	25
26	48.10	53.2	41.5	11.7	29.7155	29.958	29.374	.584	.3050	90.2	45.2	S.	21.04	10.0	10	10	00	0.32	..	0.32	26
27	31.85	51.2	23.5	27.7	29.6995	29.928	29.109	.819	.1667	85.8	28.2	W.	27.50	7 7	10	0	25	...	0.1	0.01	27
28	30.47	34.8	24.2	10.6	29.9362	29.987	29.834	.153	.1605	94.0	28.8	S.	9.75	7.5	10	2	15	....	0.2	0.02	28
SUNDAY........29	....	37.7	29.6	8.1	....	......	......	....	....	....	....	S.	15.33	...	....	..	65	....	....	....	29............SUNDAY
30	34.42	37.0	30.0	7.0	29.8820	30.043	29.498	.545	.1820	90.8	32.0	S.	13.42	7.7	10	0	05	0.66	....	0 66	30
31	31.30	40.6	26.0	14.6	29.1812	29.353	28 924	.429	.1568	87.3	27.8	N.	44.71	9.3	10	8	27	0.20	0.1	0.21	31
Means	22.46	28.87	16.14	12.73	30.0793	30.201	29.925	.274	.1327	90.7	19.8	S. 33°W.	15.68	6.1	8.4	3.5	34.8	2.12	12.0	3.32	... . Sums
21 Years means for and including this month	14.87	....	... .	....	30.0294	.....	......	.295	.0996	82.6	....	......	ſ16.71	6.96	..	..	¶29.65	1.33	23.4	3.62	21 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	2579	648	525	1103	3066	1635	1524	589	
Duration in hrs..	145	58	49	95	193	94	84	25	1
Mean velocity....	17.79	11.17	10.71	11.61	15.89	17.39	18.14	23.56	

Greatest mileage in one hour was 67 on the 31st.

Greatest velocity in gusts, 80 miles per hour on the 31st.

Resultant mileage, 2,425.
Resultant direction, S. 33° W.
Total mileage, 11,669.
Average velocity 15.68 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.

¶ 14 years only. ſ Ten years only.

The greatest heat was 54.4° on the 21st; the greatest cold was —10.3° on the 13th, giving a range of temperature of 64.7 degrees.

Warmest day was the 26th. Coldest day was the 12th. Highest barometer reading was 30.772 on the 17th. Lowest barometer was 28.924 on the 31st, giving a range of 1.848 inches. Maximum relative humidity was 100 on the 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 12th, 13th, 14th, 17th, 19th, 22nd, 26th, 28th, 30th and 31st. Minimum relative humidity was 65 on the 12th.

Rain fell on 10 days.
Snow fell on 11 days.
Rain or snow fell on 17 days.
Auroras were observed on 1 night, 8th.
Lunar halos on 1 night, 4th.
Lunar coronas on 3 nights, 24th, 25th and 27th.
Hoar frost on 4 days, 9th, 14th, 24th and 30th.
Earthquake shock at 12.25 a.m. on 9th.
Very heavy wind storm on 31st.

Meteorological Abstract for the Year 1895.

Observations made at McGill College Observatory, Montreal, Canada. — Height above sea level 187 ft. Latitude N. 45° 30′ 17″. Longitude 4h 54m 18·55s 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.
January	14.89	+ 2.96	37.2	— 12.7	15.31	29.9346	30.637	29.200	241	.0789	82.8	10.6	S. 70° W.	14.6	59	40	1.36	4	24.9	18	3.76	2	20
February	14.20	— 1.64	37.2	— 19.8	14.26	29 8003	30.347	28.832	.255	.0853	87.5	11.1	S. 64° W.	20.6	60	47	0.00	2	24.7	15	2.45	1	16
March	22.13	— 2.15	40.7	— 6.0	15.29	29.9327	30.496	29.381	.247	.1093	81.0	18.2	S. 67° W.	16.1	51	59	0.45	4	5.6	15	1.01	2	17
April	41 17	+ 1.17	68.6	16.0	16.06	29.9984	30.656	29.236	.222	.1934	73.4	32.7	N. 34° W.	13 7	51	46	3.76	12	0.0	1	3.76	..	13
May	58.27	+ 3.66	87.1	32.8	19.96	29.9663	30.498	29.429	.155	.3537	67.8	46.9	S. 59° W.	14.6	54	53	3.31	17	0.0	1	3.31	1	17
June	69.54	+ 4.51	86.4	52.8	17.14	29.9877	30.428	29.603	.148	.5489	79.2	61.0	S. 51° W.	13.4	55	63	3.74	12	....	..	3.74	..	12
July	67.21	— 1.54	87.5	51.2	16.84	29.8944	30.189	29.471	.138	.4632	69.0	56.1	S. 56° W.	12 3	56	56	2.38	12	....	..	2.38	..	12
August	65.84	— 0.87	82.2	47.7	15.10	29.8658	30.242	29.589	.148	.4916	77.2	58.0	S. 54° W.	15.7	53	58	6.92	23	...	..	6.92	..	23
September	60.30	+ 1.70	86.3	36.5	16.88	29.9508	30.313	29.587	.172	.4211	76.1	62.3	S. 44° W.	14.5	47	63	3.40	10	....	..	3.40	.	10
October	41.22	— 4.13	61.1	23.8	15.09	29.9812	30.571	29.462	.272	.1993	74.2	33.2	S. 25° W.	15.4	63	43	0.64	14	0.8	2	0.71	.	16
November	34 34	+ 1.92	61.3	7.5	12.19	30.1198	30.594	29.248	.298	.2487	85.4	30.6	S. 45° W.	15.2	71	27	3.80	11	12.7	8	5.07	3	16
December	22.46	+ 3.51	54.4	— 10.3	12.73	30.0793	30.772	28.924	.274	.1327	90.7	19.8	S. 33° W.	15.7	61	35	2.12	10	12.0	11	3.32	4	17
Sums for 1895	...	...	....	....	....	....	....	....	....	....	....	....	...	....	....	....	31.88	131	80.7	71	39 83	13	189
Means for 1895	42.63	+ 0.76	....	....	15.57	29.9634	....	....	.214	.2772	78.9	35.9	S. 52° W.	15.15	57.0	49.2	....	....	....	..	3.32	..	16
Means for 21 years ending Dec. 31, 1895.	41.82	....	....	....	....	29.9783	....	....	....	.2519	74.7	....	....	*a* 15.18	61.0	§ 45.6	28.17	133	118.1	78	39.67	16	200

Month.	Ten years (1885-94) Means of bi-hourly temperatures at Montreal. 1h	3h	5h	7h	9h	11h	13h	15h	17h	19h	21h	23h	Means.
January	11.34	10 59	9 76	9 53	10.41	12 88	14.37	14.95	13.92	13.50	12.69	12.13	12.17
February	12.21	11.45	10.49	9.95	11.82	14.69	16.24	17.01	15.85	14.86	14.16	13.45	13.51
March	22.39	21.41	20.09	20.36	23.08	25.98	27.76	28.42	27.55	25.83	24.68	23 81	24.28
April	36.78	35.46	34.14	36.38	39.86	43.32	45.47	46.27	45.65	42.31	40.25	38.73	40.39
May	50.66	49.12	47.73	51.08	55 29	58.76	61.41	62.33	61.22	57.55	54.77	52.81	55.23
June	60.69	59.40	58.64	62.26	65.82	69.13	71.21	71.80	70.31	66.86	63.89	62.23	65 19
July	64.25	62.82	62.11	65.69	69.65	73.17	75.01	75.75	74.02	70.25	67.42	65.83	68.83
August	61.44	61.32	59 44	62 02	66.22	69.75	71.78	72.09	70.39	66.30	63 90	62.53	65.52
September	51.48	53.46	52.77	54 01	58.25	61 91	63.78	64.29	62.53	58.68	56.93	55.52	58.05
October	43.00	42.16	41 65	41 69	44 98	48.20	49.72	49.94	48.10	45.77	44.43	43.50	45.26
November	31.95	31.49	31.03	30.77	32 44	31.61	35.64	35.56	34.28	33.37	32.54	31.88	32.97
December	18.64	18.31	17.37	16 83	17 73	19.71	20.73	21.02	19 96	19.61	19.12	18.77	18.98
Sums for 1895	.....	.....	.	.....	.	.....	....	.....	.....	.....	.....	.....	500.38
Means for 1895	38.99	38.00	37.10	38.38	41 30	44.34	46.10	46.12	45.31	42.91	41.23	40.10	41.70
Means for 21 years ending Dec. 31, 1895.	. ...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.. .

* Barometer readings reduced to 32° Fah. and to sea level. † Inches of mercury. ‡ Saturation 100. § For 14 years only. ¶ "+" indicates that the temperature has been *higher*: "—" that it has been *lower* than the average for 21 years inclusive of 1895. 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 9 years only.

The greatest heat was 87.5° on July 8: the greatest cold was 19.8° below zero on February 6. The extreme range of temperature was therefore 107.3. Greatest range of the thermometer in one day was 31.8° on Januuary 4; least range was 2.8° on November 13. The warmest day was July 8, when the mean temperature was 78.55°. The coldest day was February 6, when the mean temperature was 13.33° below zero. The highest barometer reading was 30.772 on December 17, Lowest barometer reading was 28.832 on February 8, giving a range of 1.940 for the year. The lowest relative humidity was 29 on May 18. The greatest mileage of wind recorded in one hour was 67 on December 31, and the greatest velocity in gusts was at the rate of 80 miles p. h. on December 31. The total mileage of wind was 129,326. The resultant direction of the wind for the year is S.52° W., and the resultant mileage was 62 856. Auroras were observed on 15 nights. Fogs on 11 days. Thunder storms on 9 days. Lunar halos on 14 nights. Lunar coronas on 7 nights. Solar halos on 20 days. Earthquakes were felt on 2 days, April 17th and December 9th. The sleighing of the winter commenced in the city on November 21. The first appreciable snowfall of the autumn was on October 20.

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, 1896.

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

DAY.	THERMOMETER.				BAROMETER.				†Mean pressure of vapor.	‡Mean relative humidity.	Dew point.	WIND.		SKY CLOUDED IN TENTHS			Per cent. of possible. Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY
	Mean.	Max.	Min.	Range.	Mean.	Max.	Min.	Range.				General direction.	Mean velocity in miles perhour	Mean.	Max.	Min.					
1	26.13	29.2	24.2	5.0	29.6668	29.912	29.461	.451	.1035	73.3	19.0	N.W.	37.75	8.3	10	0	00	....	Inap.	Inap.	1
2	27.50	31.8	20.6	11.2	29.8643	30.024	29.597	.427	.1275	84.7	23.7	S.	14.42	8.3	10	4	51	....	1.4	0.14	2
3	23.52	35.3	6.3	29.0	29.5475	29.728	29.431	.297	1053	78.3	17.7	N.	30.08	6.5	10	0	68	....	0.4	0.04	3
4	—5.80	6.3	—13.0	19.3	30.0698	30.235	29.885	.350	.0312	94.5	—7.3	N.	23.62	5.2	10	0	18	....	....	....	4
SUNDAY.........5	.....	—13.1	—19.7	6.6	......	......	......	....	.....		....	N.	11.83	....	......	..	67	....	....	....	5.........SUNDAY
6	—15.45	—11.4	—21.2	9.8	30.6507	30.675	30.591	.084	.0203	98.3	—16.0	N.	6.58	0.0	0	0	95	....	....	....	6
7	—6.23	—0.2	—13.0	12.8	30.4145	30.619	30.272	.347	0312	95.8	—7 3	N.	16.00	4.5	10	0	00	....	Inap.	Inap.	7
8	2.42	6.4	—3.0	9.4	30.2613	30.345	30.170	.175	.0373	78.2	—3 2	N.	1.96	1.2	7	0	87	....	....	....	8
9	8.27	10.8	4.3	6.5	30.0830	30.110	30.048	.062	.0575	90.3	6.0	N.	15.04	7.0	10	0	00	....	1.0	0.10	9
10	11.07	15.4	7.8	7.6	30.2392	30.298	30.172	.126	0670	94.0	9.3	N.	15.54	3.7	10	0	74	....	0.1	0.01	10
11	9.70	14.7	4.6	10.1	30.2642	30.327	30.178	.149	.0640	94 7	8.5	N.	7.29	0.0	0	0	76	....	....	....	11
SUNDAY.........12	.....	26.7	2.2	24.5	....	.....	......	...	....	....	....	E.	9.46	....	...	..	04	....	2.0	0.20	12...........SUNDAY
13	21.33	23.8	17.9	5.9	29.9730	30.108	29.887	.221	.0982	85.5	17.7	W.	17.39	9.3	10	8	36	....	Inap.	Inap.	13
14	18.58	22.8	15.2	7.6	30.1027	30.235	30.012	.223	.0925	91 5	16.5	N.W.	15 17	8 5	10	5	41	....	1.1	0.11	14
15	11.05	17.3	6.6	10 7	30.4358	30.517	30.309	.208	.0615	86.0	7.7	N.W.	19.83	3.3	10	0	51	....	....	....	15
16	13.93	20.0	5.4	14.6	30.2870	30.508	30.123	.385	.0788	94.0	12.3	S.	7.83	8.3	10	0	00	...	0.9	0.9	16
17	14.58	21.8	11.6	10.2	30.3300	30.419	30.244	.175	.0728	85.8	11.3	N.W.	11.04	4.3	10	0	72	....	....	....	17
18	17.68	20.9	13.0	7.9	30.1958	30.258	30.145	.113	0863	88.8	15.0	N.W.	9.62	7.5	10	0	48	....	0.1	0.1	18
SUNDAY.........19	.....	20.2	10.8	9.4	......	......	......	....	....	....	....	N.W.	19.21	....	...	.	67	....	....	....	19...........SUNDAY
20	13.93	18.6	8.0	10.6	30.2638	30.370	30 124	.246	.0748	90 8	11.5	N.W.	12.21	7.3	10	0	28	....	0.3	0.03	20
21	20.45	24.2	17.2	7.0	30.1377	30.222	30 091	.131	.1023	93.2	18.7	S.	4.92	10.0	10	10	00	....	1.6	0.14	21
22	19.23	23.6	14.8	8.8	30.3837	30.472	30 258	.214	.0918	88.3	16.3	N.W.	7.50	6.0	10	0	65	....	....	....	22
23	15.03	18.1	12.6	5.5	30.4528	30.519	30.385	.134	.0817	94.2	13.7	N.	9.29	7.0	10	0	43	...	....	....	23
24	19.72	26.2	11.4	14.8	30.1162	30.298	29.922	.376	.1030	94.2	18.2	N.	19.29	8.3	10	0	00	....	6.6	0.66	24
25	27.42	30.6	23.8	6.8	30.0000	30.070	29.916	.154	.1425	95.2	26.0	N.	10 67	10.0	10	10	00	....	2.9	0.30	25
SUNDAY.........26	.....	28.6	24.0	4.6	....	.....	......	....	....	....	....	N.W.	6.12	...	....	..	00	....	2.3	0.28	26...........SUNDAY
27	15.18	26.3	10 3	16.0	30.0640	30.114	30.025	.089	.0780	87.8	12 2	N.W.	22.33	7 0	10	0	55	...	....	.	27
28	1.83	10.3	—2 6	12.9	30.2687	30.345	30.157	.188	.0403	85.5	—1.7	N.W.	16.92	1.0	6	0	100	....	....	....	28
29	2.15	4.8	—2 0	6.8	30.3175	30.384	30.232	.152	.0417	87.2	—1.2	N.	10.42	8.0	10	0	00	....	....	....	29
30	13.45	18.8	6.0	12.8	30.3098	30.464	30.223	.241	.0662	80.8	8.5	N.W.	14.18	5.0	10	0	48	....	Inap.	Inap.	30
31	7.07	15.0	4.0	11.0	30.4468	30.547	30 260	.287	.0475	80.0	1.8	N.E.	10.71	6.2	10	0	49	...	....	....	31
Means	12.36	17.54	6.71	10.83	30.1906	30.300	30.078	.222	.0742	88.5	9.4	N. 20° W.	14.52	6.0	9.0	1.4	40.1	....	20.7	2.11	.... Sums
22 Years means for and including this month......	11.94	20.32	4 11	16.21	30.0596	.....	......	.324	.0726	81.5	....	......	§16.68	6.3	..	..	¶30.9	....	28.8	3.54	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	4379	484	456	32	487	69	304	4352	
Duration in hrs..	311	26	59	3	16	4	15	260	20
Mean velocity....	14.08	18.62	7.75	10.67	10.59	17.25	20.27	16.74	

Greatest mileage in one hour was 52 on the 1st.

Greatest velocity in gusts, 60 miles per hour on the 1st.

Resultant mileage, 7,710.

Resultant direction, N. 20° W.

Total mileage, 10,563.

* 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. § Ten years only.

The greatest heat was 35.3° on the 3rd; the greatest cold was —21.2° on the 6th, giving a range of temperature of 56.5 degrees.

Warmest day was the 2nd. Coldest day was the 5th. Highest barometer reading was 30.675 on the 6th. Lowest barometer was 29.431 on the 3rd, giving a range of 1.244 inches. Maximum relative humidity was 100 on the 4th, 5th, 6th, 7th, 9th, 10th, 11th, 12th, 16th, 23rd and 24th. Minimum relative humidity was 61 on the 1st.

Snow fell on 17 days.

Auroras were observed on 2 nights, 3rd and 9th.

Hoar frost on 2 days, 11th and 12th.

Lunar halos on 1 night, 28th.

Lunar coronas on 2 nights, 3rd and 9th.

ABSTRACT FOR THE MONTH OF FEBRUARY, 1896.

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	21.12	32.8	4.6	28.2	29.7548	30.163	29.456	.707	.1168	95.8	20.0	N.	13 79	10 0	10	10	00	....	1.9	0.20	1
SUNDAY.........2	.....	29.0	13.0	16.0	......	......	......	....	.....		....	N.W.	22.83	....	......	..	28	....	0.2	0.02	2.........SUNDAY
3	10.43	14.8	3.8	11.0	29.9937	30.112	29.876	.236	.0603	86.5	7.2	N.	14.00	4.8	10	0	07	....	....	....	3
4	15.52	20.8	7.6	13.2	29.8975	29.918	29.867	.051	0817	91.3	13.5	N.W.	12.08	9.0	10	4	05	....	0.7	0.05	4
5	30.28	33.7	19.5	14.2	29.8978	29.921	29.857	.064	.1447	87.3	26.7	S.W.	11.46	10.0	10	10	00	....	0 8	0.08	5
6	32.95	34 4	31.6	2.8	29.5222	29.921	28.934	.987	.1777	94.8	31.5	N.E.	21.17	10.0	10	10	00	....	3.3	0.52	6
7	31.83	33.6	30.5	3.1	29.1032	29.424	28.786	.638	.1712	95.7	30.7	N.W.	18.58	9.5	10	7	00	....	1.0	0.25	7
8	21.92	30.5	18.8	11.7	29.8822	30.000	29.668	.332	.1082	93 0	20 0	N.W.	23 21	1.8	10	0	100	....	....	....	8
SUNDAY........9	.....	18.8	7.6	11.2	......	......	......	...	.....	....	....	N.	21 12	....	...	..	00	....	5.2	0.48	9..........SUNDAY
10	18 02	22.3	11.4	10.9	29.5820	29.644	29.464	.180	.0878	88.3	15.0	N.W.	23.21	5.8	10	0	95	....	1.0	0.10	10
11	24.40	30.3	19.6	10.7	29.4203	29.649	29 293	.356	1165	87.3	21.3	N.W.	35.46	9.5	10	5	36	....	1.4	0.14	11
12	12.28	19.5	8.9	10.6	30.0975	30.240	29.851	.389	.0658	85.2	9.0	N.W.	29 75	2.0	10	0	100	....	....	....	12
13	11.33	14.2	8.4	5.8	29.8973	30.236	29.538	.698	.0683	94 2	10.2	N.	16.87	10.0	10	10	00	....	2.6	0.35	13
14	13.08	19.4	7.3	12.1	29.8250	30.081	29.621	.460	.0665	83.8	8.7	N.W.	26.50	4 5	10	0	76	....	0.2	0.02	14
15	0.78	7.3	—1.5	8 8	30.0235	30.141	29.914	.227	.0405	90.7	—1.5	N.	19.46	8.3	10	0	00	....	1.7	0.19	15
SUNDAY.......16	.....	2.7	—17.2	19.9	......	......	......	....	.....	....	....	N.	13.62	....	...		94	...	....	....	16..........SUNDAY
17	—16.02	—10.0	—22.6	12.6	30.5542	30.601	30.517	.084	.0192	93.3	—17.3	N.	22.08	0.0	0	0	100	....	....	....	17
18	—10.92	— 3.3	—23.4	20.1	30.2185	30.499	29.890	.609	.0250	94.3	—12.2	N.E.	11.79	1.3	5	0	86	....	....	....	18
19	8.23	22.6	— 7.0	29.6	29.5465	29.784	29 363	.421	0598	90.5	5.8	E.	9.37	7.8	10	0	35	....	0.4	0.05	19
20	14.80	20.6	11.9	8.7	29.4598	29 719	29 327	.392	.0798	92.5	15.0	N.W.	18 85	6.8	10	0	00	....	3.9	0.35	20
21	1.15	12.2	— 1.7	13.9	30.0530	30.189	29 853	.336	.0383	84.2	—2.7	N.W.	28.29	2.0	8	0	86	....	..	....	21
22	14.52	23.6	— 2.9	26.5	30.0378	30.197	29 943	.254	.0842	90.2	12.3	N.W.	30.04	4.8	10	0	33	....	Inap.	Inap.	22
SUNDAY........23	.....	35.7	13.6	22.1	....	. ....	......	....	... .	....	....	S.	25.92	...	....	..	00	...	1.5	0.17	23..........SUNDAY
24	25.10	35.8	11.1	24.7	29.7283	29.956	29.547	.409	.1247	88.3	22.0	N. W.	26.21	7.7	10	4	51	....	0.1	0.02	24
25	2.55	11.1	— 2.6	13.7	30.0555	30.104	29.988	.110	.0418	85.8	—0.2	N. W.	20 33	0.0	0	0	100	...	....	....	25
26	2.28	9.8	— 5.0	14.8	29.8390	29.945	29.760	.185	.0455	92.5	0.2	N. W.	13.33	2.3	8	0	40	......	....	....	26
27	11.07	20.6	— 1.5	22.1	29.8533	29.913	29.744	.169	.0658	87.7	8 0	S. E.	7.54	4 7	10	0	56	...	....		27
28	34.92	40.5	19.4	21.1	29.6955	29.736	29.677	.059	.1753	85.0	30.7	S.	23.12	7.2	10	3	53	....	....	....	28
29	37.18	41.5	33 4	8.1	29.8437	29.899	29.774	.125	.2215	99.0	37.2	S.	20.42	10.0	10	10	00	0.35	....	....	29
30	.....	.....	.....	.....	......	......	......	....	.....	....	....	......	.....	...	....	..	..	....	....	....	30
31	.....	.....	.....	.....	......	......	......	....	.....	....	....	......	.....	....	...	..	.	...	....	....	31
Means	14.75	21.54	6.78	14.76	29.8314	29.999	29.660	.339	.0915	90.3	12.44	N. 30¾° W.	20.02	6.0	8.8	2.9	40.7	0.35	25.9	3.34	... . Sums
22 Years means for and including this month......	15 34	23.60	6 79	16.80	30.0272	.....	......	.305	.0824	79.8	....	......	ᵴ18.48	5.9	..	..	¶41.6	0.765	22.6	2.96	22 Years means for and including this mooth.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles	2728	800	544	444	1666			7750	
Duration in hrs..	151	40	60	33	88			320	4
Mean velocity....	18.07	20.00	9.07	13.45	18.93			24.22	

Greatest mileage in one hour was 66 on the 11th.

Greatest velocity in gusts, 90 miles per hour on the 11th.

Resultant mileage, 7,930.

Resultant direction, N. 30¾° W.

Total mileage, 13.932

* 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. ᵴ Ten years only.

The greatest heat was 41.5° on the 29th; the greatest cold was —23.4° on the 18th, giving a range of temperature of 64.9 degrees.

Warmest day was the 29th. Coldest day was the 17th. Highest barometer reading was 30.601 on the 17th. Lowest barometer was 28.786 on the 7th, giving a range of 1.815 inches. Maximum relative humidity was 100 on the 6th, 15th, 17th, 18th, 19th, 28th. and 29th. Minimum relative humidity was 71 on the 19th.

Rain fell on 1 day, 29th.

Snow fell on 17 days.

Rain or snow fell on 18 days.

Auroras were observed on 2 nights, 14th & 21st.

Lunar halos on 1 night, 28th.

Lunar coronas on 2 nights, 24th and 27th.

Hail storm on the 24th.

ABSTRACT FOR THE MONTH OF MARCH, 1896.

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. of possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
SUNDAY.........1	.....	39.0	32.0	7.0	......	......	......	....	.....	....	....	N.W.	21.46	....	......	..	00	0.38	....	0 38	1..........SUNDAY
2	19.57	32.0	14.2	17.8	29.7067	29.775	29.589	.186	.0798	89.7	12.7	S.W.	38.54	9.8	10	8	08	....	3.6	0.42	2
3	16.82	20.4	10.6	9.8	29.9262	30.041	29.771	.270	.0823	86.8	13.7	N.W.	23.83	7.5	10	0	00	....	3.9	0.44	3
4	10.07	21.4	0.9	20.5	29.9867	30.066	29.884	.182	.0557	78.2	4.5	N.W.	21.33	6 5	10	0	45	....	Inap.	Inap.	4
5	15.60	23.9	7.8	16.1	30.0278	30.075	29.992	.083	.0682	77.3	9.5	S.	14.42	9.5	10	9	00	....	0.2	0.02	5
6	24.03	27.0	18 8	8.2	30.0210	30.125	29.879	.246	.1063	82.7	19.7	S.	9.47	9 3	10	7	06	....	Inap.	Inap.	6
7	30.80	35.2	24.0	11.2	29.4955	29.798	29.275	.523	.1605	93.0	28.7	S. E.	24.71	10 0	10	10	00	....	5.4	0.61	7
SUNDAY.........8	.....	29.3	15.1	14.2	....	....	......	...	.....	....	....	N.W.	34.87	....	...	..	27	....	Inap.	Inap.	8..........SUNDAY
9	14.95	19.7	10.5	9.2	29.8042	29.866	29.732	.134	.0575	78.7	9 8	N.W.	28 50	7.8	10	0	03	....	....	....	9
10	10 58	16.6	4.5	12.1	29.8892	29.912	29.850	.062	.0537	76.3	4.3	N.W.	22.00	0.3	2	0	87	....	....	....	10
11	9.25	14.2	0.4	13.8	29.8242	30.001	29 522	.479	.0502	76.3	3.2	N.W.	21.04	5.8	10	0	62	....	Inap.	Inap.	11
12	11.22	16.4	7.8	8.6	29.4577	29.820	29.247	.573	.0643	83.3	8.5	N.W.	31.12	8.3	10	0	00	....	2 0	0.21	12
13	7.82	13.4	1.6	11.8	30.1685	30.331	29.975	.356	.0425	69 7	—0.8	N.	23.29	4 3	10	0	75	....	....	....	13
14	11.67	19.1	1.9	17.2	30.3997	30.431	30.363	.068	.0582	76.3	6.2	N.	19.33	0.0	0	0	71	....	....	....	14
SUNDAY.........15	.....	21.7	6.6	15 1	....	......	......	....	....	...	....	N.	14.29	....	...	.	56	....	....	....	15..........SUNDAY
16	16.83	23.8	2.5	21.3	30.0598	30.173	29.898	.280	.0798	83.5	12.7	N.	11.00	6.3	10	0	21	...	1.3	0.05	16
17	26.18	32.6	20.8	11.8	29.9402	30.089	29.835	.254	.1218	86.7	22.8	N.	18.79	4.5	10	0	57	....	1.1	0.18	17
18	29.08	35.3	22.2	13.1	30.2010	30.231	30.166	.065	.1425	89.2	26.3	N.	14.58	5.0	7	0	54	....	Inap.	Inap.	18
19	30.15	31.7	28.4	3.3	29.7093	30.133	29.189	.944	.1648	98.3	29.5	N.E.	19.33	10.0	10	10	00	0.08	14.5	2.04	19
20	23.12	32.1	15.5	16.6	29.3700	29.793	29 039	.754	.1147	88.7	20.5	N.	13.37	8.3	10	0	00	0.26	2.3	0.43	20
21	20.08	29 8	9.2	20.6	29.9647	30.049	29 829	.220	.0958	86.3	16.7	N.	13.75	3.2	9	0	73	....	....	....	21
SUNDAY.........22	.....	39.1	9 0	30.1	....	......	......	....	....	....	....	N.W.	20.79	...	....	..	71	0.02	....	0.02	22..........SUNDAY
23	2.65	9.0	— 2.0	11.0	30.5950	30.650	30 562	.088	.0403	82.8	— 1.5	S.	6.50	0.5	6	0	79	...	....	....	23
24	8.12	16.7	— 3 2	19.9	30.5612	30.682	30.376	.306	.0488	76.5	2.2	S.	6.67	1.0	5	0	73	....	....	....	24
25	26.32	35.8	8.4	27.4	29.8978	30.086	29.640	.446	.1307	87.5	23.0	S.	23 87	6.5	10	0	65	..	Inap.	Inap.	25
26	33.28	38.8	22.9	15.9	29.5093	29.594	29.420	.174	.1897	97.8	32.5	S.	15.08	10.0	10	10	00	1.29	2.0	1.53	26
27	16.98	23.0	9.9	13.1	29.7410	29.940	29.540	.400	.0820	86.5	13.3	N. W.	32.54	2 3	10	0	84	...	2.0	0.16	27
28	20.70	27.3	12 5	14.8	30.1708	30.219	30.051	.168	.0945	85.0	17.0	W.	16.16	0.5	6	0	97	....	....	....	28
SUNDAY.........29	.....	37.2	11.6	25.6	....	......	......	....	.....	....	....	W.	4.38	....	...	..	00	0.04	1.2	0.22	29..........SUNDAY
30	39.83	45.6	36.3	9.3	29.7848	29.885	29.747	.138	.2152	88.3	36.2	S. W.	11.04	4.8	10	0	67	0.06	....	0.06	30
31	35.30	43.1	25.7	17.4	30.0695	30.251	29.989	.262	.1793	87.3	31.5	S. W.	18.96	1.3	6	0	90	....	....	....	31
Means	19.65	27.42	12.46	14.96	29.9339	30.078	29.783	.295	.0995	84.5	15.5	N.51¼° W.	19.23	5.5	8.5	2.1	41.0	2.13	39.5	6.97	... . Sums
22 Years means for and including this month......	24 07	31.43	16 45	14.76	29.9672	.....	.....	.263	.1083	76.3	....	......	ƒ18.10	6.0	..	..	¶46.8	1.00	23.6	3.38	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	3304	245	5	917	1771	1345	1063	5655	
Duration in hrs..	193	10	2	46	116	68	67	234	8
Mean velocity....	17.12	24.50	2.50	19.78	15.27	19.78	15.87	24.12	

Greatest mileage in one hour was 60 on the 7th and 12th.

Greatest velocity in gusts, 72 miles per hour on the 7th.

Resultant mileage, N. 51¼° W.

Resultant direction, 6,800.

Total mileage, 14,305.

* 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. ƒ Ten years only.

The greatest heat was 45.6° on the 30th; the greatest cold was —3.2° on the 24th, giving a range of temperature of 48.8 degrees.

Warmest day was the 30th. Coldest day was the 23rd. Highest barometer reading was 30.682 on the 24th. Lowest barometer was 29.039 on the 20th, giving a range of 1.643 inches. Maximum relative humidity was 100 on the 1st, 7th, 12th, 19th, 20th, 22nd and 26th. Minimum relative humidity was 52 on the 13th.

Rain fell on 7 days.

Snow fell on 18 days.

Rain or snow fell on 21 days.

Auroras were observed on 2 nights, 14th & 22nd.

Lunar halo on 1 night, 24th.

Fog on 1 day, 23rd.

Hail fell on 4 days, 6th, 7th, 25th and 29th.

Mock Suns on 21st.

ABSTRACT FOR THE MONTH OF APRIL, 1896.

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	24.12	28.2	19.2	9 0	30.1580	30.293	29.874	0.419	.1082	83.0	19.7	N.E.	10 87	3.3	10	0	94	Inap.	....	Inap.	1
2	32.13	35.7	27.3	8.4	29.6493	29 730	29.581	0.146	.1703	93.7	30.3	S.W.	17.87	7.2	10	0	00	0.46	2 0	0.67	2
3	24.62	28.7	19.3	9 4	29.4793	29.558	29.419	0 139	.1173	88 7	22.0	S. W.	31 50	6 8	10	0	2)	....	0.4	0.05	3
4	24 72	29.2	17 6	11.6	29.7987	29.987	29.640	0.347	.1202	89 0	22.2	S. W.	30.21	9.5	10	2	03	....	0.1	0.01	4
SUNDAY.....5	.....	34.1	23.3	10.8	......	......	......	.....	.....	..	....	S.W.	22.12	....	......	..	03	....	Inap.	Inap.	5..........SUNDAY
6	31.28	36.2	27.1	9 1	30.1205	30.163	30.086	0.074	.1528	87.3	27 7	S. E.	10.71	3 2	10	0	74	....	....	....	6
7	32.05	37 6	26.6	11.0	30.2795	30.424	30.143	0.281	.1557	80.0	28.3	N.E.	16.37	7.0	10	0	63	....	....	....	7
9	33.32	39.5	26.7	12.8	30.5462	30.586	30 540	0.046	.1498	80.0	27.3	N.	9.17	0 7	2	0	94	....	....	....	8
8	33.32	41.1	24.4	16.7	30 4225	30.556	30.267	0.289	.1382	74.7	25.3	N.E.	6.62	0.0	0	0	89	....	....	....	9
10	36.65	47 6	24.5	23.1	30.2655	30.323	30 215	0.108	.1505	70.5	27.2	S E.	7.42	1.7	10	0	93	....	....	....	10
11	40.65	44.3	36.6	7.7	30.2152	30.245	30.187	0 058	.2132	84.7	36,2	S.W.	19.75	6.5	10	0	39	....	....	....	11
SUNDAY......12	.....	48.0	36.2	11.8	......	......	......	.....	.....	....	....	N.E.	10.29	....	...	..	76	0.01	....	0.01	12..........SUNDAY
13	40.97	51.8	34.0	17.8	29 9233	29.952	29 925	0 047	.2123	81.7	35.5	W.	14.13	7 2	10	0	57	....	....	....	13
14	44 66	55.8	32.4	23.4	29.8167	29.897	29.760	0 137	.2545	84 7	40.0	S. W.	21.04	4 8	10	0	31	0.15	....	0.15	14
15	55.08	66.8	44 8	22.0	30.0008	30.036	29.963	0 073	.3310	76 7	47.5	S. W.	16 67	5 3	10	0	78	...	....	....	15
16	55.03	72.3	41.6	30.7	29.9865	30.034	29.930	0 104	.3448	77.2	47 5	S. W.	12.58	1.2	4	0	87	...	....	....	16
17	45.70	54.4	36.1	18.3	29.9957	30.091	29.911	0.180	.2818	90.7	43.0	S. W.	13.00	7.3	10	0	11	Inap.	....	Inap.	17
18	46.93	51.4	44.7	6.7	30.0180	30.063	29.918	0.145	.2818	87.3	43 3	N. E.	10 38	7.7	10	0	01	0.04	...	0.04	18
SUNDAY......19	.....	77.0	42 3	34.7	......	....	......	.....	.....	...	...	S. W.	18 96	....	....	..	58	0.01	....	0.01	19..........SUNDAY
20	53.87	65.8	45 6	20 2	29.9408	30.032	29.849	0.183	3015	71 3	44.5	S. W.	24.33	3.8	10	0	73	0.04	....	0.04	20
21	38.48	47.0	34.2	12.8	29.8763	29 994	29.743	0.251	.1333	56.8	24.5	E.	17.92	8.2	10	0	03	0.05	0.5	0 11	21
22	41.85	50.2	32.2	18.0	29.9588	30.025	29 796	0.229	1557	59.8	23.3	N.E.	20.29	4.5	10	0	52	...	0.2	0.02	22
23	48.58	60.8	38.2	22.6	30.0965	30.173	30 035	0 138	.1752	53.0	31.2	S. W.	16 42	0.2	1	0	91	....	...	....	23
24	44.12	54.2	35.0	19 2	30.1762	30.242	30.123	0.119	.1622	56.8	29.2	N.E.	13 08	4 7	8	0	71	....	....	...	24
25	46.57	55.8	34.3	21 5	30.0962	30.128	30 058	0.070	2005	64.8	34.0	S E.	11.58	6.5	10	0	39	0.05	...	0.05	25
SUNDAY........26	.....	61.2	44 3	16.9	....	......	.....	.....	.....	....	....	S. W.	4.13	...	....	..	75	Inap.	....	Inap.	26..........SUNDAY
27	57.43	69.2	41 0	28.2	30.2260	30.292	30.166	0.126	.2935	62 3	43.8	S. E.	12.63	2.0	8	0	86	....	...	....	27
28	50.63	55 8	48.3	7.5	30.1915	30.249	30.158	0 091	.2922	78.8	43.8	S.	12.25	10 0	10	0	00	0.04	....	0.04	28
29	48.18	59.3	38.8	20 5	30.3008	30 360	30.249	0 111	.1722	51.7	30 7	N E.	19.00	2.3	10	0	95	....	...	....	29
30	47.42	58.6	33.3	25.3	30.2428	30.332	30.155	0.177	.1510	48 2	27.7	N.E.	§12.37	0.0	0	0	94	....	....	....	30
Means	44.48	50.58	33.66	16.92	30.0685	30.1448	29.9876	.1572	.2008	74.59	33.10	S. 44¾° W.	18.23	4.68	8.19	0 08	55.3	0.85	3.2	1.20	... . Sums
22 Years means for and including this month	40.07	48.59	32 36	16.22	29.9576	....	.....	.203	.1713	66.8	....	.....	ɾ16.71	6.13	..	..	¶51.4	1 61	6.0	2.21	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	1436	2405	442	779	378	5237	390	61	
Duration in hrs .	91	167	38	78	29	266	33	9	9
Mean velocity....	15.78	14.40	11 63	9.98	13.04	19.69	11.82	6.78	

Greatest mileage in one hour was 40 on the 3rd.
Greatest velocity in gusts, 48 miles per hour on the 3rd.

Resultant mileage, 2045.
Resultant direction, S. 44¾ W.
Total mileage, 11,128.
Average velocity, 15.45 miles per hour.

* 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. ɾ Ten years only.

The greatest heat was 77.0° on the 19th; the greatest cold was 17.6° on the 4th, giving a range of temperature of 59.4 degrees.

Warmest day was the 19th. Coldest day was the 1st. Highest barometer reading was 30.586 on the 8th. Lowest barometer was 29.419 on the 3rd, giving a range of 1.167 inches. Maximum relative humidity was 99 on the 1st, 3rd, 6th, 17th and 18th. Minimum relative humidity was 30 on the 23rd and 30th.

Rain fell on 12 days.

Snow fell on 6 days.

Rain or snow fell on 16 days.

Auroras were observed on 2 nights, 23rd & 24th

Lunar halo on 1 night, 24th.

Hail fell on 17th and 21st.

Rainbow on 19th.

ABSTRACT FOR THE MONTH OF MAY, 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 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	51.33	66.7	36.0	30.7	30.0960	30.183	30.021	.162	.1753	49.0	31.0	N.E.	12.75	1.7	10	0	91	....	....	....	1
2	55.02	68.2	37.1	31.1	30.0135	30.082	29.947	.135	.2645	62.3	41.5	S.E.	8.54	2.0	8	0	79	....	....	....	2
SUNDAY........3	.....	69.3	48.5	20.8	....	......	......	....	.....	.	....	S.	9.54	....	...	..	27	....	....	....	3............SUNDAY
4	60.08	70.5	52.9	17.6	29.8277	29.872	29.768	.104	.4095	79.3	53.5	S. W.	18.13	3.7	8	0	53	0.01	....	0.01	4
5	53.78	65.7	43.5	22.2	29.8742	30.104	29.759	.345	.2928	72.2	44.2	S. W.	16.92	7.7	10	2	66	Inap.	....	Inap.	5
6	47.83	57.9	41 0	16.9	30.2867	30.366	30.204	.162	.2390	71.8	38.8	N.E.	17.75	5.8	10	0	45	....	....	....	6
7	53.78	64.2	38.8	25.4	30.3177	30.408	30.211	.197	.2712	66 0	42.0	S.	2.21	5.0	10	0	73	Inap.	....	Inap.	7
9	62.10	72.1	53.3	18.8	30.1218	30.262	30.005	.257	.4223	76.5	44.2	S. W.	10.54	9.0	10	8	23	0.07	....	0.07	8
8	71.37	83.5	56.0	27.5	29.8295	30.008	29.705	.303	.4965	66.3	58.8	S. W.	23.00	3.0	5	0	71	Inap.	....	Inap.	9
SUNDAY........10	.....	88.7	57.4	31.3	....	.....	......	....	.....	....	....	S. W.	25.17	....	....	..	86	1.22	....	1.22	10............SUNDAY
11	62.27	74.0	56.3	17.7	29.8055	29.901	29.750	.151	.4095	73.2	54.0	N.	9.75	4.3	8	0	75	0.01	....	0.01	11
12	57.35	68.6	51.0	17.6	29.9675	30.046	29.916	.130	.2472	53.5	39.7	N.W.	9.17	0.0	0	0	98	....	....	....	12
13	53.78	63.2	44 4	18.8	30.1488	30.228	30.082	.146	.2318	57 0	38.0	S.	10.17	0.7	2	0	98	....	....	....	13
14	60.42	70.1	44.5	25 6	29.9678	30.076	29.872	.204	.2675	52.0	41.8	S.	6.12	1 0	4	0	84	....	...	....	14
15	61.70	72.4	49.9	22.5	29.9117	29.961	29.886	.075	.3340	61.7	47.7	E-	8.12	4.5	10	0	55	0.19	....	0.19	15
16	59 27	67.2	52.8	14.4	29.9788	30.020	29.961	.059	.3463	69.3	49 0	S.W.	13.12	4.7	10	0	28	....	...	....	16
SUNDAY........17	.....	70.5	49.7	20.8	....	......	......	....	.....	....	....	S. W.	13.21	....	......	..	69	....	...	....	17............SUNDAY
18	62.27	69.4	54.7	14.7	29.6317	29.757	29.493	.264	.4445	72.7	53.3	S. W.	19.96	5.0	9	0	50	0.05	....	0.05	18
19	51.85	62.0	45.2	16.8	29.9082	30.078	29.765	.313	.2478	65.0	39.7	N. W.	9.21	4.8	10	0	50	0.02	....	0.02	19
20	55.78	65.4	44.2	21.2	30.1927	30.282	30.137	.145	.2460	56.0	39.7	S W.	4.58	1.8	6	0	91	....	....	....	20
21	59.15	69.0	47.9	21.1	30.0488	30.205	29.906	.299	.3515	70.3	49.0	S E.	13 50	1.2	7	0	80	....	....	....	21
22	60.75	72.8	54.1	18.7	29.9073	30.071	29.836	.235	.4232	79.3	54.3	N.W.	12.17	6.2	10	3	45	0.09	...	0.09	22
23	53.82	61.5	46.6	14.9	30.2907	30.338	30.202	.136	.2445	59.8	42.3	N W.	7.79	1.7	5	0	97	...	....	....	23
SUNDAY........24	.....	69.4	45.0	24.4	....	......	......	....	... .	....	....	S. E.	6.58	....	..	..	38	....	....	....	24............SUNDAY
25	61.40	69.6	50.4	19.2	29.9733	30.160	29.763	.397	.3395	62 2	48.2	S.E.	13.25	3 0	10	0	80	....	...	....	25
26	62.65	76.8	51.1	25.7	29.5752	29.659	29.496	.163	4097	74.0	53 3	S.E.	15.67	5 7	10	0	45	0.23	...	0.23	26
27	59.13	67.5	53.2	14.3	29.8730	30.025	29 680	.345	.3453	69.3	48.5	S W.	8.04	4.5	10	0	74	0.01	....	0.01	27
28	54.73	59.9	46.6	13.3	29.8910	30.069	29.7[illegible]2	.347	.3440	79.0	48.2	E.	11.25	8.0	10	0	16	0.47	....	0.47	28
29	54.62	60.8	51.1	9.7	29.7352	29.776	29.704	.072	.3298	77.0	47 3	S W	6.83	8.8	10	3	28	0.37	....	0.37	29
30	53.07	58.3	48.0	10.3	29.7542	29.765	29.736	.029	.2953	73.3	44.5	S.W.	8 04	9 8	10	9	07	Inap.	....	Inap	30
SUNDAY........31	.....	64.8	45 8	19.0	....	......	......	....	.....	....	....	W.	5 58	....	..		21	....	....	....	31............SUNDAY
Means	57.66	68.39	48 29	20.10	20.9588	30.065	29.866	.199	.3319	67.2	45.9	S. 33¾° W.	11.54	4.37	8.2	1.0	59.5	2.74	....	2.74	... . Sums
22 Years means for and including this month	54.74	64.11	45 75	18.81	29.9077	.....	......	.169	.2887	65.7	....	......	ʃ14.50	6.1	..	..	¶51.0	2.94	....	2.94	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	405	1170	315	1098	708	3810	373	705	
Duration in hrs..	31	87	47	110	71	263	47	75	13
Mean velocity....	13.07	13.45	6.70	9.98	9.97	14.49	7.94	9.40	

Greatest mileage in one hour was 43 on the 10th.
Greatest velocity in gusts, 48 miles per hour on the 10th.

Resultant mileage, 2950.
Resultant direction, S. 33¾° W.
Total mileage, 8,584.
Average velocity, 11.54 miles per hour.

* 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. ʃ Ten years only.

The greatest heat was 88.7° on the 10th; the greatest cold was 36.0° on the 1st, giving a range of temperature of 52.7 degrees.

Warmest day was the 10th. Coldest day was the 1st. Highest barometer reading was 30.408 on the 7th. Lowest barometer was 29.493 on the 18th, giving a range of .915 inches. Maximum relative humidity was 97 on the 28th. Minimum relative humidity was 28 on the 1st.

Rain fell on 16 days.

Auroras were observed on 4 nights, 2nd, 16th, 17th and 18th.

Rain fell on the 3rd.

Rainbow on the 3rd.

Thunder and lightning on 2 days, the 10th and 15th.

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THE

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Canadian Stromatoporoids.

By J. F. Whiteaves.[1]

In Canada, as elsewhere, only the more obvious characters of the Stromatoporoidea were examined by the first students of this difficult group of fossils, and it is probable that some of the earlier species proposed will have to be abandoned, as inadequately defined.

Of late years, however, these organisms have been studied much more systematically, especially by Professor H. Alleyne Nicholson, of the University of Aberdeen, and the minute structure of the different species has been elucidated and their probable affinities ascertained by means of thin microscopic sections.

While engaged in the preparation of his monograph of the British species for the Palæontographical Society, Professor Nicholson kindly examined and either identified or described, specimens of most of the Canadian species of Stromatoporoids that were then represented in the Museum of the Geological Survey at Ottawa, but some additional material has since been received at that Museum, especially an interesting series of specimens

1 Communicated by permission of the Director of the Geological Survey of Canada.

from the (Galena) Trenton of Lake Winnipeg and its vicinity, which has yet to be examined. The determinations and descriptions of Canadian Stromatoporoids are scattered through many publications that are not always easily accessible, and the present paper, therefore, will consist of a stratigraphical and systematic list, with references, etc., of all the species that have either been recognized or even supposed to have been recognized in Canada, or described from Canadian localities, commencing with those that have been examined microscopically.

A. Species that have been examined with the microscope.

(*Cambro-Silurian species.*)

Clathrodictyon variolare, Rosen. (Sp.)

Stromatopora variolaris, Von Rosen. 1867. Ueber die Natur der Stromatop., p. 61, pl. 2, figs. 2-5.

Clathrodictyon variolare, Nicholson. 1887. Ann. and Mag. Nat. Hist., ser. 5, vol. XIX., p. 4, pl. 1, figs. 4-6.

" " Nicholson. 1889. Mon. Brit. Stromatop., pt. 2, p. 150, pl. 18, figs. 1-5, and pl. 17, fig. 14.

Specimens which appear to be referable to this species were collected from the Hudson River formation at the Jumpers, Anticosti, by J. Richardson in 1856, and at Cape Smyth, Lake Huron, by Dr. R. Bell in 1859. It is the species referred to on page 304 of the Geology of Canada as *Stromatopora concentrica*, which, according to Professor Nicholson, "so far as at present known" (in 1891), "is a purely European species and entirely confined to the Devonian rocks."

LABECHIA CANADENSIS, Nicholson and Murie. (Sp.)

Stromatocerium Canadense, Nicholson and Murie. 1878. Journ. Linn. Soc., Zool., vol. XIV., p. 223, pl. 3, figs. 9 and 10.

Labechia Canadensis, Nicholson. 1886. Mon. Brit. Stromatop., pt. 1, pl. 2, figs. 3-5: and Ann. and Mag. Nat. Hist., ser. 5, vol. XVIII., pl. 14, pl. 2, fig. 5.

" " Nicholson, 1891. Mon. Brit. Stromatop., pt. 3, p. 163, pl. 20, fig. 9.

In Canada, so far as the writer is aware, this species has only been found in the Trenton limestone at Peterborough and Lake Couchiching, Ontario. At present it is not represented in the Museum of the Geological Survey at Ottawa.

LABECHIA HURONENSIS, Billings. (Sp.)

Stenopora Huronensis, Billings. 1865. Geol. Surv. Canada, Pal. Foss., vol. I., p. 185.

Tetradium Huronense, Foord (partim). 1883. Contr. Micro-Palæont. Silur. rocks of Canada, pl. 7, figs. 1 and 1*a*, but not figs. 1, *b-e*.

Labechia Ohioensis, Nicholson. 1886. Mon. Brit. Stromatop., pt. 1, p. 32, foot-note, pl. 2, figs. 1 and 2: and Ann. and Mag. Nat. Hist., ser. 5, vol. XVIII., p. 13, pl. 2, figs. 1 and 2.

Labechia montifera, Ulrich. 1886. Contr. Amer. Palæont., vol. I., p. 33, pl. 2, figs. 9 and 9*a*.

The types of *Stenopora Huronensis* are from the Hudson River formation at Cape Smyth, Lake Huron, where several fine specimens were collected by Dr. R. Bell in 1859, and not by Mr. A. H. Foord as supposed by Professor Nicholson. Mr. L. M. Lambe, who has recently studied these specimens somewhat exhaustively, is convinced that

Labechia Ohioensis, Nicholson, is identical with *Stenopora Huronensis*, and that the species ought to be called *Labechia Huronensis.* Most of the specimens of this coral from Cape Smyth are large and some of them are massive, but one encrusts a colony of *Tetradium fibratum* and another nearly covers a shell of *Cyrtoceras Postumius.* Of the six specimens figured by Foord under the name *Tetradium Huronense* (op. cit., pl. 7), Mr. Lambe finds that while fig. 1 represents a portion of a specimen of *Labechia Huronensis* encrusting *Tetradium fibratum*, and fig. 1*a* a portion of a massive specimen of *L. Huronensis*, that figs. 1, *b-e* are sections of *Tetradium fibratum*, Safford.

A few specimens of *L. Huronensis* were collected from the Hudson River formation at Club Island, Lake Huron, by Dr. R. Bell in 1865, and from rocks of the same geological horizon on the Credit River at Streetsville, by Mr. J. B. Tyrrell in 1888.

BEATRICEA NODULOSA, Billings.

Beatricea nodulosa, Billings. 1857. Geol. Surv. Canada, Rep. Progr. 1853-56, p. 344.
" " Hyatt. 1865. Am. Journ. Sc., vol. XXXIX., p. 266.
" " Nicholson. 1886. Mon. Brit. Stromatop., pt. 1, pp. 86, 88 and 89, pl., 8, figs. 1-8.

In his " Catalogues of the Silurian fossils of the Island of Anticosti," Mr. Billings says that this species was collected by Mr. James Richardson in 1855, from the Hudson River formation at Wreck Point, Salmon River, and Battery Point, Anticosti, and from Division 1 of the Anticosti group at Macastey Bay. Specimens of the same species in the Museum of the Geological Survey at Ottawa are labelled as having been collected by Mr. T. C. Weston, in 1865, from the same formation at and near the West end lighthouse, at English Head, and at Gamache (or

Ellis) Bay, Anticosti. Professor A. Hyatt, who has collected many specimens of *B. nodulosa* at various localities on the same island, says that the size of the species, "as nearly as could be inferred from fragments, is not over four feet long, by from three to five inches in diameter at the larger end." To the naked eye some of the specimens look as if they were encrusted by a parasitic species of *Labechia.*

A silicified specimen which appears to be referable to this species, though its internal structure is almost obliterated, was collected by Mr. Weston in 1884 from the upper beds of the Hudson River formation at Stony Mountain, Manitoba.

BEATRICEA UNDULATA, Billings.

Beatricea undulata, Billings. 1857. Geol. Surv. Canada, Rep. Progr. 1853-56, p. 344.
" " Hyatt. 1865. Amer. Journ. Sc., vol. XXXIX., p. 266.
" " Billings. 1865. Can. Nat. and Geol., ser. 2, vol. II., p. 405, fig. 1.
" " Nicholson. 1886. Mon. Brit. Stromatop., pt. 1, pp. 86 and 89.

Numerous specimens of this remarkable fossil were collected from the Hudson River formation and from Divisions 1 and 2 of the Anticosti group, at several localities on the island of Anticosti, by Mr. J. Richardson in 1856, by Messrs. Verrill, Shaler and Hyatt in 1861, and by Mr. Weston in 1865. Characteristic examples of *B. undulata* have since been collected from the Hudson River formation at Snake Island, Lake St. John, P.Q., by Mr. Richardson in 1857; at Rabbit and Club islands, Lake Huron, by Dr. R. Bell in 1859; and in the "Upper beds" at Stony Mountain, Manitoba, by T. C. Weston, and A. McCharles in 1884. A specimen in the Museum of the Geological Survey at Ottawa, collected by Mr. Richardson at Gamache Bay, Anticosti, which is imperfect at both ends, is ten feet five inches in length, as stated by Mr. Billings, and a similarly imperfect specimen collected by Messrs. Verrill, Shaler and Hyatt, is said to be thirteen feet and a half in length. Professor Hyatt is of the opinion that the length of an entire and adult specimen of this species was "certainly not less than twenty feet."

(*Silurian species.*)

ACTINOSTROMA MATUTINUM, Nicholson.

Actinostroma matutinum, Nicholson. 1891. Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 322, pl. 9, figs. 1 and 2.

L'Anse au Gascon, five miles and a half east of Port Daniel, in the Baie des Chaleurs, Dr. R. Bell, 1862: one specimen, from Division 1 of the Chaleur group, which is supposed to be "about the horizon of the Niagara limestone." The *Stromatopora concentrica* of the list of Port Daniel fossils on page 444 of the Geology of Canada is almost certainly this species.

CLATHRODICTYON VESICULOSUM, Nicholson and Murie.

Clathrodictyon vesiculosum, Nicholson and Murie. 1878. Journ. Linn. Soc., Zool., vol. XIV., p. 220, pl. 2, figs. 11-13.

" " Nicholson and R. Etheridge, jun., 1880. Mon. Silur. Foss. Girvan, p. 238, pl. 19, fig. 2.

" " Nicholson, 1887. Ann. and Mag. Nat. Hist., ser. 5, vol. XIX., p. 1, pl. 1, figs. 1-3: 1889, Mon. Brit. Stromatop., pt. 2, p. 147, pl. 17, figs. 10-13, and pl. 18, fig. 12.

Specimens which have been recently identified with this species were collected from the Niagara limestone at

Lake Temiscaming by Sir W. E. Logan in 1845, at Thorold, Ontario, by E. Billings in 1857, and in the Anticosti group at Junction Cliff and the west side of Gamache or Ellis Bay, Anticosti, by T. C. Weston in 1865. It appears to be very abundant at Lake Temiscaming, where specimens were recently collected by Dr. R. Bell in 1887, and by Mr. A. E. Barlow in 1893 and 1894.

CLATHRODICTYON FASTIGIATUM, Nicholson.

Clathrodictyon fastigiatum, Nicholson. 1886. Mon. Brit. Stromatop., pt. 1. p. 43, figs. 3, *a-b*: and, 1887, Ann. and Mag. Nat. Hist., ser. 5, vol. XIX., p. 8, pl. 2, figs. 3 and 4: also, 1888, Mon. Brit. Stromatop., pt, 2, p. 152, pl. 19, figs. 1-5.

In the Guelph formation at Glenelg Township, six miles from Durham, where a few specimens were collected by Mr. Townsend in 1884.

CLATHRODICTYON OSTIOLATUM, Nicholson.

Stromatopora ostiolata, Nicholson. 1873. Ann. and Mag. Nat. Hist., ser. 4, vol. XII., p. 90, pl. 5, figs. 1 and 1*a*: 1874, Rep. Pal. Prov. Ont., pl. 1, figs. 1 and 1*a*: 1875, Rep. Pal. Prov. Ont., p. 63: and, 1878, Journ. Linn., Soc. Zool., vol. XIV., pl. 2, figs. 1 and 2.

Clathrodictyon (*Stromatopora*) *ostiolata*, Nicholson. 1886. Mon. Brit. Stromatop., pt. 1, p. 14.

Clathrodictyon ostiolatum, Nicholson. 1887. Ann. and Mag. Nat. Hist., ser. 5, vol. XIX., p. 11, pl. 3, figs. 1-3.

The type of this species was collected at Guelph, in the Guelph formation, by Mr. John Wilkie, not later than the year 1873, and specimens have since been obtained at

Elora by Mr. David Boyle in 1880, and at Durham by Mr. Joseph Townsend in 1884.

STROMATOPORA ANTIQUA, Nicholson and Murie.

Pachystroma antiqua, Nicholson and Murie. 1878. Journ. Linn. Soc., Zool., vol. XIV., p. 224, pl. 4, figs. 2-5.

Stromatopora antiqua, Nicholson. 1886. Mon. Brit. Stromatop., pt. 1, p. 17, pl. 5, figs. 8-11.

The types of this species were collected by Professor Nicholson from the Niagara limestone at Thorold, and there is a single specimen in the Museum of the Geological Survey at Ottawa, which was collected from the Guelph formation at Durham, by Mr. Townsend in 1884.

STROMATOPORA GALTENSIS, Dawson. (Sp.)

Cœnostroma Galtense, Dawson. 1875. Life's Dawn on the Earth, p. 160: and, 1879, Quart. Journ. Geol. Soc. Lond., vol. XXXV., p. 52.

Stromatopora Galtensis, Nicholson. 1891. Mon. Brit. Stromatop., pt. 3, p. 173.

Hespeler, T. C. Weston, 1867: one specimen. Professor Nicholson, who has examined a portion of this specimen, says (op. cit.) that its minute structure "is practically destroyed by dolomitization, but all its general characters would lead to the belief that it is very closely related to *Stromatopora typica*, Rosen, and is probably identical with it." He further states that *Cœnostroma constellatum* of Spencer, from the Niagara limestone near Hamilton, does not appear to be in any way distinguishable as regards its general characters from *C. Galtense*, Dawson, and that he is "strongly disposed to think that it is really identical with *S. typica*, Rosen. If the above view should prove to be correct, then *Cœnostroma Galtense*, Dawson, and *C.*

constellatum, Spencer, must be considered as synonyms of *S. typica*, Rosen."

It remains to be seen whether Spencer's *C. constellatum* is the same as Hall's *Stromatopora constellata* (Pal. N. York, vol. II., 1852, p. 324, pl. 72, figs. 2, *a-b*), which latter species has not been examined microscopically.

STROMATOPORA CONSTELLATA, Spencer. (Sp.)

Cænostroma constellata, Spencer. 1884. Bull. Mus. Univ. St. Missouri, vol. I., No. 1, p. 48, pl. 6, fig. 11.

"Near the top of the Niagara series, at Carpenter's lime-kiln, two miles and a half south of Hamilton, where it is abundantly found associated with *Cænostroma botryoideum*." Spencer. See the remarks on the preceding species.

STROMATOPORA HUDSONICA, Dawson. (Sp.)

Caunopora Hudsonica, Dawson. 1879. Quart. Journ. Geol. Soc. Lond., vol. XXXV., p. 52, pl. 4, fig. 9, and pl. 5, fig. 10.

Stromatopora Hudsonica, Nicholson. 1891. Mon. Brit. Stromatop., pt. 3, p. 172: and Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 312, pl. 8, figs. 1-3.

The type of this species was collected by Dr. R. Bell in 1878 on the Albany River, Hudson's Bay, in rocks which are said to be of Upper Silurian age, though upon what evidence is not stated. Another specimen, which has since been identified with *S. Hudsonica*, was obtained by Dr. R. Bell in 1878 at Cape Churchill.

STROMATOPORA CARTERI, Nicholson.

Stromatopora Carteri, Nicholson. 1891. Mon. Brit. Stromatop., pt. 3, p. 174, pl. 1, figs. 6-7: and Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 314, pl. 9, figs. 5 and 6.

"The only Canadian example I have seen is from a loose boulder of Silurian age, from Hayes River, Hudson's Bay," collected by Dr. R. Bell in 1878. Nicholson, on page 315 of the paper in the Annals and Magazine of Natural History indicated in the preceding reference.

SYRINGOSTROMA RISTIGOUCHENSE, Spencer. (Sp.)

Cœnostroma Ristigouchense, Spencer. 1884. Bull. Mus. Univ. Missouri, vol. I., No. 1, p. 49, pl. 6, fig. 12.

Syringostroma Ristigouchense, Nicholson. 1886. Mon. Brit. Stromatop., pt. 1, p. 97, pl. 11, figs. 11 and 12: and, 1891, Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 324, pl. 8, figs. 6-8.

In rocks believed to be of the age of the Lower Helderberg limestone of the State of New York, at Dalhousie, N.B., where specimens were collected by Sir J. W. Dawson and A. H. Foord in 1881.

(*Devonian species.*)

ACTINOSTROMA EXPANSUM, Hall and Whitfield. (Sp.)

Stromatopora expansa, Hall and Whitfield. 1873. Twenty-third Reg. Rep. N. Y. St. Cab. Nat. Hist., p. 226, pl. 9, fig. 9.

Actinostroma expansum, Nicholson. 1891. Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 316, pl. 10, figs. 1 and 2.

Lake Winnipegosis, in limestone holding *Stringocephalus Burtini,* at a small island on the south-east side of Dawson Bay, where two specimens were collected by Mr. J. B. Tyrrell in 1889.

ACTINOSTROMA TYRRELLII, Nicholson.

Actinostroma Tyrrellii, Nicholson. 1891. Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 317, pl. 8, figs. 4 and 5.

Apparently not uncommon and in fine condition in the Stringocephalus limestone at five different localities on the shore and islands of the southern portion of Dawson Bay, Lake Winnipegosis, where specimens were collected by J. B. Tyrrell and D. B. Dowling in 1889.

ACTINOSTROMA WHITEAVESII, Nicholson.

Actinostroma Whiteavesii, Nicholson. 1891. Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 320, fig. 2, and pl. 9, figs. 3 and 4.

Peace River, near the mouth of Little Red River, Professor Macoun, 1875 : two specimens.

ACTINOSTROMA FENESTRATUM, Nicholson.

Actinostroma fenestratum, Nicholson. 1889. Mon. Brit. Stromatop., pt. 2, p. 146, pl. 17, figs. 8 and 9 : and, 1891, Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 322, pl. 10, figs. 3 and 4.

North-west shore of Lake Manitoba, at Pentamerus Point, three miles and a half north of the mouth of Crane River, J. B. Tyrrell and J. F. Whiteaves, 1888; several specimens. Lake Winnipegosis, on two small islands at the southern end of Dawson Bay; also on the south-western shore of Dawson Bay a little to the west of Salt Point, and at the south end of Rowan Island, in the western portion of the bay, J. B. Tyrrell, 1889 : one specimen from each of these localities.

CLATHRODICTYON CELLULOSUM, Nicholson and Murie.

Clathrodictyon cellulosum, Nicholson and Murie. 1878. Journ. Linn. Soc., Zool., vol. XIV., p. 221, pl. 2, figs. 9 and 10. Nicholson, 1887. Ann. and Mag. Nat. Hist., ser. 5, vol. XIX., p. 11, pl. 2, figs. 7 and 8.

" Not uncommon in the Corniferous Limestone (Devonian) of Port Colborne and other localities in Western Canada." Nicholson.

CLATHRODICTYON LAXUM, Nicholson.

Clathrodictyon laxum, Nicholson. 1887. Ann. and Mag. Nat. Hist., ser. 5, vol. XIX., p. 12, pl. 3, figs. 4 and 5.

" Corniferous limestone, Port Colborne, Ontario," Nicholson. A fine specimen in the Museum of the Geological Survey at Ottawa, which was identified with this species by Professor Nicholson, was collected from the Corniferous limestone at Pelee Island, Ont., by the Rev. W. Minter Seaborn in 1884.

CLATHRODICTYON RETIFORME, Nicholson and Murie. (Sp.)

Stylodictyon retiforme, Nicholson and Murie. 1878. Journ. Linn. Soc., Zool., vol. XIV., p. 222, pl. 2, fig. 14, and pl. 3, figs. 1-3.

Clathrodictyon retiforme, Nicholson. 1887. Ann. and Mag. Nat. Hist., ser. 5, vol. XIX., p. 13, pl. 3, figs. 6-8.

" Rare in the Hamilton formation (Devonian) at Arkona, Ontario," where it was discovered by Dr. G. J. Hinde. Nicholson.

STROMATOPORA. (Sp.)

" Cfr. *S. bücheliensis,* Bargatzky, sp." Nicholson. 1891. Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 313.

According to Professor Nicholson (op. cit.) two specimens collected by Mr. Tyrrell in 1889 from the Stringocephalus limestone of two small islands in Dawson Bay, Lake Winnipegosis, " have the general aspect of *Stromatopora bucheliensis,* Barg. sp., and are probably referable to this species. Unfortunately the specimens in question are dolomitized, and their internal structure is so far altered that this reference cannot be regarded as free from doubt."

STROMATOPORA. Sp.

" Cfr. *Stromatopora Hüpschii,* Barg., sp." Nicholson. 1891. Ann. and Mag. Nat. Hist., ser. 6, vol. VII., p. 314.

Lake Winnipegosis, at the south end of Snake Island (one specimen), and on a small island on the south-east side of Dawson Bay (one specimen); J. B. Tyrrell, 1889.

In reference to these two specimens Professor Nicholson observes (op. cit., p. 314) that they " belong to a species of *Stromatopora* in many respects similar to *S. Hüpschii,* Barg. Structurally they agree with the latter common European and British type, and differ from *S. Bucheliensis,* Barg., in their coarse skeleton fibre, the lax reticulation of the skeleton, and the loose spreading form of the astrorhizæ. The internal structure of these specimens is, however, very poorly preserved, and it would be rash to refer them unreservedly to *S. Hüpschii.*"

STROMATOPORELLA GRANULATA, Nicholson.

Stromatoporella granulata, Nicholson. 1873. Ann. and Mag. Nat. Hist., ser. 4, vol. XII., p. 94, pl. 4, figs. 3 and 3*a* : and, 1886, Mon. Brit. Stromatop., pt. 1, pp. 93, 94, pl. 1, figs. 4, 5 and 15, pl. 4, fig. 6, and pl. 7, figs. 5 and 6: also, 1891, Ibid., pt. 3, p. 202, pl. 26, fig. 1.

Hamilton formation at Arkona and near Thedford, Ontario. According to Professor Nicholson (Mon. Brit. Stromatop., p. 203), this species has been found only in the Hamilton formation and *S. Selwynii* in the Corniferous.

STROMATOPORELLA SELWYNII, Nicholson.

Stromatoporella Selwynii, Nicholson. 1892. Mon. Brit. Stromatop., pt. 4, p. 205, pl. 1, fig. 14, and pl. 26, figs. 2-4.

"Not uncommon in the Corniferous limestone of Port Colborne, Ontario." Nicholson, op. cit., p. 205.

STROMATOPORELLA INCRUSTANS, Hall and Whitfield. (Sp.)

Stromatopora (*Cœnostroma*) *incrustans,* Hall and Whitfield. 1873. Twenty-third Rep. Reg. N.Y. St. Cab. Nat. Hist., p. 227, pl. 9, fig. 3.

Stromatopora nulliporoides, Nicholson. 1875. Rep. Pal. Prov. Ont., p. 78.

Stromatoporella incrustans, Nicholson. 1891. Ann. and Mag. Nat. Hist., ser. 6, vol. VII., pp. 309 and 310, footnote.

"Hamilton formation at Arkona, and Corniferous limestone, at Port Colborne, Ontario." Nicholson. It is also abundant in the neighborhood of Thedford, Ontario, in the Hamilton formation.

STROMATOPORELLA (?) TUBERCULATA, Nicholson.

Stromatopora tuberculata, Nicholson. 1873. Ann. and Mag. Nat. Hist., ser. 4, vol. XII., p. 92, pl. 4, figs. 2 and *2a:*

1874, Ibid., ser. 4, vol. XIII., p. 8, figs. 1, *a-c:* Rep. Pal. Prov. Ont., p. 14, pl. 1, figs. 2 and 3, and figs. 2, *a-c*, on p. 15: and, 1887, Ann. and Mag. Nat. Hist., ser. 5, vol. XIX., p. 15, pl. 3, figs. 9-11.

Common in the Corniferous limestone at Ridgeway and Port Colborne. Nicholson.

B. Species of doubtful affinities, that have not yet been examined with the microscope.

(*Cambro-Silurian species.*)

Stromatocerium rugosum, Hall.

Stromatocerium rugosum, Hall. 1847. Pal. N. York, vol. I., p. 48, pl. 12, figs. 2, 2, *a-b*.

Stromatopora rugosa, Billings. 1873. Geol. Canada, p. 140, fig. 72.

According to Professor Hall, "this coral, so far as known, is confined to the Black-river limestone, and to the dark layers alternating with the Bird's-eye limestone." (op. cit., p. 48). In the Province of Quebec, specimens of this species were collected at Lake St. John, two miles west of the Metabechouan River by Mr. James Richardson in 1857. In Ontario, specimens were collected at Paquette's Rapids, on the Ottawa River, by Sir W. E. Logan in 1845; at Balsam Lake, Victoria Co., by Mr. Alexander Murray in 1853; and on Lot 13, Con. 4, of Stafford, by Mr. Richardson in 1853. In the "Geology of Canada" for 1863 the species is recorded as occurring on the Moira River, Hastings Co.; in the township of Douro, near Peterborough; and on Lacloche Island, Lake Huron. The specimens are usually silicified and their minute structure seems to be obliterated. At Paquette's Rapids there are two forms (the one with a massive and the other with an encrusting cœnosteum), both of which have been identified with this species by J. W. Salter and E. Billings. The encrusting form, which often almost entirely covers the exterior of shells of *Maclurea Logani*, has somewhat the appearance of a *Labechia*.

(*Silurian species.*)

STROMATOPORA HINDEI, Nicholson.

Stromatopora Hindei, Nicholson. 1874. Ann. and Mag. Nat. Hist., ser. 4, vol. XIII., p. 12, and p. 13, figs. 3, *a-e.* : also Rep. Pal. Prov. Ontario, p. 13, figs. 1, *a-e.*

"Common in a magnesian limestone of the age of the Niagara limestone (Upper Silurian), at Owen Sound, Ontario. Collected by Mr. G. J. Hinde." Nicholson. This species must be abandoned, as, in a letter recently received by the writer, Professor Nicholson says that "it was founded on a weathered *Cœnites* perforated by some boring organism."

STROMATOPORA STRIATELLA, Nicholson.

Stromatopora striatella (D'Orbigny), Nicholson. 1875. Rep. Pal. Prov. Ont., p. 49.

"Common in the Niagara Limestone of Thorold. Rare at Rockwood." Nicholson. This identification, however, is not confirmed, as the occurrence of *S. striatella*, D'Orbigny (which is now known to be a *Clathrodictyon*) at these localities, is omitted by Professor Nicholson in his most recent references to that species.

CAUNOPORA WALKERI, Spencer.

Caunopora Walkeri, Spencer, 1884. Bull. Mus. Univ. St. Missouri, vol. I., No. 1, p. 46, pl. 6, figs. 9 and 9*a*.

Lower beds of the Niagara formation at Hamilton, Ontario. "In the specimens that I have seen, the original matter is all silicified" Spencer.

CAUNOPORA MIRABILIS, Spencer.

Caunopora mirabilis, Spencer. 1884. Bull. Mus. Univ. St. Missouri, vol. I., no. 1, p. 47, pl. 6, figs. 10, 10, *a-b*.

"Only one specimen has been obtained from the Niagara formation at Hamilton, so far as I am aware." Spencer.

CÆNOSTROMA BOTRYOIDEUM, Spencer.

Cœnostroma botryoideum, Spencer. 1884. Bull. Mus. Univ. St. Missouri, vol. I., no. 1, p. 50, pl. 6, figs. 13, 13, *a-b*.

Abundant "in the Upper Niagara beds at Carpenter's limekilns, about two and a half miles south of Hamilton, Ontario." Spencer.

DICTYOSTROMA RETICULATUM, Spencer.

Dictyostroma reticulatum, Spencer. 1884. Bull. Mus. Univ. St. Missouri, vol. I., no. 1, p. 51, pl. 6, figs. 14 and 14*a*.

"It occurs in the cherty beds of the Niagara formation at Hamilton, Ontario." Spencer.

(*Devonian species.*)

STROMATOPORA PERFORATA, Nicholson.

Stromatopora perforata, Nicholson. 1874. Ann. and Mag. Nat. Hist., ser. 4, vol. XIII., p. 11, and p. 12, figs. 2, *a-c* ; also Rep. Pal. Prov. Ont., p. 15, and p. 16, figs. 3, *a-c*.

"Rare in the Corniferous limestone of Port Colborne," Ontario. Nicholson.

STROMATOPORA MAMILLATA, Nicholson.

Stromatopora mammillata, Nicholson. 1873. Ann. and Mag. Nat. Hist., ser. 4, vol. XII., p. 94, pl. 4, fig. 4: and, 1874, Rep. Pal. Prov. Ont., p. 17, pl. 1, fig. 4.

"Rare, in a silicified condition, in the Corniferous limestone of Port Colborne." Nicholson.

THE FLORA OF MONTREAL ISLAND.

By ROBERT CAMPBELL, D.D., M.A.

(*Continued from Vol. VI., Number 7, p. 405.*)

The season of 1896 was well fitted to bring into prominent notice the plant life, scattered over the Island of Montreal. Vegetation was very rank, owing to the abundance and frequency of the rainfall. Even those forms of life that usually escape observation and have to be searched for, came forth out of their obscurity and were more easily found than in ordinary years. This will account for the fact that the appended list of the new captures made by the writer during the season just closed is so large, and contains so many varieties that had hitherto not obtruded themselves on his attention. It is especially interesting to note how many of the species in the Holmes Herbarium are here duplicated, showing that they have survived all the changes and chances of seventy-five years.

RANUNCULUS FLAMMULA, L., var. REPTANS, E. Meyer. —(Smaller Spearwort)—In pasture field at St. Michel—August, 1896—(Reported by Dr. Holmes from St. Helen's Island.)

VIOLA PUBESCENS, Ait. var. SCABRIUSCULA, Torr & Gray—(Downy yellow violet)—Bagg's Woods—September, 1896.

Hypericum maculatum, Watt.—(Spotted St. John's Wort)—Bagg's Woods—August, 1896.

Geranium maculatum, L.—(Wild Crane's bill)—Westmount—June, 1896.

Ilex verticillata, Gray.—(Black Alder. Winter berry) Mountain Swamp and St. Michel—June, 1896.

Rhamnus alnifolia, L'Her.—(Buckthorn)—St. Michel, June, 1896—(Reported by Dr. Holmes from same district.)

Medicago sativa, L.—(Lucerne. Alfalfa)—Near cottage at north-west corner of Mount Royal Cemetery.

Spiræa tomentosa, L.—(Hardhack. Steeplebush)—Montreal Junction—June, 1896—(Reported by Dr. Holmes from Papineau Woods.)

Potentilla argentea, L.—(Silvery Cinque-foil)—Montreal Junction—June, 1896.

Chrysoplenium Americanum, Schwein.—(Golden Saxifrage)—Mountain Marsh and Back River—May, 1896—(Reported by Dr. Holmes from Mountain.)

Myriophyllum spicatum, L.—(Water milfoil)—St. Lawrence River—Point St. Charles—September, 1896.

Callitriche heterophylla, Pursh.—(Water starwort)—Back River Swamp—September, 1896.

Lonicera glauca, Hill.—(Honeysuckle)—Mountain Park, near Keeper's Lodge—June, 1896—(Reported by Dr. Holmes from Mountain as *L. parviflora.*

Solidago ulmifolia, Muhl.—(Golden-Rod)—St. Michel—September, 1896.

Solidago Canadensis, L., var. Scabra—(Golden-Rod)—Mount Royal—August, 1896.

Aster patulus, Lam.—(Aster)—Mount Royal, below high reservoir—August, 1896.

Aster salicifolius, Ait.—(Aster)—Mount Royal Park—September, 1896.

Aster dumosus, L.—(Aster)—Point St. Charles, and foot of Mount Royal—September, 1896.

ASTER JUNCEUS, Ait.—(Aster)—St. Michel—September, 1896.

ASTER LONGIFOLIUS, Lam.—(Aster)—Bagg's Woods—September, 1896.

ASTER TARDIFLORUS, L.—(Aster)—Point St. Charles—August, 1896.

ASTER DIFFUSUS, Ait.—(Aster)—Bagg's Woods and St. Michel—August, 1896—(Holmes names it *divergens.*)

ASTER DIFFUSUS, Ait., var. THYRSOIDEUS, Gray—St. Michel—September, 1896.

ASTER DIFFUSUS, Ait., var. HIRSUTICAULIS, Gray—Point St. Charles—September, 1896.

HELIANTHUS ANNUUS, L.—(Common Sunflower)—Point St. Charles.

ACTINOMERIS SQUARROSA, Nutt.—St. Michel—August, 1896—Now first reported from the district.

BIDENS CONNATA, Muhl. var. COMOSA, Gray—(Swamp Beggar-Ticks)—September, 1896.

LAMPSANA COMMUNIS, L.—(Nipple-Wort)—Montreal Junction and St. Michel—June and August, 1896.

HIERACIUM PANICULATUM, L.—(Hawkweed)—St. Michel—September, 1896—(Reported by Dr. Holmes from Papineau Woods.)

PRENANTHIES ASPERA, Michx.—(Rattlesnake-Root)—St. Michel—September, 1896.

STEIRONEMA CILIATUM, Raf.—(Loose Strife)—St. Michel—August, 1896—(Called *Lysimachia ciliata* by Dr. Holmes.)

ASCLEPIAS INCARNATA, L.—(Swamp Milkweed)—Westmount—June, 1896—(Reported from Recollet suburbs in 1821 by Dr. Holmes.)

EPIPHEGUS VIRGINIANA, Bart.—(Beech drops, Cancer-root)—Mount Royal and St. Michel—September, 1896—(Reported by Dr. Holmes from Papineau Woods as *Orobanche Virginiana.*)

Lycopus sinuatus, Ell.—(Water Horehound)—St. Michel—September, 1896.

Polygonum orientale, L.—(Prince's Feather)—Point St. Charles—September, 1896.

Euphorbia maculata, L.—(Spurge)—Point St. Charles —September, 1896.

Carpinus Caroliniana, Watter.—(American Hornbeam. Blue Beech)—Canadian Pacific Railway ground, Westmount—August, 1896—(Reported by Dr. Holmes as *C. Americana.*)

Quercus bicolor, Willd.—(Swamp White Ash)—St. Michel—August, 1896.

Ceratophyllum demersum, L.—(Hornwort) — Pond near Back River—September, 1896.

Elodea Canadensis, Michx.—(Waterweed)—River St. Pierre—June, 1896.

Vallisneria spiralis, L.—(Tape-grass, Eel-grass)—St. Lawrence, near mouth of St. Pierre River—(Reported by Dr. Holmes.)

Microstylis Monophyllos, Lindl.—(Adder's Mouth)—Little Mountain—June, 1896.

Microstylis ophioglossoides, Nutt.—(Adder's Mouth) St. Michel—August, 1896.

Corallorhiza innata, R. Brown.—(Coral-Root)—St. Michel—September, 1896—(Reported by Dr. Holmes from Papineau Woods as *Cymbidium corallorhizum.*)

Habenaria psycodes, Gray.—(Purple Fringed Orchis) —Mountain Swamp—July, 1896—(Reported by Dr. Holmes as *Orchis fimbriata.*)

Pontederia cordata, L.—(Pickerel Weed)—St. Lawrence River bank above Point St. Charles—(Reported by Dr. Holmes from River St. Pierre.)

Juncus effusus, L.—(Common or Soft Rush)—Bank of St. Lawrence, Point St. Charles—August, 1896.

Spirodela polyrrhiza, Schleid.—(Duck Weed)—River St. Lawrence, near mouth of St. Pierre River—August, 1896—(Reported as common by Dr. Holmes by the name of *Lemna polyrrhiza*, L.)

LEMNA MINOR, L.—(Duck Weed, Duck's Meat)—Ditch St. Michel and River St. Pierre—August, 1896.

SAGITTARIA VARIABILIS, Engelm, var. ANGUSTIFOLIA—(Arrowhead)—Bank of St. Lawrence, above Point St. Charles—August, 1896—(Given by Dr. Holmes as *S. gracilis.*)

POTAMOGETON FLUITANS, Tuckerm.—(Pond Weed)—River St. Lawrence, Point St. Charles—September, 1896—(Reported by Dr. Holmes.)

POTAMOGETON HETEROPHYLLUS, Schreb.—(Pond Weed)—River St. Lawrence, Point St. Charles—September, 1896.

POTAMOGETON PERFOLIATUS, L.—(Pond Weed)—River St. Lawrence, Point St. Charles—August, 1896—(Reported by Dr. Holmes from River St. Pierre.)

POTAMOGETON PERFOLIATUS, L., var. LANCEOLATUS, Robbins.—(Pond Weed)—Point St. Charles—September, 1896.

POTAMOGETON ZOSTERÆFOLIUS, Schum.—(Pond Weed)—River St. Lawrence, Point St. Charles—September, 1896.

POTAMOGETON MUCRONATUS, Schrad.—(Pond Weed)—River St. Lawrence, Point St. Charles—September, 1896.

POTAMOGETON PUSILLUS, L.—(Pond Weed)—Point St. Charles—September, 1896.

CHARA FLEXILIS, L.—(Feather Beds)—Pond near Back River—September, 1896.

EQUISETUM SYLVATICUM, L.—(Horse-tail)—St. Michel—August, 1896.

EQUISETUM PALUSTRE, L.—(Horse-tail)—Lachine—June, 1896—(Reported by Dr. Holmes.)

ASPIDIUM SPINULOSUM, Swartz.—(Shield Fern. Wood Fern)—Bagg's Woods—August, 1896.

ASPIDIUM SPINULOSUM, Swartz, var. INTERMEDIUM, D. C. Eaton—(Shield Fern)—Bagg's Woods—September, 1896.

Aspidium Bootii, Tuckerm—(Shield Fern)—St. Michel—August, 1896—(Reported by Dr. Holmes as *A. cristatum.*)

Aspidium Goldianum, Hook.—(Shield Fern)—Bagg's Woods—August, 1896—(Reported by Dr. Holmes from Mount Royal.)

Aspidium acrostichoides, Swartz.—(Christmas Fern)—Bagg's Woods—August, 1896—(Reported by Dr. Holmes from Mount Royal.)

Dicksonia pilosiuscula, Willd.—(Dicksonia)—Bagg's Woods—August, 1896.

Nematophyton crassum.

By D. P. Penhallow.

Since my last summary of the genus Nematophyton, in which eight species were enumerated,[1] additional material has been received, which, on the basis of more ample and more perfectly preserved specimens, serves to extend and confirm our previous knowledge of certain species.

The specimen now under consideration was received from Mr. F. K. Mixer, of the Buffalo Society of Natural Sciences, who reports that it was obtained from the upper part of the water-lime group (Lower Helderberg) of the Upper Silurian. Heretofore the occurrence of this genus, at so low a horizon, has been confined to N. Hicksii, N. Logani and, more recently, N. Storriei, all of which have been from European localities, while N. Logani has also been found sparingly and in fragmentary specimens at Cap Bon Ami, New Brunswick.

This is the first time the species now under consideration has been observed in the Silurian of America, the lowest and only horizon heretofore recorded being Middle Erian. It, therefore, affords important testimony bearing upon the great antiquity of the genus as a whole, and of this species in particular.

[1] Ann. Bot. X., 41, 1896.

The specimen obtained by Mr. Mixer represents the base of the stem or stipe, and in this respect it is similar to the recently described specimen of N. Ortoni.[1] It measures 56 centimeters long. At the top it is 7.5 c.m. broad, while at the base, where the root processes arise, it widens out to 16.5 c.m. Externally the surface is roughened as if from the result of superficial decay, and shows somewhat extended carbonized areas, within which the material separates in small angular fragments. In the transverse section no concentric structure is observable.

Sections of this specimen were prepared by Dr. J. M. Clarke, of Albany, N.Y., and forwarded to me for study. They represent a fairly well preserved structure, and even a hasty examination served to show that they exhibited several elements of interest.

Transverse Section.

The structure is somewhat altered, in consequence of which the large cells are, to some extent, wanting in a sharply defined outline, but nowhere was there that extreme alteration met with in specimens of the same species as formerly obtained from the Hamilton group of New York. Nevertheless, the alteration has been carried sufficiently far to render the small hyphæ lying between the large cells, to a great extent unrecognizable.

The best material representing this species, heretofore studied, was that originally collected by Dr. Bell from Gaspé, but it was in small fragments and did not permit of extended study. It, nevertheless, showed the large cells of the medulla to be very perfectly preserved, and the hyphæ also, to be unaltered in form.[2] It was upon a study of this material that the diagnosis of the species was first based. Later, a revision of the Celluloxylon primævum of Dawson, as represented by material from the Hamilton group of New York, collected by Dr. J. M.

[1] Ann. Bot. X., 41, 1896.

[2] Trans. R. Soc. VII., iv., 20, 21.

Clarke, showed that this plant was referrable to N. crassum, but that it had been highly altered by crystallization.[1] More recently, material collected by Prof. C. S. Prosser from the Hamilton group of New York, furnished specimens much more perfectly preserved, but yet much altered by crystallization.[2] From this it is to be observed that the excellent state of preservation of the material now at hand, affords excellent opportunities for verification of the previous diagnoses.

The cells of the Medulla are large, ranging from 40 μ.–62 μ. broad, but are chiefly rather uniform in size, and average about 56 μ. in diameter. This, it will be observed, is rather larger than observed in former specimens of this species, which showed a range of 23 μ.–46 μ. in one case[3] and 32 μ.–39 μ. in another.[4]

The entire structure is rather lax—not so much so as in N. laxum and N. Ortoni, but closely comparable with previous specimens of N. crassum. Medullary spots are numerous and irregularly distributed. They are of an irregularly rounded or oblong form, and appear to range from 174 μ. to 261 μ. in diameter. Here and there they seem to have undergone exceptional alteration leading to the formation of spherical cavities about 436 μ. in diameter. They are, however, in most cases, occupied by a somewhat loose plexus of hyphæ having a somewhat variable diameter, ranging upwards from 4.68 μ.—similar in general character and size to the hyphæ lying between the large cells of the medulla.

Even without the aid of a magnifying glass, a certain concentric structure with broad zones is apparent in the transparent section, but this is by no means as clearly defined as in N. Logani. Under a magnifying power of moderate strength, this appearance entirely disappears,

[1] l. c. VII., iv., 25.
[2] Proc. U.S. Nat. Mus., XVI., 116.
[3] Proc. U.S. Nat. Mus., XVI., 116.
[4] Trans. R. Soc. Can., VII., iv., 20—23, 29.

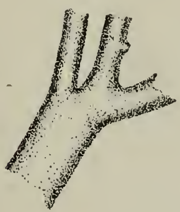
and it is extremely difficult to determine precisely upon what it depends, but it seems probable that it is determined by a peculiar disposition of the cells in relation to the medullary spaces.

Large transverse sections also exhibit radial fissures due to shrinkage, but there appears to be a total absence of those radial bands simulating medullary rays, so conspicuous in N. Logani. On the other hand, the medullary spots, already described, are connected radially and tangentially by more continuous and open tracts as medullary spaces, which thus form a sort of netted system between the various sub-divisions of which the large cells lie in distinct and often more or less rounded groups. This distribution of the elements gives the transverse section a very characteristic appearance. It had already been noted in the previously described specimens of N. crassum, but owing to the very limited area of the Gaspé sections, and the highly altered character of the specimens from the Hamilton group, a proper description was not possible, and this structural feature was, therefore, omitted from the diagnosis. It is, nevertheless, an important diagnostic element, under the present circumstances of limited material, since it seems to definitely differentiate this species from all the others.

Longitudinal Section.

In longitudinal section the cells of the medulla are somewhat strongly interlacing, while groups of a dozen or more often cross the general direction of growth more or less abruptly, and sometimes turn off nearly at right angles for a short distance. These features also appear in previously described specimens, both from Gaspé and from New York. The intercellular hyphæ are freely interlacing and cross the large cells in all directions, but their structure is so altered by decay as to render it impossible to determine if they are septate or not. Nowhere have trumpet hyphæ been found, thus confirming previous observations in this respect.

The medullary spots are, in most cases, elongated vertically, assuming an oblong or lenticular form, two to several times higher than broad, features also characteristic of the formerly described specimens of this species. The spots are, as in other cases, crowded with interlacing hyphæ, and into them there also project large cells from the surrounding structure, which branch more or less freely. These sections afford numerous instances of branching cells, and in one spot there were found two such cases, (figs. 1 and 2), one of which exhibited five subdivisions, primary and secondary, while the other showed three primary divisions terminal to the parent cell.



1

2

So many are the instances of this kind, and so varied are the dimensions of the branches, that I cannot but consider this specimen as affording very strong evidence in support of the conclusions already reached, that the medullary spaces "are the special areas within which branching is accomplished," and that it is here that the small hyphæ have their origin from the large cells of the medulla.[1]

The present material is thus found to not only extend our knowledge of the geographical range and stratigraphical horizon of this plant, but it affords strong corroborative testimony with respect to previous conclu-

[1] Trans. R. Soc. Can., VI., iv., 42; VII., iv., 22.

[2] Ann. Bot., X., 46, 1896.

sions, and extends its differential characters to an important extent. It thus becomes necessary to revise our original diagnosis in conformity with the facts now at hand.

NEMATOPHYTON CRASSUM (Dn.) Pen.

Transverse.

Concentric structure rather obscure. Radial tracts none. Medullary spots numerous, irregularly round or oval, chiefly 174 μ.–261 μ. broad, and connected by narrow spaces which form a more or less distinct network, enclosing groups of large, thick-walled cells. Cells of the medulla not very compact, rather uniform, ranging from 23 μ.–62 μ. broad, chiefly about 40 μ.

Longitudinal.

Cells of the medulla interlacing, often in groups. Medullary spots vertically lenticular or oblong, crowded with small hyphæ, 2 μ.–10 μ. broad, which arise within these areas from branching cells derived from the surrounding structure.

Highly crystalline forms often show a replacement of the normal structure by a pseudo-cellular structure (Celluloxylon.)

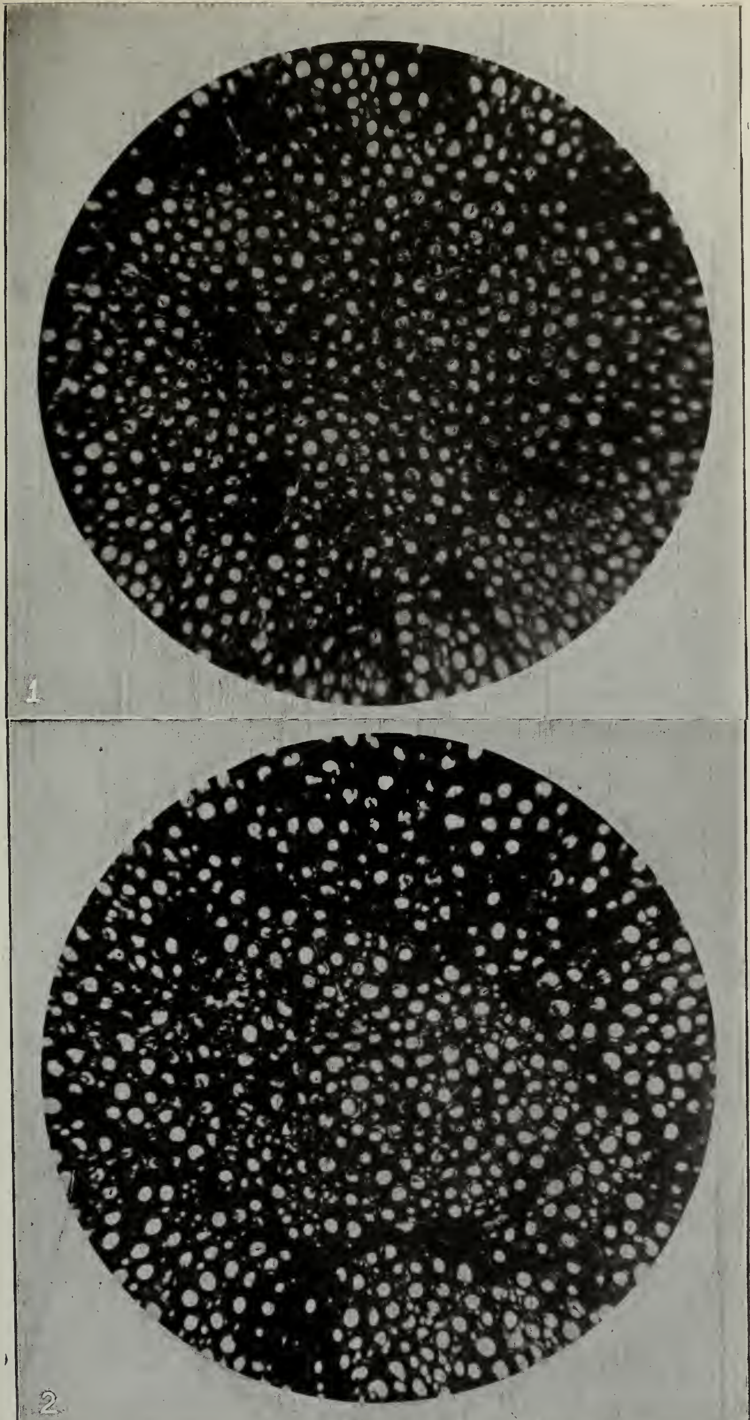
Found as fragments, also the base of the stipe showing root processes.

Middle Erian (Devonian) of Gaspé (*Bell*); Hamilton group (Middle Erian) of New York (*Clarke and Prosser*), and the Upper Silurian (Lower Helderberg) of New York (*Mixer.*)

DESCRIPTION OF FIGURES.

Fig. 1. Transverse section of Nematophyton crassum, showing the distribution of the medullary spots. x 45.

Fig. 2. Transverse section of Nematophyton crassum, showing distribution of the medullary spaces connecting the medullary spots. x 45.



Nematophyton crassum.

Pre-Cambrian Fossils Especially in Canada.

(Abstract of a paper by Sir W. Dawson, LL.D., F.R.S. Read in the Geological Section of the British Association, Liverpool Meeting, September, 1896.)

The paper was intended to be introductory to the exhibition by the lantern of specimens of *Eozoon Canadense*, for the purpose of showing its structures to geologists who may not have had opportunities of seeing authentic or perfect specimens. Canadian examples of the rocks and fossils were referred to, because that country possesses the greatest areas and the best exposures of Pre-Cambrian rocks, because in that country large portions of them have been well explored and mapped, and because, in Canada, Eozoon was first discovered.

The base of the Cambrian system may, for the present, be fixed at the lower limit of the Olenellus fauna, now recognized in Newfoundland and in the western part of Canada, as well as in the United States. With this the Protolenus horizon of Matthew in Southern New Brunswick should probably be associated; and there, as well as in Newfoundland, the lowest bed of the series is marked by a barren sandstone.[1] The Olenellus Zone affords, according to Walcott, 165 species, representing all the leading types of Marine Invertebrate life.[2]

Beneath this, in New Brunswick and Newfoundland, is a great thickness of red and greenish slates or shales, resting on a base of conglomerate, which lies unconformably on the Huronian system (Coldbrook Series), of whose debris it is, in part, composed. It contains, as far as known, no Trilobites, but has a few fossils referred to Ostrocods, Mollusks, Worms, Brachiopods, Cystideans, and Protozoa. Matthew has named this group in New Brunswick the Etcheminian system. He regards it as Pre-Cambrian, but still Palæozoic. It seems to correspond

1 Matthew, *Protoleuus Fauna*, Trans. Acad. Science, N.Y., March, 1895.

2 Memoir on Lower Cambrian, U.S. Geol. Survey.

with the Signal Hill Series and Random Sound Series of Murray and Howley in Newfoundland, with the Kewenian or Kewenawan Series of Lake Superior, which, according to the observations of the Canadian Survey, covers great areas between Lake Superior and the Arctic Sea. It may be correlated with the Chuar and Grand Canyon formations of Walcott in Arizona. In the latter these occur with a few other fossils, including a fragment of a Trilobite, numerous specimens of large laminated forms, which may be regarded as connecting the *Cryptozoon* of the Cambrian, and the *Archæozoon* of the Upper Laurentian with Eozoon.[1]

If, with Matthew, we regard the Etcheminian beds and their equivalents as lowest Palæozoic, then the fossiliferous formations underlying these should be included under the term *Eozoic*, proposed by the author many years ago in connection with the description of Eozoon; and the term Algonkian, used by the United States Geological Survey, will include both Palæozoic and Eozoic formations.[2]

Next below the Etcheminian in New Brunswick, Newfoundland, Lake Superior and Lake Huron, and also, apparently, in Colorado, we have the great thickness of mostly coarse, clastic sediments, associated with contemporaneous volcanic outflows and ash-rocks, originally described by Logan and Murray as the *Huronian* system. These rocks are of a character not likely to yield many fossils. There are, however, slates, limestones, and iron ores associated with them, which have afforded laminated bodies comparable with Eozoon, burrows of worms, spicules of sponges and indeterminate fragments referable to Algae or to Zoophytes. In rocks of similar age in Brittany, Barrois and Cayeux announce the occurrence of Sponges, Foraminifera and Radiolarians.

[1] Hall, Report on Palæontology of N. York, No. 36, Matthew Bulletin, N. Brunswick, Nat. Hist. Society, 1890, Walcott l.c.

[2] This term is, in any case, unhappy in form and sense, and perhaps should be dropped.

Doubt has, however, been cast on these in a recent paper by Dr. Rauff, of Bonn. It is not improbable that the Huronian may admit of sub-division into two members; and, if its deep sea limestones could be found, perhaps into three. It underlies the Etcheminian unconformably, and, so far as known, is itself unconformable to the Laurentian, which must have been subjected to some disturbance and to much intrusion of igneous matter, as well as to great denudation, before and during the Huronian period.

Next in descending order is the Upper Laurentian, or *Grenvillian* system (the upper part of Logan's Lower Laurentian), which is well developed in the St. Lawrence and Ottawa Valley and also in New Brunswick, as well as in the Adirondacks and the eastern slope of the Apalachians. It contains various gneissose and schistoze rocks, which, though crystalline, show, on analysis, the same composition with Palæozoic slates,[1] and it includes also bands of quartzite and of graphite and graphitic schist, as well as large beds of magnetite. Above all, it is remarkable for the occurrence of great zones or belts of limestone, associated with what seem to be altered sedimentary beds, and is in many places rich in graphite and in apatite. It is scarcely possible to doubt that in this great system of several thousands of feet in thickness we have evidence of tranquil oceanic deposition and of abundant animal and vegetable life. It, no doubt, also occupies great areas covered by later deposits, while there is evidence that the portions exposed have undergone enormous denudation.

The graphite of this system has yielded no distinct structures, except imperfectly preserved fibres; but in some places it assumes the form of long ribbon-like bands, suggestive of fronds of algæ, and an American palæontologist, Mr. Britton, has described one of these forms from

[1] Adams—Am. Journal of Science, July, 1895.

the Laurentian limestone of New Jersey, under the name of *Archaeophyton Newberrianum*.[1]

It is in one of the limestones, the highest of the series, rich in nodules and grains of Serpentine, that the forms described as *Eozoon Canadense* occur. It is not the object of this paper to enter into any details as to these, or any discussion of their claims to be regarded as of animal origin, but to allow the specimens exhibited to speak for themselves, referring to previous publications for a more particular account of their structure and modes of occurrence.[2]

Below the Grenville series we find an immense thickness of orthoclase gneiss, associated with igneous dykes and masses, without limestones or other indications of organic remains, but presenting alternations with thick bands of Hornblendic schist. This is the "Ottawa gneiss" of the Geological Survey of Canada, a fundamental rock, perhaps a portion of the primitive crust of the earth, or a product of aqueo-igneous, or crenitic action, before the beginning of regular sedimentation. It is the Lower Laurentian or Archæan complex of some authors, and is quite distinct from the overlying Grenvillian, except in the occurrence of orthoclase gneisses in both.

The Eozoic group of systems will thus for the present include the Huronian and Grenvillian or Upper Laurentian, the fauna of which is characterized by the prevalence in the former of Annelida, Sponges and Protozoa, and in the latter, so far as known, of Protozoa alone, represented by peculiar and gigantic forms, as Eozoon and Archæozoon, and some smaller types (Archæospherinæ).

As at present known, these systems are of a character unfavorable to the preservation of organic remains—the Huronian because of its coarse and littoral character, the Grenvillian because of its great metamorphism. It may,

[1] Annals N.Y. Academy, Vol. IV., No. 4.

[2] See papers in the Geological Magazine for 1895, also Memoir in Publications of Peter Redpath Museum.

however, be hoped that should deep sea deposits of Huronian age be discovered, or the Grenvillian rocks in a less altered state, additional species may be found; nor is it impossible that there may be additional formations filling the probable gaps in time between the Lower Laurentian and the Grenvillian, or between it and the Huronian, or between the latter and the Etcheminian. In any case there is ample scope for the labor of those who have the necessary skill and patience. It was added that important detailed explorations of the Laurentian and Huronian, supplementary to those of Logan, are now in progress, under Dr. Dawson, Director of the Geological Survey of Canada; more especially by Dr. Ells, Dr. Adams and Mr. Barlow, and may be expected to yield important results.

In concluding, the author insisted on the duty of palæontologists to give more attention to the Pre-Cambrian rocks, in the hope of discovering connecting links with the Cambrian, and of finding the oceanic members of the Huronian, and less metamorphosed equivalents of the Upper Laurentian, and so of reaching backward to the actual beginning of life on our planet, should this prove to be attainable. At the close of the paper a number of micro-photographs, showing the forms and structures of Eozoon and other ancient remains, supposed to be organic, were projected on the screen.

The President said that they were all delighted to have the subject presented in this way. The dawn of life on the globe was, perhaps, the most fascinating of all subjects with which the geologist had to deal. The subject of Eozoon Canadense was intimately associated with the name of Sir William Dawson.

Dr. Hicks said no one else could possibly have given such an exposition of Eozoon.

In the discussion which followed, Mr. Matthew, Dr. Johnston Lavis, Sir James Grant, Professor Rupert Jones, Professor Bonney, and others took part. One speaker remarked that Eozoon had been attacked for many years, but there were some geologists who still had faith in it.

In responding, Sir William Dawson thanked the speakers for the fair and friendly manner in which they had received his old friend of the Laurentian rocks, and hoped it was not merely on the principle that nothing but good was to be said of the dead. His object had been to exhibit to a representative audience a series of characteristic examples of these curious objects, leaving those present to form their own conclusions. In any case, he thought they must admit that the discussion of the subject had been of advantage to science; and he hoped it would eventually lead to a great extension of our knowledge of the earliest forms of life.

It was announced that additional specimens were on exhibition at University College Museum, and that some of these would be demonstrated under the microscope on the following afternoon. (Partly from Report in Liverpool *Post.*)

Remarks on the Distinctive Characters of the Canadian Spruces[1]—*Species of Picea.*

By George Lawson, Ph.D., LL.D., F.R.S.C., Professor of Chemistry, Dalhousie College, Halifax, Nova Scotia.

Our native spruces (belonging to the genus *Picea*) have received attention at different times from many botanists, but their conclusions in regard to the number of species,

[1] This important paper, originally presented to the Royal Society of Canada in 1887, appears to have been published privately, since it cannot be found in any of the journals of that year. The renewed interest which has of late centred in the possible distinction of *Picea nigra* and *P. rubra* makes it desirable that these observations should be placed in some publication through which they may be brought more prominently under the notice of working botanists, to whom they are known, but not accessible. D. P. Penhallow.

Montreal, October, 1896.

and the exact relations of these to each other, have not been concordant. It seemed desirable to invite attention again to the subject, and this was done in a preliminary paper read in Section IV. of the Royal Society of Canada, at the meeting held at Ottawa in May last (1887.) The discussion on that occasion, and subsequent correspondence, have shown that the matter is not without interest, and have suggested the desirability of publishing some of the facts then stated, as well as results subsequently reached, together with some historical details—so as to indicate our present knowledge on the snbject, the information still needed, and the directions in which profitable enquiry may be made. Local observers and collectors throughout the Dominion, and travellers visiting northern points, may do much to aid in determining the geographical range of the several species, varieties and forms, and the continuity or intermittence of their distribution in different regions.

The beautiful evergreen coniferous trees called "spruces" form a marked feature of the wild forest lands of the Canadian Dominion, especially in the Atlantic maritime districts, and in the tracts of country lying around the great lakes. The spruces are valued, not only for their large yields of useful lumber, applicable to so many purposes of life on land and sea, and for the summer shade and winter shelter which, as living trees, they afford our dwellings, but they are likewise regarded with interest, and as having some importance, from scientific points of view. How far the differences in structure and habit presented by the several species, and their aberrant or so-called intermediate forms, are to be regarded as indicative of genetic differences, or may be accounted for by the mere effects of past or present external conditions, is a question of more than incidental interest. It naturally leads to a comparison of these trees with their allies in other parts of the northern hemisphere, far beyond the range of the present Canadian forest, immense as it is, and to the consideration of other facts bearing upon their probable ancestry, in regard to which, however, the results, so far, are insufficient to warrant satisfactory conclusions.

These trees, and their extra-Canadian allies, have been variously described by botanists, at different times, under the several generic names: *Pinus, Abies, Picea.* Linnæus, upon whose system our nomenclature is founded, embraced under *Pinus:* the true pines, the Lebanon cedar, the larch, the silver (or balsam) fir, and the hemlock. In selecting specific names for the silver fir and spruce, he adopted those used by Pliny and other classical writers, who called the spruce *Picea* and the silver fir *Abies.* But he unfortunately transposed these names, calling the spruce *Pinus Abies,* and the silver fir *P. Picea.* This opened the way for much confusion, for when the old aggregate genus *Pinus* came to be successively divided up into segregate genera, and the classical names were adopted as generic ones, choice had to be made between two courses—either to apply these names so as to denote the trees intended by the classical writers, or to use them, at variance with classical usage, in accordance with the Linnæan nomenclature. As has just been indicated, succeeding botanists separated the true pines, and other marked groups of the Linnæan genus *Pinus,* into separate genera; at first the spruces and firs were classed together under the one generic name *Abies.* Link, in 1841, separated the two groups into distinct genera, restoring the classical names, *Picea* for the spruces, and *Abies* for the firs. But in Britain, where Coniferæ have been grown to an enormous extent, both for ornament and use, especially since the middle of the present century, a silver fir continued to be almost universally called a *Picea,* and a spruce an *Abies*—until within the last few years, when English scientific writers have adopted Link's use of the names, and thus adapted their nomenclature to continental custom and classical usage. Among English foresters, gardeners and nurserymen, however, the old way, so long familiar, will be given up slowly, and not without regret.

The Canadian spruces, so far as regards their distinctive specific characters, have been a puzzle to botanists. They were not known to Linnæus. Miller and Aiton recognized two species, *alba* and *nigra*, and Lambert introduced a third (*rubra*) that had been recognized by the younger Michaux as a variety of *nigra*. Accordingly, in most of the works on Coniferæ published since Lambert's (1825) by European and English botanists,[1] we find the three species described without hesitation. But there have not been wanting expressions of doubt as to the permanent distinctness of the third species, and of suspicion even, that all three were connected by intermediate forms so closely as to be doubtfully entitled to rank as more than varieties of one species. A full statement of synonymy would occupy too much space, and, indeed, be out of place in this publication; a brief indication of the views held by a few prominent botanists will suffice for the present.

In Persoon's Synopsis Plantarum, 1807 (the authorship of which is believed to belong to Richard), *rubra* is described with rubicund cones, slightly bilobed scales, and red brown bark, and is curiously enough assigned geographically to Hudson Strait; *alba*, with incurved leaves, lax subcylindrical cones, entire scales, whitish bark; *nigra*, with straight leaves, ovate black-purple cones, scales undulated at the margins, bark blackish.

Endlicher, in the standard work on Coniferæ for the time (1847), "Synopsis Coniferarum," characterized three species as follows: (pp. 112–15); *alba*, cones subcylindrical, lax, pendulous, scales broadly obovate undivided, entire (faces of leaves whitened glaucous, pulvinuli pale brown,

[1] Persoon, Antoine, Don, Loudon, Link, Parlatore, Endlicher, Gordon, etc.

cone long-stalked, cylindrical or ovoid oblong, 2 to 2½ inches long, largest diameter, ½ inch, scales quite entire, at first green, changing to pale brown) ; *rubra*, cones ovate-oblong, scales split into two lobes, margin otherwise quite entire (doubtfully distinct from the next, leaves more acute, cones larger, green when young, scales constantly and evidently split-lacerate irregularly, margin otherwise entire, the wood becoming reddish); *nigra*, cones ovate-acute, scales obovate, undivided, erose, denticulate, bark blackish, faces of leaves white-dotted; cones shortly peduncled, drooping, an inch and a half long, at first purpurascent, finally reddish brown, scales with thin margins becoming undulate-lacerate.

Professor Beck, in the Botany of the Northern and Middle States (1833), which formed the precursor of Dr. Asa Gray's standard Manual, described three species (p. 340), as: *nigra*, * * * leaves straight, strobile ovate, scales elliptical, undulate on the margin, erosely denticulate at the apex; *rubra*, * * * strobile oblong, scales rounded, somewhat two-lobed, entire on the margin; *alba*, leaves incurved, strobile subcylindrical, loose, scales obovate, very entire.

I have not been able to refer to the first edition of Dr. Gray's Manual of Botany of the Northern United States (published in 1848), but in the second edition (1856) the red spruce of Beck is dropped, and only *nigra* and *alba* described—the former with dark rigid sharp green leaves, cones ovate, or ovate-oblong (one to one and a half inch long), the scales with a thin and wavy or eroded edge—a common variety in New England having lighter colored or glaucous-green leaves rather more slender and loosely spreading, and indistinguishable from *alba* except by the cones. *A. alba* is characterized as having oblong-cylindrical cones (one to two inches long), the scales with firm and entire edges; otherwise as in the lighter-colored variety of the last. The remark is added : Probably these two, with the red spruce, are mere forms of one species.

In subsequent editions of the same work the descriptions are amended, the leaves of *nigra* being characterized as either dark green or glaucous-whitish, and the cones are said to be recurved, persistent while those of *alba* are two inches long, nodding, cylindrical, pale, deciduous, the thinner scales with an entire edge (the latter a handsomer tree than the former, more like a balsam fir.) These descriptions point to the red and black spruces being both included under *nigra.*

Professor Alphonso Wood, in his Class Book and Flora of the United States and Canada, also characterized only two species : *alba,* with incurved leaves, cones lax, subcylindric, with entire two-lobed scales ; *nigra,* with straight leaves, ovoid cones, scales erosely dentate at the edge.

Dr. Chapman, in the Flora of the Southern United States (1860) likewise gave two species (pp. 434–5) : *nigra,* leaves dark green, cone one and one-half inch long, ovate, or ovate-oblong, the scales with a thin wavy or denticulate margin ; *alba,* leaves more slender and less crowded, light green, cones 1 and 2 in. long, oblong cylindrical, with the scales entire.

The late Prof. Brunet, of Laval University, an acute and careful botanist, of whom Dr. Gray had a high opinion, described three forms : *alba, nigra* and a variety *grisea* (Canadian Naturalist, new series, vol. iii., p. 108).

The Abbe Provancher, in Flore Canadienne, characterized *alba* and *nigra* clearly.

The late Andrew Murray, who took so much interest in American Coniferæ, in his later writings ignored *rubra.*

Professor Fowler, in his carefully prepared list of the plants of New Brunswick, gives two species, *alba* and *nigra,* as common throughout that province.

Prof. Parlatore, in the Monograph of Coniferæ in De

Candolle's Prodromus, Vol. xvi., second section, pp. 413–14, published in June, 1868, recognizes our Canadian species as three: *nigra*, the black spruce or double spruce of Anglo-Americans; *rubra*, with leaf-faces albo-glaucescent (indicating that he probably had a form of *nigra* in view): and *alba*, with oval-oblong, or oval-cylindrical cones, pendulous, on longer branchlets than the others (the geographical range extending to the Rocky Mountains, on authority of specimen from Bourgeau).

In Dr. Robert Bell's chart of the northern limits of trees forming the Canadian forests, the two spruces, *alba* and *nigra*, are lined together.

Prof. Macoun, in the Catalogue of Canadian Plants of the Geological Survey of Canada, gives two species, combining *rubra* with *nigra*.

Sir Joseph Hooker, in his tabulation in the Outlines of Distribution of Arctic Plants (Linnæan Transactions, 1864), gives only *alba* and *nigra*, and Sereno Watson, in the Botany of California, also dismisses our spruces in N.E. as "two species."

The following descriptions of the several species are not thrown into systematic form, being merely intended to call attention to points of difference, and to suggest observation and enquiry, so that the necessary information may be obtained for the formation of accurate and permanent diagnostic characters:

1. Picea alba.—Link, in Linnæa, xv., p. 519.

Picea alba, the white spruce of Canada, is recognized at a distance, from the allied species, by the comparative massiveness of the foliage with which its horizontal or pendant boughs are clothed, and by its glaucous or whitish-green tint—the leaves when newly expanded being pale and silvery, as if covered with the most delicate coating of hoar frost. This appearance, however, is caused by the individual leaves not being wholly green, but having longitudinal rows of apparently white or colorless dots or spaces, owing to the non-development of chlorophyll in certain surface cells at regular intervals. The old bark of the stem is grayish, not dark-colored, and the young shoots of the year present a smooth, shining, ivory-white surface, altogether destitute of trichomes or roughness of any kind. The leaves vary in actual size with the vigor of the tree, but are longer in proportion than those of either of the other species; the leaf-bases from which they arise are arranged uniformly around the horizontal branches, but, although, spreading in direction at their bases, are more or less curved upwards in a secund manner, presenting a nearly uniform flattened brush-like surface of foliage. The cones vary in absolute size, according to vigor of tree, etc., but are always of much greater length and usually more slender than those of the other species, being nearly cylindrical, not sensibly thickened in the middle as in *nigra*, nor below the middle as in *rubra*. Dr. Bell well expresses their form as finger-shaped. The scales are also more numerous than in the allied species, and the spiral arrangement is different. The cones are green at first, the individual scales being sometimes clouded with a slight brown band-like patch on the exposed part, but not extending to the edge. In ripening, the green color mellows into a more or less decided straw color, but the cones when mature are never either dark or decidedly reddish. When of a lively straw-color, and profusely produced all over the tree, as we often see them along the shore, hanging down from the drooping tips of the young branchlets, the contrast with the bright silver-frosted needle foliage is very pleasing, so that the white spruce is one of the most ornamental of our native trees, and admirably adapted for sea-side shelter. The edges of the cone scales are always quite entire.

Prof. Bell, M.D., President of the Fourth Section of the Royal Society, has very kindly made careful observations, and communicated them to me, on the several points of difference between the white and black spruces. Through his kindness, also, I have had opportunity of examining specimens from widely separated localities throughout the Dominion. His opportunities of travel, for observation and collection of specimens, during his long connection with the Geological Survey of Canada, have been exceptionally favorable. Dr. Bell points out that the most obvious distinctions between the black and white spruce are (1) that the latter is a larger tree than the black, coarser, lighter in general color, as well as in color of bark, twigs, etc.; (2) that, in the white spruce, the boughs are stiffer, more vigorous, and flatter than in the black; (3) that the cones differ in many ways: in the white, they are scattered all over the tree, although most abundant near the top, and drop off every year, whereas the black spruce cones adhere for two, three, four or five years—the current year's crop being at the top (mostly), the previous year's next below, that of the year before still farther down, etc., the quantity of cones diminishing downwards and their age increasing. (4). The white spruce cone is finger-shaped, and green in color till it dries and opens, whereas the black is deep purple and plum-shaped, bulging in the centre. (5). The white is attached by a straight peduncle, the black by a curved thickening one. (6). The number of scales in each is very different, numerous counts of the scales of cones from many trees in northern regions of the Dominion yielding the following results: the white spruce cone seldom has fewer than 60 scales or more than 90—average about 70; whilst the black seldom has many over 30, the average may be about 33—so that the white spruce cone has more than double the number that the black has. Eleven white spruce cones from a tree at Kingston, Ontario, gave an average number of 77, and of five cones of the same from a tree at the Emerald Mine, near Buckingham (Co. Ottawa, P.Q.), the average is 61.

The white spruce is observed especially along the shores of the ocean, estuaries and lakes, as in Cape Breton Island, around the Atlantic and Bay of Fundy shores of Nova Scotia and New Brunswick, also around the shores of the St. Lawrence Gulf and up the St. Lawrence River, and along the Ontario lakes. Dr. Bell sends a beautiful photograph of this species, showing its characters well, from Grand Lake House, on the Upper Ottawa. I have a specimen collected at Lake Winnipeg by his Hon. Lieut.-Governor Schultz, M.D., in the summer of 1860.

I desire specially to call the attention of observers to one point in regard to the geographical distribution of *Picea alba*. For many years it has appeared to me to be essentially a maritime species, growing around the Atlantic and northern coasts of Canada, and extending by way of the St. Lawrence westward to the great lakes, as far, at least, as shown by Governor Schultz's specimen, as Lake Winnipeg. Its absence in *inland* localities is not noticed, so far as I have ascertained, in published works, yet, even in the narrow peninsula of Nova Scotia, bounded on one side by the Atlantic Ocean, and on the other by the Bay of Fundy and waters connecting with the Gulf of St. Lawrence, the absence or scarcity of this tree in inland localities, or even in such as are only a few miles distant from the shore, is very marked. It appears, therefore, to be especially desirable, in recording localities for its occurrence, to note their distance from seaboard or great lakes. I have already endeavored to impress upon observers the consideration that the only reliable material for tracing geographical distribution must consist of substantial data, actual local observations carefully noted and authenticated by specimens, corrected, reduced and compared, after the manner of H. C. Watson, and left on record in such form as to render elimination of errors possible, and that mere general impressions received by travellers over the country, although often of great practical value, are not to be regarded as absolute scientific results.[1] In the early days, when Douglas and Thomas Drummond were solitary wanderers over the Continent, and Menzies was touching the coast at Chebucto and nameless points on the Northern Pacific shores, every scrap of information, and especially their notes on range of species, was of substantial value, but now we have the means of working out problems by more systematic and scientific methods, and of eliminating the errors of individual observation.[2]

2. PICEA NIGRA, *Link*, in Linnæa XV., p. 520.

The black spruce is a sombre tree, the old bark of dark color, the surface of young shoots of the year of a dark brown, and clothed with a short sparse fur of thick short curved trichomes. The foliage is of a decidedly dark green color, but distinctly glaucous or hoary. The leaves are short, almost straight, radiating from the branch in a bottle brush fashion at a nearly uniform angle except that they are turned away from the lower surface of the branch. The leaves (as in other species) vary in size with vigor of tree, but are always much shorter than in the other species, and blunt at the apex. The cones, when young, are of a deep purple, or purpurascent color, becoming reddish-brown as they ripen, darkening with age, and ultimately changing to a deep dark gray-black when old. The other species drop their cones during the first winter after they are formed; *P. nigra* retains them for several years, the recent crop of the year being near the top of the tree mostly, the previous years next below, that of the year before further

[1] See Trans. Royal Soc. of Canada, Vol. II., Sec. iv., p. 16.

[2] *Abies arctica*, Murray, Seeman's Journal, 1867, p. 273, cum ic., is referred by Parlatore as a variety of *alba*.—DC, Prodromus, XVI., p. 414. On same page there is description of something no doubt quite different, *Abies arctica*, Cunningh., ex Henk. & Hochst. This is referred to *rubra*.

down, and so on, the cones diminishing in quantity downwardly as their age is increased. The cone is attached to its branchlets by a curved stalk (whereas that of *P. alba* is straight), and the cone itself is conspicuously much wider in the middle than towards base or apex ; several of these differences are taken from Dr. Bell's notes, but are entirely in accordance with my own observations.

This species appears to be widely distributed, both in coast and inland districts, extending apparently far north, and in the south ascending the mountains. Black spruce is famed among lumbermen as a tree yielding sound, strong and lasting timber. In Nova Scotia it is found, not on dry ground, but on wet flats, apparently irrespective of atmospheric moisture. In inland districts, groves of it occur in the red spruce forests, on the wet lands around lakes, and along river sides, and on shelving terraces on the hill sides, but it also grows down to the sea-shore intermixed with *P. alba*—the favoring condition apparently being a retentive moist soil. In the north and north-west, the tree appears, from accounts and photographs received, to be more vigorous than along the Atlantic region of Nova Scotia.

3. PICEA RUBRA, *Link*, in Linnæa, xv., p. 521.

Picea rubra, the red spruce, is readily known by its clean, uniform bark (not broken into large scales) of a distinctly reddish color, by its long, slender shoots, giving it the appearance of being a more rapid grower than *nigra*, but not so robust in habit as *alba*, and by its bright green foliage, without any trace of hoariness or glaucescence. The leaves, as compared with those of the allied species, are short, incurved, not so secundly as in *alba*, but bent inwards towards the branchlets, and on the leading shoots they are more or less closely appressed to the leader, giving it a very elongated slender appearance. The year's shoots are of a lively chestnut-red color, and are beset with short, erect, thickish, curved, epidermal processes (trichomes), which arise especially around the edges of the flat basal plates of the leaf-bases, variously called peg-processes, sterigmata, etc. The cones are of a bright chestnut color, regularly ovate in form. The wood is softer than that of the black spruce, it is also less enduring under open air exposure, as we know from experience; every season the red spruce poles have to be replaced more frequently than the black in fences.

The best general description that has hitherto been published of *P. rubra* is that of my late friend, William Gorrie, in the Transactions of the Botanical Society of Edinburgh, Vol. X., p. 353. Mr. Gorrie's description was taken from the tree as observed by him in the plantations and pleasure grounds in Britain, but, so far as it goes, it corresponds entirely with the tree as seen in the Nova Scotian woods :—" The red spruce fir, or Newfoundland red pine, is found in Nova Scotia, some parts of Lower Canada, and northward to Hudson Bay, but is not included in Dr. Asa Gray's Flora of the Northern United States. It is said to be a better and finer tree than either of its allies—the black and white spruces—from which it further differs in being entirely devoid of that glaucous green by which the leaves of these two are distinguished. It is, in fact, exactly like the common Norway spruce in the color both of its foliage and young branches, but differs from it in its thinner and more slender growth, shorter leaves, and much smaller cones. From this close resemblance in color of *rubra* and *excelsa*, Americans call the latter the red spruce of Europe. Like the *alba*, the *rubra* drops its cones in the course of the first winter and succeeding spring, while those of *nigra* are retained on the tree for two or more years. Like its two American associates, *alba* and *nigra*, *rubra* seems to delight in moist soils containing a proportion of peat and moist upland climates. Those now growing at Tynehead were reared from seeds gathered in Newfoundland, and a portion of the plants which were planted on good, dry, heavy soil, within from two to three miles, and at half the altitude, dwindled away after the first few years, till they entirely perished. The trees at Dunmore are, no doubt, growing at a low altitude, but they are sheltered by a high-wooded bank on the south, and are on a damp bottom. Mr. Andrew Murray, a distinguished member of the Botanical Society, and recognized authority on Coniferæ, has ignored the existence of *rubra*, but he has probably never seen it growing, as, although long introduced, it is still scarce in Britain." In illustration of these remarks, Mr. Gorrie exhibited and presented to the Botanical Society branches and cones of (1) *P. rubra* taken from a group of trees growing on the railway banks, near Tynehead Station, in Midlothian, at an altitude of about 800 feet. The trees had then (13th January, 1870), been about fifteen years planted, and were from 12 to 18 feet in height; (2). *P. rubra*, from a group of trees growing in drained and improved ground, which must once have been marshy, in Dunmore Park, near Stirling, Scotland, not 50 feet above high-water mark, seemingly about the same age as the last, and from 15 to 20 feet in height; (3). *P. alba*, from near Tynehead Station; (4). *P. nigra*, from Dunmore Park.

In addition to acknowledgments for specimens already made in this paper, my best thanks are due to Mr. John MacAloney, of Halifax, who collected for me the several forms growing on the shores of the Bay of Fundy; to Mr. W. S. Calkin, B.A., now of Cornell University, who, while an undergraduate of Dalhousie College, obtained those of the district around Truro; and to Mr. S. J. McLennan, B.A., who made similar collections around Sydney Harbor, Cape Breton.

Segregation in Ores and Mattes.

By David H. Browne, Sudbury, Ontario.

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During the last few years, the origin of the Sudbury nickel-ore deposits has been the subject of much discussion. The igneous and the aqueous theories have been both strongly championed, and at the present date, while the balance of opinion leans to the igneous side, the lack of any decisive testimony on which arguments *pro* and *con* could be based, has tended to make a decision necessarily difficult and unsatisfactory.

Bell, in his report on the Sudbury ores,[1] says : "The general character of the deposits seems to indicate that they have originated primarily from a state of fusion." H. B. Von Fullon[2] states that "Die Erze sind nicht wâsserigen, soudern feuer flüssigen Ursprunges," *i.e.*, "not of aqueous but of igneous origin." Vogt[3] assigns these and other similar sulphide ores to "segregation from a molten basic magma," and Kemp[4] gives it as his opinion that the appearance of the ores "leaves no reasonable alternative but to conclude that they are as much an original crystallization from the igneous magma as any other mineral in the rock."

On the other hand, Posepny refers to the igneous theory as something extraordinary ; Emmens[5] thinks that nickel is an essential constituent of the gangue, and Argall[6] "submits that it is to the leaching of basic eruptives at or near the surface our principal deposits of nickel are due."

All these latter opinions, based as they are on resemblance to other ore-deposits, may be considered as

[1] Report on the Sudbury Mining District, p. 49.

[2] Ueber Einige Nickelerzvorkommen, p. 281.

[3] Zeitschrift fur praktische Geologie, Nos. 1, 4, 7, 1893.

[4] Ore-Deposits of the United States, p. 319.

[5] Canadian Mining and Mech., Rev., August, 1893.

[6] Nickel, etc., Colorado Scientific Society, December, 1893.

obiter dicta. To one familiar with the unique appearance of the Sudbury ores, their immense size, their geological and commercial importance would seem to warrant close study, long-continued observation and experimental research before a sound judgment as to their origin could be reached. In order to furnish some material or basis on which a judgment can be made, the following data concerning the similarity of segregation in mattes and ores are submitted.

Copper nickel matte, made in water-jacketed blast-furnaces from roasted copper-nickel ore, consists of a mixture of sulphides of copper, nickel and iron. An average matte will contain, approximately,

Cu,	24	per cent.
Ni,	20	" "
Fe,	28	" "
S,	28	" "

This matte is tapped into hemispherical or conical cast-iron matte pots or moulds, in which it is allowed to set, after which it is turned out on the dump to cool. These moulds or matte pots are about 24 inches diameter by 14 inches deep. After the matte has set, and while cooling on the ground, it cracks by contraction, the cracks extending either radially from the centre, splitting the matte into pyramidal or cuneiform fragments, or else vertically through the centre, dividing the matte into quarter sections. On a pot of matte broken in the latter shape, concentric iridescent bands of color show the rate at which the matte has cooled from outside to centre. The specific gravity of matte does not vary appreciably throughout a pot, it being, as a rule, from 5 to 5.2.

After matte has been broken, two separate forms of incrustations may be observed on its surface. The first consists of small hairs or wiry crystals of copper, often occurring in small geodes or bubbles near the top or outside of the matte pot. The second consists of ferro-nickel crystals,[1] generally found near the centre or bottom, and having the form of squares or rectangular triangles about $\frac{1}{8}$ to $\frac{1}{16}$ inch in diameter. These are tin white, very thin, flexible and highly magnetic, and have the formula Fe_8Ni_9. While comparatively rare, yet close examination will discover the presence of ferro-nickel in every pot of matte.

It has been known for several years that matte is not homogeneous throughout each casting, nor is it surprising that in such a fluid mixture of different sulphides the elements should, during the time of cooling, attempt to arrange themselves with regard to their respective affinities. A long series of experiments to determine what these tendencies were may be thus briefly summarized.

Numerous analyses showed that in one and the same matte casting a sample broken from the top will be, as a rule, higher in copper and lower in nickel than a sample from the bottom. Eleven pots thus examined gave an average as follows:—

	Cu.	Ni.
11 top samples..............	23.26	20.15
11 bottom samples.....	21.14	20.32
	2.12	0.17

Gain Cu at top, 2.12 per cent.
" " bottom, .17 per cent.

The copper seems to vary more rapidly than the nickel from top to bottom.

Further analyses showed that nickel was higher at the centre than at the bottom of the casting. A few examples will illustrate this tendency. A pot casting broken into quarters was sampled at the points shown in the sketch, and analyzed as follows :

[1] Jour. Anal. Chem., March, 1892.

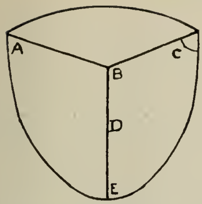


Fig. 1.

	A.	B.	C.	D.	E.
Copper	25.00	25.62	25.02	20.80	24.46
Nickel	20.2	20.9	20.5	21.60	20.20
Iron	29.4	27.3	28.8	35.5	31.5

These analyses show that copper tends toward the top and outside of the casting, while nickel and iron tend to concentrate toward the centre.

A half pot was now selected in which radial cracks seemed to show the centre of segregation. Small portions were broken off at the points indicated and analyzed as follows:

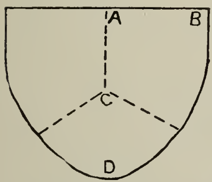


Fig. 2.

	A.	B.	C.	D.
Copper	24.46	23.68	22.46	22.80
Nickle	18.02	19.06	19.16	18.74
Iron	31.0	31.5	31.5	32.00

These samples showed as before the upward and outward tendency of copper, but did not so clearly show the inward tendency of nickel. The reason was found to lie in the manner of sampling, as it was found almost impossible to break with a hammer the sample desired, at the exact point in question. In order to get a correct sample, and to map out, if possible the variations of copper and nickel, a quarter pot was placed under a drill and sampled as indicated in the following sketch by drilling with an inch drill holes one half inch deep at the points marked. These samples were then carefully analyzed, and as they were entirely free from slag, the sulphur was in each case taken as the difference between the sum of copper nickel and iron and 100 per cent. which has been found to be very nearly the correct amount.

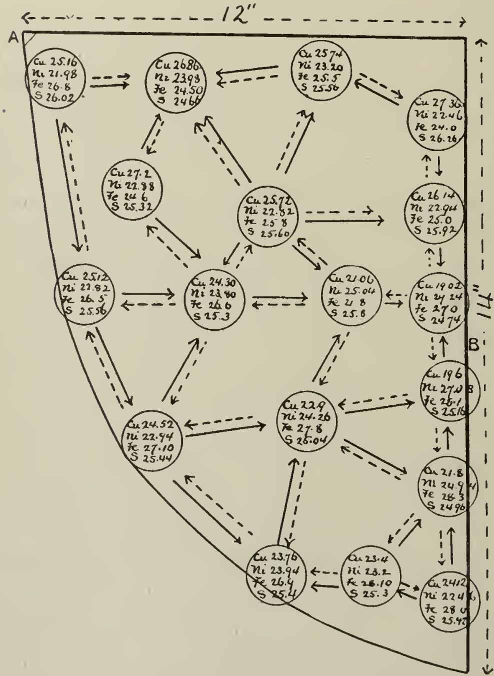
The entire quarter pot was now crushed, quartered, sampled and analyzed.

It contained	Cu,	24.64
	Ni,	22.86
	Fe,	26.70
	S,	25.82

The analyses are for convenience written in their respective locations.

The specific gravity of matte at the point A was 5.26 and at B was 5.2. The solid arrows in the sketch indicate the movement of nickel, while the dotted arrows show the movement of copper. Examining these lines carefully, it will be seen that the segregation of nickel to the centre and the dispersion of copper to the outside is very pronounced, variations in the percentage of these two ingredients to the amount of 7 per cent. occurring over a space of three or four inches. It will also be noticed that copper and nickel seem to be mutually antagonistic, an inward flow of nickel being almost always accompanied by an outflow of copper.

FIG. 3.



Section of quarter pot a little over one-third natural size.

Taking the vertical central line and the horizontal central line, as showing the tendencies of the metals at their greatest fluidity, we may now map the variations in a curve.

From the vertical central lines it will be seen that the curves of copper and nickel are nearly reciprocal. The horizontal central line shows a similar tendency. From these examples, which are given merely as an illustration of what has been proved true by numerous other analyses, the following statements may be inferred:

1. In a mass of molten copper-nickel iron matte, the sulphides of copper and nickel are mutually antagonistic.
2. The tendency of nickel and, though in less degree, that of iron is also to concentrate toward the centre, with a slight downward inclination.
3. The tendency of copper is to disperse toward the outside and to rise toward the top of the casting.

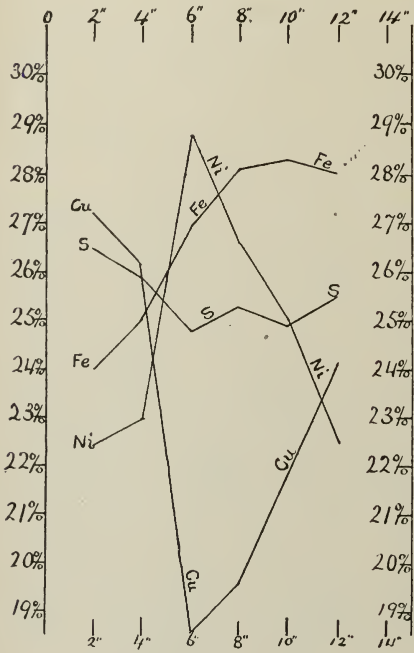
These statements are verified in a striking manner by furnace practice. The matte as it flows from the blast furnace passes first to a forehearth in which it accumulates and the slag rising to the surface is separated. In this forehearth, where the matte is subjected to a prolonged heat, nickel tends to sink to the bottom, and as after every tapping there remains a layer of matte perhaps two or three inches thick in the forehearth below the tapping ring, this matte becomes gradually enriched in nickel and impoverished in copper. On changing the forehearth after several weeks running the bottom is found coated with a tough magnetic matte which averages about 46 per cent. nickel and 12 per cent. copper. The matte made in this forehearth has during the run averaged perhaps 22 per cent. copper and 18 to 20 per cent. nickel. This shows that under prolonged heating the copper nickel sulphides are more perfectly separated the copper going upward and the nickel downward.

Again, the Orford process[1] of separating copper from nickel consists in smelting matte with sodium sulphide

[1] Mineral Industry, 1892, vol. i., p. 357.

produced by reduction of salt-cake with coal. The sodium sulphide forms with the matte an exceedingly fluid magma, from which, on cooling nickel separates as a "bottom" or cake of nickel sulphide occupying the lower part of the matte pot, while copper floats upward with the soda sulphide. After cooling a sharp demarcation line is found between the two sulphides, and separating the "bottoms' or crude sulphide of nickel and repeatedly resmelting with sodium sulphide the copper can be almost entirely removed and pure sulphide of nickel can be produced. We are thus justified in drawing the following inference.

Fig. 4.



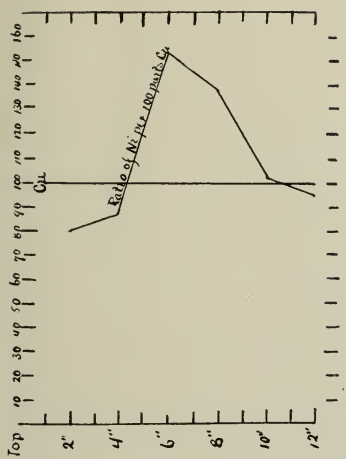
Central vertical line of matte.

Vertical column = per cent. Horizontal column distance from top of pot.

If copper-nickel-iron sulphides can be held in a molten condition either by using prolonged heat or by imparting fluidity by the addition of fluxes for a sufficient period of time to allow the mutual repulsion of the metals to act, the copper and nickel will separate as individual minerals, the sharpness of separation being dependent on the fluidity of the mass and the time occupied in cooling.

If we now examine the Sudbury ore-deposits, a general resemblance in their formation to the formation of mineral in mattes may be readily seen. The tendency of copper pyrites to separate from the nickeliferous pyrrhotite is very noticeable. However closely the two minerals may be intermingled, each is entirely free from traces of the other. The chalcopyrite is free from nickel, while the pyrrhotite beside it is equally free from copper. Beside this chemical separation, there is an equally noticeable physical separation. Bell[1] Kemp[2] and others have remarked the tendency of copper pyrites to separate in veins or stringers of ore surrounding masses of included diorite. It may be stated, as a rule, that copper tends toward the rock, whether forming the vein-walls or forming included masses. The miners often remark the way in which copper follows the rock, and look on the presence of massive copper ore as indicating an approach to the rock. In driving a drift from the shaft which is sunk in the clean diorite to and through the ore, the first symptoms of the presence of the vein are small shots or pockets of copper pyrites impregnating the rock. Coming nearer to the ore-body, the amount of copper increases,[3] large masses being met with before any nickel is found. On reaching the ore-vein proper, the copper pyrites is found

FIG. 4A.

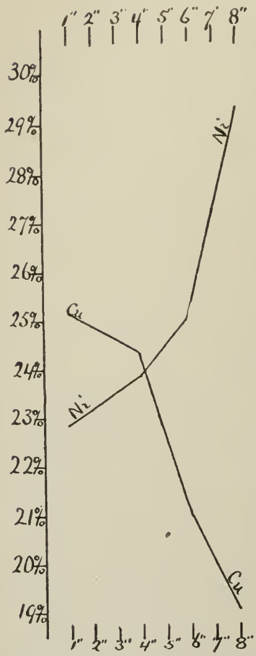


Central vertical line of matte.
The per cent. copper taken as 100.
Vertical lines distance from top. Horizontal = variation of nickel.

[1] Report on Sudbury Mining District, 1888–90, p. 49.
[2] Ore-Deposits of the United States, p. 319.
[3] Peters: Modern Copper Smelting, p. 291.

mixed with pyrrhotite and rock, while in the heart of the vein a large quantity of nearly pure pyrrhotite almost free from copper is found. The cross-section of the ore-body then shows as follows: rock, copper-ore and rock, copper-nickel ore, nickel ore, copper-nickel ore, copper ore and rock, and, finally, rock again. This can be mapped in the form of a curve across the ore-body in a horizontal line, the height of the curves showing the ratio of copper and nickel.

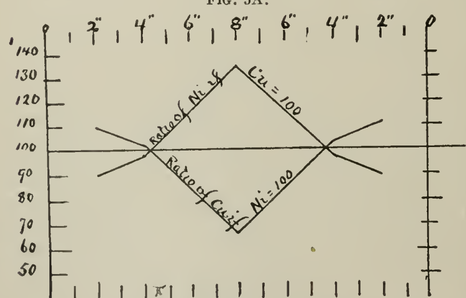
Fig. 5.



Central horizontal line of matte. Vertical column = percent. Horizontal column = distance from outside.

The figure does not, of course, represent a cross-section of any particular mine, but shows, as well as can be done without figures, the manner in which copper and nickel are found on cross-cutting a large vein such as at the Copper Cliff mine. As there is much ore intermixed with the rocky walls, and many included fragments of rock in the ore-body itself, and as each mass of rock tends to attract copper-ore, it follows that the ore as mined shows about equal amounts of copper and nickel. Fig. 6 must then be taken merely as a general indication of the way in which the minerals occur at the Copper Cliff mine.

Fig. 5A.

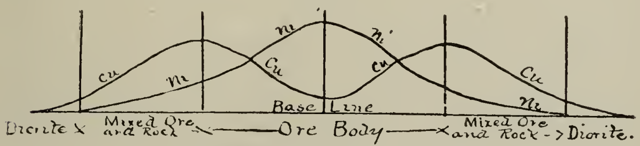


Central horizontal line of matte.
Horizontal distance = distance from outside to centre of pot.
Vertical height = per cent. of metals.

A general tendency of copper to disperse to the rock and to the vein walls, and of nickel to concentrate towards the centre of the deposit, is thus shown to exist in the ore-body. Comparing Fig. 6 with Fig. 5, it will be seen that in matte, as well as in ore, the travel of the metals is the same, copper moving outward along a horizontal line toward the cool outer surface, and nickel moving inward to the centre.

That copper-ore is attracted by the rock is readily seen on examining the rock heaps at the various mines. This

Fig. 6.



Horizontal Central Line of Ore-Body.

rock occurs not only at the edges of the deposit, but also in masses of every shape and size in the ore-body. If the ratio of copper and nickel in the ore be taken as 1 to 1, *i.e.*, 100 pounds copper to every 100 pounds nickel, the ratio in the sorted rock will be from 150 to 200 pounds copper to every 100 pounds nickel. These metals are not an essential constituent of the rock, but occur as shots and veinlets of ore scattered through a dioritic matrix.

We are justified, then, in stating that in the ore-body the tendency of copper is outward along a horizontal line toward the rock, while the motion of nickel is inward toward the centre of the vein.

It has been often said that the Sudbury ore-deposits were originally worked for their copper contents, and that the presence of nickel was noticed only after deeper excavations had been made. This is in a certain sense true. The surface workings of the Copper Cliff mine, for example, yielded nearly pure copper pyrites, while the lower levels give nearly equal proportions of copper and nickel. The change is regular and gradual.[1] Business considerations forbid the use of comparative figures, but in general terms it may be said that a deposit which shows large amounts of copper and small amounts of nickel at the surface, changes regularly with the depth to a nearly equal ratio at the present time. The tendency of copper and nickel to separate—the copper outward and the nickel inward—seems also to increase with the depth. Taking the copper as unity, and plotting the percentage of nickel at each level as a factor thereof, the ratio of the two metals will be shown to approach each other as the depth increases.

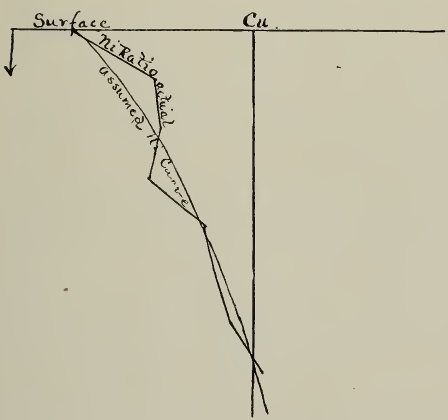
Comparing this Fig. 7 with Fig. 4A, it will be seen that in the mattes the tendency is to change from a high copper matte at the surface to matte carrying nearly equal amounts of copper and nickel at about one-third the depth of the pot, then a rapid decrease of copper and increase of nickel near the centre, and a recovery to nearly equal parts of copper and nickel at the bottom. In the ore we cannot tell what proportion of the depth of the deposit has been opened out, but there is, nevertheless, a parallelism between the ratio of copper and nickel in the ore as far as opened and the ratio of copper and nickel in the upper half of the matte pot.

From the behavior of copper-nickel mattes kept for a long time in a molten condition, we have drawn the inference that in proportion as the time of cooling is prolonged, the more perfect is the separation of copper and nickel into their respective sulphides. If the theory of igneous origin be the correct explanation of the Sudbury ore-bodies, it is evident that the upper and outer portions of the deposit were the first to cool, while in the centre and lower part of the deposit the sulphides have longer remained fluid. If, then, a parallelism exists between the ore and the matte, we would expect to find the separation

1 Levat: Progres de la Metallurgie du Nickel, p. 27.

of nickel more perfect on the lower levels than on the upper. This is in reality the case. The nickel-bearing portion of the Sudbury ores consists of magnetic pyrrhotite containing more or less intermixed pentlandite. Nickel may be considered to exist in the pyrrhotite as a foreign element, replacing a certain portion of the iron. Pentlandite, on the other hand, is a true nickel mineral (Fe + Ni), S, containing, approximately, Ni, 35 per cent.; Fe, 30.25; S, 34.75. While it is true that the percentage of nickel in the picked nickel ore does not vary much with the depth, yet the deeper the mine the more perfect will be the separation of nickel as a true nickel mineral. This nickel mineral does not occur in separate massive form, but as small crystals or patches, varying in size from that of a pin's head to a hazel nut, intimately associated with the pyrrhotite. By crushing to a rather coarse powder and sorting with a magnet, the minerals can be separated for analysis.

FIG. 7.



Vertical central line of ores.

Ratio of nickel to copper in ores. Vertical line = copper taken as unity. Heavy line = ratio of nickel. Light line shows average variation of nickel ratio. Vertical distance shows depth from surface.

In ore from near the surface the crystals of pyrrhotite are small-grained, bright and sharply lustrous, containing more than one-half of the total nickel as an element replacing iron; while in ore from a depth of several hundred feet the pyrrhotite is largely in soft, dull crystals containing very little nickel as an element replacing iron. The following analyses will show this tendency :

Copper Cliff Mine.	Depth in feet.	Per cent. of Total Ni in Pyrrhotite.	Per cent. of Total Ni in Pentlandite.
	Surface.		
Picked Ni ore		51.7	48.3
" "	600	34.	66.
" "	700	29.	71.
" "	800	18.	82.

In samples of ore of the same percentage in nickel, taken from different depths in the deposit, the nickel separates as an individual mineral more perfectly as the depth increases, or, in other words, at those points in the deposit where, if the igneous theory be true, the ore has remained longest in the molten condition, and better opportunity has been offered for physical and chemical separation.

We have now seen that an agreement in the method of arrangement of the elements exists between the ores and mattes along the following lines :—

1. The tendency of copper in both ores and mattes is to rise vertically upward and accumulate at the surface, and also,

2. To travel horizontally outward from the centre and accumulate on the outer cooling surfaces.

3. The tendency of nickel in both ores and mattes is to sink vertically toward the centre, and also,

4. To leave the outer cooling surfaces and to travel horizontally inward toward the centre.

5. In both ores and mattes the separation of nickel in the lower part of the deposits as an individual mineral sulphide is in direct proportion to the fluidity of the mass and the length of time occupied in cooling.

It does not seem possible to explain this parallelism by any other theory than this; that the nickel deposits of Sudbury existed primarily as eruptions of molten sulphides mixed with the constituents of the dioritic enclosures, and that by gradual cooling the diorite was first separated, then the copper as copper pyrites, and the iron as pyrrhotite containing some nickel, and, finally, in those portions remaining longest molten the nickel separated as a true nickel mineral. While this view may be at variance with the theories of many authorities, yet it seems to be the only conclusion feasible in view of the similarity in the manner of segregation of the elements in copper-nickel ores and mattes.

Appended Note to the Paper[1] of Mr. Browne.

By J. F. Kemp.

That the reactions of metallurgical processes have served to throw much light on the problems of igneous rocks has long been recognized, and from the observations of J. H. L. Vogt, and others, on slags and the artificial minerals yielded by them, important inferences have been drawn regarding rocks. This source of evidence is a fruitful and suggestive one, for, although on a small scale when compared with volcanic phenomena, the parallelism, so far as it goes, is close—the principal difference being that slags cool quickly, under slight pressure and without the presence of mineralizers. The advantages are that the reactions are under observation, and all the factors can be noted.

Late developments in the mining of associated nickel and copper ores, and attempts both recent and early to utilize titaniferous magnetites have exposed such geological relations that many observers have felt compelled to regard the ores themselves as of igneous origin. They occur in rocks of this original character, and ores that show small evidence of any geological disturbance. In the case of the associated sulphides of nickel and copper, the occurrence of the ores in the outer portions of the intrusions has been the chief argument

1 This note is added with the full sanction of Mr. Browne.

against their igneous origin, for they have been regarded as contact deposits, and have been referred by the writers cited above by Mr. Browne, to aqueous solutions.

But as our knowledge increases of the changes that take place in those molten magmas that have remained in this condition some time before crystallizing, we have come to recognize that very important differentiations take place, and always with the relative increase of the basic minerals toward the outer portions. Alfred Harker has shown this for gabbros in England; Pirsson has done the same for syenitic rocks in Central Montana, and G. P. Merrill for others in the south-western portion of the same State. Many other observers have noted equally significant, though less extensive manifestations of similar phenomena. Instead of magmas being fairly homogeneous and stable, we must regard them as quite the reverse, and as subject to changes and differentiation, whose causes we perhaps do not yet fully understand.

It is not every magma that holds enough metallic elements to yield an ore-body; but where such are present with sulphur, it is reasonable to infer that the resulting sulphides would follow the course of the basic minerals. If the latter tend to segregate toward the contacts, so would the former. This is the line of argument that has been previously followed. Mr. Browne's paper now adds the further important point that even in small amounts of fused matter, and above all in those made still more fluid in the Orford process by the addition of sodium sulphide, the two metals, nickel and copper, tend to separate according to the relations that are observed on a large scale in ore-bodies.

While we do not fail to appreciate that it is a long step from a pot of fused matte to a great ore-body some hundreds of feet in extent, yet the parellelism is very significant, and it is fair to infer that what holds good for the small amount would be even more marked in the large.

Note.

The *British Medical Journal* states that a new and unexpected agency is having a most beneficial effect in contributing to the abatement of the smoke nuisance in London. The relative clearness of the London atmosphere within the last twelve months has been plainly apparent, and the smoke cloud which obscures the London atmosphere appears to be progressively lightening. Mr. Ernest Hart, Chairman of the Smoke Abatement Exhibition in London, frequently pointed out that the greatest contributors to the smoke cloud of London were the small grates of the enormous number of houses of the poor, and a great deal of ingenuity had been exhausted with relatively little success in endeavoring to abate this nuisance. The use of gas fires was urgently recommended, but had hitherto been difficult, owing to its cost and the want of suitable apparatus. The rapid and very extensive growth of the use of gas for cooking as well as lighting purposes by the working classes, due to the introduction of the "penny-in-the-slot" system, is working a great revolution in the London atmosphere. During the last four years the South London Gas Company alone has fixed 50,000 slot metres and nearly 38,000 small cooking stoves in the houses of the workingmen.

Book Notices.

Appleton's School Physics. (American Book Company.)

This handsome volume of 544 pp. is the joint production of Professors Mayer, Nipher, Holman and Crocker, under the literary superintendence of Professor Quackenbos. It is beautifully printed, various kinds of type being most judiciously employed, and profusely adorned with admirable illustrations specially prepared for this book. One looks in vain for the familiar cuts that have done duty in so many of its predecessors. Altogether it is most attractive to the student and pleasant to work in.

Nor is the matter unworthy of its presentment. It is written throughout with direct reference to practical things on the one hand, and to scientific principles and the method of establishing them by experiment on the other. Very properly a thorough account of the mechanics of visible bodies, and the properties of matter is made the basis of the other branches of Physics, and occupies no less than 228 pp. out of the whole 544 pp. The whole subject, including the introductory mechanics, is treated in a very fresh and interesting manner. Much information not usually found in Text-books of Physics (*e.g.*, the capital account of meteorology) is given. The numerous examples interspersed between the sections are mostly new, and drawn from practical life. It is justly remarked in the preface that "the reputation of the several contributors, and the standing of the great scientific schools which they represent, must secure for this work a consideration accorded to few American school-texts." We think that the general merits of the book will assure the fulfilment of this prophecy, and as it is important that a book which is to be widely used should be as perfect as possible, we shall without further description of the general features of a work which every teacher of physics should see for himself, employ the rest of our space in pointing out certain blemishes which could hardly fail to arise in an attempt to re-write freshly such familiar subjects as Mechanics and Physics.

The attention of teachers is called in the preface to the "thorough and original treatment of motion, energy, force, and work. . . . . These subjects are treated with the greatest simplicity, precision, and thoroughness, for it is believed that a proper understanding of them lies at the base of all scientific knowledge, however far it may be pursued." It is as difficult as it is important to write with simplicity and precision on elementary mechanics, especially when any attempt is made at originality of treatment; and on this account most of the criticisms we have to make will be directed against the earlier part of the book.

We will note first some faults of precision. In the preliminary statements and definitions (which seem to us rather advanced in character compared with succeeding chapters) occurs the statement (p. 8) that "all our knowledge of time and space is, therefore, essentially *relative*," by which is meant that we can only define one point of time or space by reference to some other. This is not the usual meaning of the word *relative*, as applied to knowledge in philosophy. Nor is it correct to define (p. 12) any body as *homogeneous*, when it is of the same *density* in all its parts. Velocity is stated (p. 18) to be the *ratio* of the distance travelled to the time occupied. But ratios are only between like things. On p. 16 a distinction is formally drawn between *uniform* and *constant*. But on pp. 18, 20, 24, 26, 28, and generally this distinction is ignored. On p. 19 for continu*al* read continu*ous*. The appeal to "experience" on p. 22, while discussing the purely kinematical motion of a point, is confusing. The value of g is stated on p. 20 for all parts of the earth without limitation. On p. 25 the figure is not drawn to the scale described in the text. A much more serious error (p. 90) is the use of the meaningless phrases "the unit of acceleration is one centimetre per second," "an acceleration of a centimetres per second" several times over. An incline of 5 in 100 surely means in 100 along the incline, not along the horizontal, as on p. 153. In the section on Heat (p. 290) "in proportion to" is used in the popular and, in this case, inaccurate sense. On p. 390 the figure of the vibrating string is misleading, and at the foot of the page the omission of "inversely" makes the statement of the number of vibrations give the opposite of the fact. c, at the foot of p. 417, is a misprint for C, and there are misprints of numbers in lines 6 and 7 of p. 418. On p. 436 we read "an electrified body brought near to any other body of different potential will *attract* it." P. 474 should read "The *Grove and* Bunsen cells also give off." We note on p. 481 "If wires twice as *thick* are used, the resistance is one half as great," and on p. 503, "Why is dry air a good insulator? *Because it is a non-conductor.*" Further data are required to solve Questions 2 and 6 on p. 369; and C.D. (p. 431) is not drawn a horizontal through the centre of the needle, as described. The sine of an angle should not be defined as a line on p. 310, while the ordinary meaning of the tangent is assumed on p. 493.

Passing to more important matters, we think that a strict logical order is too often departed from. Conservation of energy is doubtless the principle by which the branches of Physics should be connected. But surely it should be reached as a generalization after the meaning and methods of measuring energy have been carefully studied. Instead of this we first have (p. 33) with no better definition than that "energy, or the capacity of doing work, is possessed by matter in virtue of its mass and velocity" (Capitals), a general statement of the conservation, transformations, and availability of energy. It is not till p. 95 that the student learns how energy depends on velocity, and then only from a *definition* of the energy as $\frac{1}{2}MV^2$. Work having been independently defined as measured by the product of the force into the distance, a numerical example is then taken of the energy acquired by a falling body. Its velocity is calculated (p. 96) from the formula $V^2 = 2gs$. The energy and work done having been deduced from the formulæ $E = \frac{1}{2}MV^2$ and $W = FS$, it is remarked that these results must necessarily be the same, for the two formulæ must, *of course*, be equivalent.

Again (on p. 362) in an explanation of polarization, we find, "According to the accepted *undulatory theory* of light," though no account of this has been given, beyond a few remarks in the beginning of the chapter (70 pages before), in which it is stated that "the ether vibrations pass off in all directions by a species of wave-motion." The properties of wave-motion are not described at all till in the following chapter on Sound, where, after some examples of vfbration, we find the statement that "To represent a sound-wave a curve is used, called the sinusoidal curve," and the curve is figured. But no proof is given that this *does* represent a sound-wave, nor is simple harmonic vibration anywhere investigated.

On p. 456 the explanation of the condenser is given thus : "The reason for the greater capacity of one of the plates when near the other is due to the attraction between the two charges." But Capacity is not explained till p. 458, where the definition is reached that "The capacity of a body for electricity is measured by the amount of electricity required to raise its potential by unity." This itself will puzzle a student who has only been told (twenty pages before) that "when neighboring bodies differ in such a way that electrical phenomena are observed in the region between them, the bodies are said to be *at different potentials.*" He may wonder not only what kind of a difference this is, but also what is a *unity* of it. The excellent hydraulic illustrations given later (p. 478) will help to relieve his perplexity.

After the parallelogram of forces has been established, it seems a fault of method to recur to experiment for the proof of the principle of moments (p. 111) and of central forces (p. 113.) The fewer the experimental principles from which a science can be deduced, the better. Other experimental results then come in as verifications of theory.

Of actual mistakes we have observed few. But on p. 29 occurs the following : "It is found also to be true that the amount of work done to produce a given acceleration in a given object is the same at what ever velocity the particle is already moving ; for instance, to accelerate its motion by 10 feet a second would require no more work if the object is moving a mile a second than if its velocity is only a foot a second, or if at the outset it was zero." The student who relies on formulae will wonder how $\frac{5290^2-5280^2}{2}$ can be the same as $\frac{11^2-1^2}{2}$; or if he is in the habit of thinking out his dynamics, he will see that to produce a given acceleration requires a given force to act for a given *time ;* and that if the body is travelling at a greater rate during that time it will cover a greater space, and the force will consequently have to do more work. The source of the confusion is made clear by the question on p. 33 ; "If a ball is at rest upon the floor, and you set it in motion so that its velocity is one foot a second, is the work done by you any greater or any less than if the ball had been moving with a velocity of 5 feet a second and you had increased it to 6 feet?

How would you explain this from the statements *concerning rest* as given under kinematics ?" The reference is, of course, to the fact that we can have no knowledge except of relative motion, and the confusion arises from neglect of the warning given by Clerk Maxwell, in his little treatise on Matter and Motion, that in every mechanical problem we must *begin* by defining the system which we mean to consider. A similar oversight led Professor Newcomb into the discovery of an elaborate mare's nest about the relativity of energy, described in his paper in Vol. XXVII. of the Phil. Mag. Those who wish to see the whole matter placed in the clearest light, together with another reason why the absolute energy of a system can never be known to us, and the considerations which render this of no importance, should consult Maxwell's Matter and Motion. (§§ II, III to XXX—I, CX).

A confusion arising from the opposite error of neglecting to remember that all force is of the nature of stress and that all energy must be conceived as relative, or between parts of some system, leads the writer to a somewhat severe handling of Potential Energy. Thus (p. 36), a raised stone " before it starts has no velocity and, therefore, no energy" ; and (p. 39) "At the extreme end of the swing does the pendulum possess energy ?", to which the answer, No, is expected. On p. 42, we have—" In such instances the body does not possess actual energy, but only the possibility of acquiring it. It is said to possess *potential* or *possible* energy" ; again (p. 97), " the amount of Potential Energy relatively to a given *point*" ; and finally (p. 98) Potential Energy receives its quietus from the scathing epithet " so-called."

It is, no doubt, probable that all forms of Potential Energy may be reduced ultimately to cases of relative motion ; but it seems less confusing, meanwhile, to keep the felicitous term Potential Energy to denote those forms of the capacity to do work which depend on the relative position or condition of bodies relatively at rest, without implying that the energy is in these cases less real ; while *kinetic* covers the cases of energy due to relative motion. This is a better distinction than that between *possible* and *actual* energy (p. 42).

It is unfortunate, too, to exclude the idea of direction from the terms *velocity* and *acceleration*, as is done in such phrases as " accelerated as well as curved" (p. 56) " the motion (with uniform velocity) may be over any path, either straight or curved." This is certainly not a modern practice.

It is more in accordance with modern fashion to discard as far as possible the idea of force as a cause historically so important and fruitful, and so harmless if properly safeguarded. How necessary this conception is appears from the fact that after defining (p. 44) force as " any tendency to acceleration," and rejecting the usual definition not only in the text, but in the questions (p. 48. "Is force ever the real cause of any effect? Why not? What is the cause?") the writer finds himself compelled to announce in a footnote (p. 76) that for convenience he will in future employ the word in its usual sense, not before he has done so many times unconsciously in the interval.

We have only to add that the diagram of the Astronomical Telescope (p. 355) would be clearer if the whole pencil from one end of the arrow had been traced, instead of one ray from each end. Nothing can be learned from it as it stands, while it may easily encourage a familiar misapprehension. On p. 364 no hint is given that the length of the rhomb of calcite must bear a certain proportion to its breadth if it is to be cut as directed in constructing a Nicol Prism.

Some very recent additions to our knowledge are included in the book (*e.g.*, Mr. Woodward's ingenious way of representing a sound-wave), but we should have been glad to see some notice of Dr. Lodge's work on Lightning Conductors, since they are spoken of. Gleams of humor are not wanting, especially in the questions: *e g.*, "Wild pigeons have been shot in the latitude of Albany, N.Y., with Carolina rice in their crops. About what must have been the velocity of their flight? (Apply scale to your map of the United States)" (p. 27). The height of the Washington Monument is assumed known (p. 101.) Other traces of nationality will be observed by the foreign reader.

JOHN COX.

THE BIRDS OF MONTREAL.—By Ernest D. Wintle, Montreal. W. Drysdale & Co. Price, $1.50.

This book is a welcome and valuable addition to the literature of the Natural History of Montreal and the surrounding district. We must congratulate Mr. Wintle on the completion of his task which, he tells us in his preface, has occupied him for fifteen years. This volume supplies a long felt want, and its issue will, there can be little doubt, give an immediate impulse to the study of Ornithology, especially among young men. It will be a guide to the sportsman, as well as a hand-book for the scientist. There is no more fascinating recreation than gunning for game; and it is as health-giving as it is delightful. The author and his collaborateurs have had many a tramp through forests and by streams before possessing themselves of such a mass of facts as is packed into this attractive little volume. In reading it, one can fancy he hears the bracing October winds whistling through the reeds, and the whirring of the wings of the partridge startled in the thicket. The middle-aged citizen, who was accustomed to cricket and football in his youth, at least once a year, finds the old longing for out-door activity come upon him with irresistible force, and so he forsakes his desk and goes off, with rod and gun, into the northern wilds and is a boy again, for a week or two. Thus he renews his energies and keeps up the steadiness of nerve and firmness of muscle that ought to belong to the hardy race born and bred in this northern clime. And when the taste for science is added to the keenness of the sportsman for game, the delights of such outings are immensely enhanced. The variety and rarity of the birds his gun brings down will be a matter of greater consequence than the number he bags. Three great ends are gained by the scientific sportsman. He can compete with others in obtaining game and in securing an invigorating supply of oxygen and ozone for his blood, but he has the further advantage of adding to his stock of knowledge at the same time. Mr. Wintle and the friends who have sympathized with him and helped him in making his collection of birds had evidently many enjoyable trips to the country during the last fifteen years; and they used their opportunities well. The result has been that the author can speak confidently as to the fulness and accuracy of the list of the *Avifauna* of the Montreal district, which he supplies in this volume. To add to the list, even the spoils of the pot hunters have been carefully enquired into, the stalls of the Bonsecours and other markets having been often visited with a view to noting the species offered for sale and the localities whence they were procured.

It is fitting that the knowledge of the Natural History of the city and district of Montreal, with so famous a school of science in its centre, should be as complete as possible. This book of Mr. Wintle's will at least establish for our city a claim to precedence over every other place in the Dominion, so far as the Department of Ornithology is concerned. The geology of the district has long been known; and there is also a fair approximation to an acquaintance with its botany. This publication cannot but stimulate amateurs working in other departments not yet wholly overtaken to continue to prosecute their researches, in the hope that they too may soon be able to present to the public lists as complete as Mr. Wintle can claim this one of his of the Birds of the District is.

Not since 1839 has there been any attempt to catalogue the *Avifauna* of Montreal. A list was compiled in that year by the late Prof. A. Hall, M.D., which was published in the "Canadian Naturalist and Geologist" in 1861-2, and for which he was awarded a medal by the Natural History Society of Montreal. Although Prof. Hall's was regarded at the time as a fairly complete list, it was in comparatively few hands, and so, for practical purposes, the lovers of birds in the district had to be content with such knowledge of the subject as they themselves could pick up, with the help of those larger general works to which they could get access. There is, perhaps, no department of Natural History in which so many persons are interested as Ornithology. Birds are most attractive creatures; and those who may long have wished to know more about those beautiful, agile, gentle visitants which build nests in their orchards yearly, or flit from limb to limb of the trees on the Mountain Park, can now gratify their desire.

It is interesting to contrast Mr. Wintle's list with Dr. Hall's. Making allowance for the change of nomenclature, the whole 208 species embraced in the latter, with the exception of 13, are included by our author as having been lately seen in the district of Montreal. Mr. Wintle's volume embraces 65 additional species, in all 254 kinds of birds that are either permanently resident here, or visit us every year for a longer or shorter period. Of this number, only 11 are permanent residents, 16 are winter visitants, 77 are summer visitants, 132 are transient visitants, while as many as 17 are accounted accidental visitants.

The first 135 pages are occupied with notes on the 254 species described, giving place and date of their capture; while the next 89 pages are taken up with a detailed description of them, to help in their determination by amateur scientists. The closing pages contain some breezy sporting sketches by well known devotees of the gun in the city; and these give a completeness to the volume which adds to its attractiveness. The publishers have also done their part well; the general make-up of the book being a credit to Canadian enterprise.

R. C

ANNUAL REPORT OF THE GEOLOGICAL SURVEY OF CANADA. New Series. Vol. VII., 1894.

This large volume of over 1,200 pages contains, in addition to the Summary Report of the Operations of the Survey for 1894, seven detailed reports on certain portions of the Dominion, and is accompanied by eleven geological maps. The Summary Report shows that geological work is being carried on by the large staff of the Survey in every part of the Dominion. Especial mention is made of the trial borings now being put down at Athabasca Landing in the North-West Territories, where there is good reason to believe large supplies of oil will be obtained from the Devonian rocks at a depth of about 1,500 feet. An account is also given of the recent advances in the development of the mining industry of British Columbia, where, of late years, such extensive mineral deposits have been discovered, as well as of the explorations in the Labrador peninsula, carried out by Mr. Low, who has discovered in this inhospitable region deposits of iron ore which are believed to surpass in size any that have hitherto been discovered in North America.

Of the special reports, two deal with British Columbia, one by Dr. G. M. Dawson, containing a description of a portion of the Interior Plateau of that province in the Kamloops district, and the other by Mr. R. G. McConnell, giving an account of the exploration of the Finlay and Omineca Rivers. These are followed by a report on the country about Red Lake in Keewatin, by Mr. Dowling. The fourth report is by Dr. R. W. Ells and Dr. F. D. Adams on a portion of the

Province of Quebec, comprising the Island of Montreal and a part of the "Eastern Townships" to the south and east. Mr. Chambers then describes the superficial geology of the Provinces of New Brunswick, Nova Scotia and Prince Edward Island, while in the concluding reports Dr. Hoffmann and Mr. Ingall treat of the chemical work of the Survey on the mineral statistics of the Dominion respectively. Dr. Dawson's report contains an excellent description of the Interior Plateau of British Columbia from both a geographical and geological standpoint. The very extensive development of the Cambrian in this part of the Dominion is noted, as well as the continued volcanic activity from Cambrian to recent times, the volcanic materials, at a very moderate computation, having a thickness of 20,000 feet.

The map accompanying the report of Dr. Ells and Dr. Adams will be of the greatest value to all naturalists working in the vicinity of Montreal, combining, as it does, a presentation of the topography of the district with all roads, etc., on a scale of four miles to one inch, with that of the geological structure of this portion of the province which is well brought out by the colors in which the map is printed. The map comprises an area of about 7,500 square miles, extending from about Ste. Agathe on the north-west to Lake Memphremagog on the south-east. A more extended notice of it will be given in the next number of THE RECORD OF SCIENCE. In an appendix to the report, Dr. Ami gives a most welcome list of all the fossils hitherto recognized in the various geological formations occurring in the area, a list which will be of much service to the Society in future geological excursions.

The Geological Survey is doing excellent work for the Dominion of Canada in many ways, and it is to be especially regretted that the priceless collections illustrating the natural history of the Dominion and its economic resources, which have been gradually accumulated through a long series of years, are so miserably housed, being stored in a building which is not only not fireproof, but is in continual danger of collapse through the weight of the specimens which it contains. It might be destroyed in an hour, and the Dominion would thus be deprived of treasures, many of which could never be replaced. The offices, also, are inadequate and inconvenient, and the space available in the museum has become too restricted. The advantage to Canada of an adequate display of its mineral resources can scarcely be exaggerated, and that the museum, even in its present state, possesses much interest to the general public is evidenced by the fact that more than 26,000 visitors have registered during the past year. The Government should see that a suitable building is provided for this important department of the public service, as the present one is nothing short of a disgrace.

Proceedings of the Australian Association for the Advancement of Science, 1895.

Very few countries should be of more interest to Canadians than the large island continent of Australia. Like Canada of some forty years ago, it is a collection of some five or six different colonies professing allegiance to Britain. It is at the present time considering the question of federation, studying our political system, and endeavoring to avoid what they consider its faults. Then its natural history differs in many respects from that of Canada; its fauna as peculiar as are its aborigines; the country itself, with its large arid plains, scarcely any large rivers or lakes and a climate quite the opposite to our own. All this excites an interest, which is increased by hearing of the labors of so many earnest and talented workers in the different branches of natural science. The record of these labors in the volume mentioned above is, therefore, a most welcome addition to our scientific literature.

The meeting held at Brisbane in January, 1895, was presided over by the Hon. A. C. Gregory, who, for many years, held the position of Surveyor-General. His address was upon "The Geographical History of the Australian Continent during its Successive Phases of Geological Development."

The President, at the close of his address, gives the following summary: "Australia, after its first appearance in the form of a group of small islands on the east, and a larger island on the west, was raised at the close of the Paleozoic period into a continent of at least double its present area, including Papua, and with a mountain range of great altitude. In the Mesozoic times, after a grand growth of vegetation which formed its coal beds, it was destined to be almost entirely submerged in the cretaceous sea, but was again resuscitated in the Tertiary period with the geographical form it now presents. Thus its climate, at the time of this last elevation, maintained a magnificent system of rivers which drained the interior into Spencer's Gulf, but the gradual decrease in rainfall has dried up these water courses, and their channels have been nearly obliterated, and the country changed from one of great fertility to a comparatively desert interior, which can only be partially reclaimed by the deep boring of artesian wells."

The introductory address by J. H. Maiden, President of Section B, was upon the "Chemistry of the Australian Indigenous Vegetation."

Professor David's address to Section C deals with the two glaciations observable in Australia. The first in the Permo-Carboniferous, the second in the Pleoscene or Pleistocene time. Baron von Mueller, in Section E, considers the commerce of Australia with neighboring countries in relation to geography. In Section F is an interesting address on the Prehistoric Arts of the Aborigines of Australia. In Section I, the teaching of science in matters of health. Many other interesting papers are also to be found among the proceedings of the different sections.

Speaking of the disruption and elevation of strata in the Permo-Carboniferous age (Gympic beds) when the more important Auriferous deposits of both the eastern and western parts of the continent were formed, Mr. Gregory says in his inaugural address :—There was not only great disruption of the strata, but igneous rocks forced themselves into the fissures of the sedimentary beds, and the resulting metamorphism of the adjacent rocks increased the confusion, as beds of slate may be traced through the transformation of their sedimentary character by the recrystallisation of their component elements into diorites, having that peculiar structure of radiating crystals which usually characterises rocks of volcanic origin. As regards the Auriferous deposits in these lodes, it appears that the simple fissures were filled with water from the ocean or deep-seated sources ; but in either case the powerful electric currents which continually traverse the earth's surface east and west met resistance at the lines of disruption, and electric action being developed the mineral and metallic salts in the water in the fissure and the adjacent rocks would be decomposed, and the constituents deposited as bases, such as gold and silver, or as compounds, such as quartz, calcspar, and sulphide of iron, all which were in course of deposit at the same time, as the angles of the crystals cut into each other. The theory of thermal springs is contra-indicated as the lime appears as calcspar, a form occurring in cold solutions and not in the form of Aragonite as in hot solutions. There have been many speculations as to the sources from which the gold was derived, but that which best accords with the actual conditions is that the metal exists in very minute quantities in the mass of the adjacent rocks, from which it has been transferred through the agency of electric currents and the solvent action of Alkaline Chlorides, which dissolve small quantities of the precious metals, and would be subject to decomposition at the places where fissures caused greater resistance to the electric current. One remarkable circumstance is that the character of the rocks forming the sides of the fissures has an evident influence on the richness of the ores in metal, where lime, magnesia, or other alkaline compounds or graphite enter into their composition, the gold especially is more abundant than where the rocks contain silica and alumina only.

In Queensland, Gympic affords some instructive examples of fissure lodes. In some large masses of rock have fallen into the fissure before the ore was deposited, and have formed what miners term "horses," where the lode splits into two thin sheets to again unite below the fallen mass. . . . The ore was originally an auriferous pyrites, but the sulphide of iron was largely decomposed, leaving the gold disseminated through the oxide of iron.

The auriferous deposits, which occur in the intrusive granites, appear under conditions differing from the true lodes in sedimentary rocks, as the intrusive granitoid rock forms dykes, which fill fissures in the older true granites, and also cut through the sedimentary slates. It bears evidence of intrusion in a state of fusion, or at least in plastic condition, and has subsequently crystallised, after which there has been shrinkage, causing cavities, as the sides of the dyke were held in position by the enclosing rock. The vertical shrinkage being greater than the horizontal, the cavities were nearer the horizontal than the vertical, and, being afterwards filled with ore, formed what are called floors, one characteristic of which is the tendency to lenticular form, or a central maximum thickness with thinner edges.

E. T. Chambers.

ABSTRACT FOR THE MONTH OF JUNE, 1896.

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	58.00	66.3	52.2	14.1	29.8930	30.010	29.798	.212	.3270	67.8	47.2	N.W.	13.54	4.7	9	0	70	0.01	....	0.01	1
2	57.20	65.0	48.0	17.0	30.0870	30.122	30.037	.085	.2777	59.7	43.2	N. W.	11.75	1.8	8	0	94	....	....	....	2
3	65.42	77.1	51.9	25.2	30.0887	30.152	30.037	.115	.3558	56.3	49.2	S.W.	16.37	0.0	1	0	96	....	....	....	3
4	69.43	80.9	58.6	22.3	30.0178	30.075	29.964	.111	.3342	48.2	47.7	S. W.	12.25	0.2	1	0	99	....	....	....	4
5	73.28	86.4	56.9	29.5	30.0245	30.097	29.976	.121	.4248	53.2	54.5	W.	5.00	0.0	0	0	74	....	....	....	5
6	69.25	80.3	58.3	22.0	30.0175	30.090	29.971	.119	.5233	73.3	60.2	N.E.	7.75	5.2	10	0	51	....	....	....	6
SUNDAY.......7	.....	69.9	60.2	9.7	......	.....	......	....	....	....	....	S. E.	5.37	....	....	..	00	1.05	....	1.05	7...........SUNDAY
8	59.08	62.2	57.6	4.6	29.7432	29.838	29.646	.192	.4805	95.7	57.8	S E.	7.96	10.0	10	10	00	0.24	....	0.24	8
9	59.95	64.9	55.6	9.3	29.6265	29.675	29.587	.088	.4575	89.0	56.5	N.E.	13.46	8.3	10	0	00	1.38	....	1.38	9
10	59.97	65.9	56.0	9.9	29.6378	29.672	29.559	.113	.2445	47.5	39.8	N.W.	13.50	2.8	10	0	82	...	....	....	10
11	58.75	65.2	50.6	14.6	29.5478	29.593	29.478	.115	.2963	60.5	44.7	W.	20.66	6.7	10	0	59	Inap.	....	Inap.	11
12	56.02	61.1	50.7	10.4	29.6593	29.790	29.594	.196	.2935	66.0	44.3	N.E.	8.42	5.8	10	0	37	Inap.	....	Inap.	12
13	59.38	67.8	48.0	19.8	29.9013	29.993	29.819	.174	.3025	59.5	45.3	N.E.	6.21	0.2	1	0	91	....	....	....	13
SUNDAY......14	.....	72.4	50.2	22.2	......	......	......	....	.....	...	....	N.E.	9.38	....	.....	..	69	....	...	....	14...........SUNDAY
15	61.80	70.2	52.2	18.0	30.1802	30.219	30.105	.114	.3777	69.2	51.2	S W.	5.54	6.5	10	0	7	....	....	....	15
16	68.43	79.8	59.0	20.8	30.1190	30.188	30.061	.127	.4515	65.5	56.0	S.W.	12.33	1.2	4	0	81	....	....	....	16
17	68.95	79.4	58.1	21.3	29.9752	30.069	29.902	.167	.4562	65.8	56.3	S. W.	11.15	3.7	10	0	90	....	...	....	17
18	72.50	84.5	60.9	23.6	29.8980	29.935	29.845	.090	.5571	70.8	61.8	S. W.	14.88	0.6	4	0	86	....	....	....	18
19	73.75	82.1	63.6	18.5	29.8866	29.955	29.813	.142	.5256	63.3	60.5	S.W.	13.42	3.8	9	0	91	....	...	....	19
20	75.92	84.8	65.6	19.2	29.8635	29.875	29.837	.038	.5633	63.2	62.2	S. W.	14.03	4.0	10	0	88	....	...	....	20
SUNDAY......21	....	76.3	63.4	12.9	......	......	.....	....	....	....	....	S. W.	12.00	....	...	..	10	1.26	....	1.26	21...........SUNDAY
22	67.13	71.2	55.5	15.7	29.7360	29.937	29.612	.325	.4562	66.8	54.8	N W.	16.46	2.8	8	0	91	....	...	....	22
23	61.56	69.9	52.6	17.3	30.0492	30.096	30.006	.090	.3542	63.5	49.2	N.W.	10.56	1.8	10	0	91	...	....	....	23
24	63.25	71.0	54.0	17.0	30.2103	30.252	30.104	.148	.3488	60.3	48.6	E.	10.92	2.2	5	0	85	...	....	....	24
25	65.18	75.4	55.0	20.4	30.1826	30.276	30.067	.209	.4306	70.5	55.0	S. E.	13.88	4.5	10	0	60	....	...	....	25
26	69.15	79.8	61.0	18.8	29.9015	29.967	29.838	.129	.5012	70.3	58.7	S. W.	14.71	5.0	10	0	50	0.05	...	0.05	26
27	66.85	74.6	59.0	15.6	29.9262	30.045	29.794	.251	.4565	69.3	55.6	S. W.	11.38	1.5	4	0	89	....	....	....	27
SUNDAY........28	.....	81.3	59.9	21.4	......	......	......	....	.....	.	....	S. W.	14.12	...	...	..	39	0.04	....	0.04	28...........SUNDAY
29	59.55	68.2	51.2	17.0	29.7090	29.929	29.562	.367	.3673	71.0	49.8	S.W.	18.79	4.5	10	0	69	0.03	....	0.03	29
30	59.50	68.1	44.2	23.9	30.0587	30.161	29.992	.169	.3155	62.5	49.5	S.W.	16.25	3.7	10	0	63	Inap.	....	Inap.	30
31	.....	....	....	....	....	......	......	....	.....	....	....	......	.....	....	...	..	..	....	....	....	31
Means	64.59	73.40	55.66	17.73	29.9208	30.0005	29.8463	.1542	.4031	65.72	52.29	S. 63½° W.	12.04	3.17	7.46	0.4	64.6	4.06	....	4.06	... . Sums
22 Years means for and including this month	65.01	73.79	56.44	17.35	29.8937	.....	......	.151	.4363	69.73	....	.....	ʃ13.12	5.6	..	..	¶53.8	3.51	....	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	....	1094	213	829	203	3905	577	1873	
Duration in hrs..	....	122	32	66	27	291	45	130	7
Mean velocity....	....	8.96	6.66	12.56	7.52	13.42	12.82	14.41	

Greatest mileage in one hour was 35 on the 29th.
Greatest velocity in gusts, 48 miles per hour on the 29th.

Resultant mileage, 3706.
Resultant direction, S. 63½° W.
Total mileage, 8094.
Average velocity, 12.04 miles per hour.

* 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. ʃ Ten years only.

The greatest heat was 86.4° on the 5th; the greatest cold was 44.2° on the 30th, giving a range of temperature of 42.2 degrees.

Warmest day was the 20th. Coldest day was the 12th. Highest barometer reading was 30.276 on the 25th. Lowest barometer was 29.478 on the 11th, giving a range of .798 inches. Maximum relative humidity was 99.0 on the 9th. Minimum relative humidity was 29.0 on the 4th.

Rain fell on 11 days.

Auroras were observed on 1 night on the 16th.

Thunder storms on 2 days, on the 7th and 21st.

ABSTRACT FOR THE MONTH OF JULY, 1896.

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

DAY.	THERMOMETER.				BAROMETER.				†Mean pressure of vapor.	‡Mean relative humidity.	Dew point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent. of possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	Max.	Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	70.68	78.4	62.1	16.3	30.0913	30.131	30.011	.120	.4862	65.0	57.8	S.W.	13.00	1.2	3	0	88	0.00	....	0.00	1
2	74.50	89.3	59.2	30.1	30.0237	30.200	29.890	.310	.5173	62.3	59.7	S.W.	19.88	0.0	0	0	87	....	....	....	2
3	59.90	67.3	55.6	11.7	30.1542	30.224	30.082	.142	.3590	70 0	49.8	E.	18.58	8.3	10	5	32	0.09	....	0.09	3
4	58.66	62.3	53.7	8.6	29.9395	30.122	29.755	.367	.4835	97.9	58.2	N.E.	11.08	10.0	10	10	00	2.04	....	2.04	4
SUNDAY.........5	.....	63.6	56.0	7.6	......	....	......	....	....	....	....	N.W.	12.25	....	....	..	1	0.23	....	0.23	5..........SUNDAY
6	62.62	71.0	55.0	16.0	29.9133	29.980	29.850	.130	.5138	89 8	59.5	N.E.	7.21	8.2	10	4	26	0.00	....	0.00	6
7	65.11	73.4	58.4	15.0	29.8665	29.893	29.849	.044	.5235	84.3	60.2	S. W.	12.83	6.3	10	0	47	0.07	....	0.07	7
8	69.23	78.3	56.4	21.9	30.0160	30.121	29.891	.230	.5143	72.8	60.0	S. W.	18.38	3.2	6	0	79	....	....	....	8
9	72.05	79.1	63.3	15.8	30.1468	30.215	30.080	.135	.5883	73.8	63.0	S.	10.25	6.8	10	0	26	0.12	....	0.12	9
10	74.25	80.2	68.8	11.4	29.0533	30.133	29.982	.151	5570	66.6	62.0	S. W.	15.79	4.5	10	0	81	0.00	....	0.00	10
11	73.33	79.4	66 0	13.4	29.9447	29.997	29.887	.110	.6155	74.5	64.8	S. W.	15.33	4.2	9	0	64	....	....	....	11
SUNDAY.........12	.....	86.7	68.0	18.7	....	......	......	....	.....	...	....	S. W.	19.30	....	......	..	86	0.00	....	0.00	12..........SUNDAY
13	70.63	82.0	65.0	17.0	29.7968	29.832	29.708	.124	.6193	83.3	65.0	N.W.	8.00	5.2	10	2	46	0.36	....	0.36	13
14	68.02	75.8	60.1	15.7	29.8885	29.949	29.819	.130	.4272	62.7	54.5	N.	6.67	5.8	10	3	69	....	....	....	14
15	65.57	77.6	56.3	21.3	29.5808	29.730	29.458	.272	.4873	76.3	57.5	S.	14.58	4.5	10	0	50	0.21	....	0.21	15
16	60.33	66.9	51.3	15.6	29.7807	29.901	29.695	.206	.3913	73.0	52.0	W.	17.08	6.7	10	3	57	0.00	....	0.00	16
17	66.53	75.3	58.6	16.7	30.0903	30.205	29.971	.234	.4117	03.2	53.0	W.	5.50	4.5	10	0	44	0.00	....	0.00	17
18	70.03	79.8	56.0	23.8	30.2827	30.338	30.243	.095	.4423	60.5	55.2	S.W.	6.29	3.7	10	0	84	....	....	....	18
SUNDAY 19	.....	81.6	64.1	17.5	....	......	.....	....	.....	....	....	S.	12.63	....	...	..	31	....	....	....	19..........SUNDAY
20	67 47	70.0	64.8	5.2	29.9725	30.072	29.803	.269	.6280	93.3	65.5	S.	12.29	9.2	10	5	00	0.57	....	0.57	20
21	74.30	82.1	68.1	14.0	29.9095	29 984	29.842	.142	.6402	76.5	66.0	W.	12.92	4.5	10	0	76	0.00	....	0.00	21
22	73.87	83.7	64.3	19.4	29.8293	30.001	29 591	.410	.7348	85.3	69.3	S.	9 29	5.8	10	0	54	0.00	....	0.00	22
23	65.65	71.5	59.8	11.7	29.7905	29.917	29.638	.279	4412	69.7	55.3	S. W.	19.54	2.2	5	0	96	0.02	....	0.02	23
24	65.25	72.1	57.5	14.6	29.8543	29.933	29.780	.153	.4480	72.5	56.0	S.W.	12.50	4.2	9	0	47	....	....	....	24
25	68.90	78.6	61.0	17 6	29.8425	29.935	29.779	.126	.4815	68.3	57.8	S.W.	17.17	3.2	10	0	82	....	...	....	25
SUNDAY.........26	.....	81.2	61.5	19.7	......	......	......	....	.....	.	....	S. W.	19.88	...	....	..	82	....	...	....	26..........SUNDAY
27	70.87	77.8	63.6	14.2	29.8025	29.863	29.756	.112	.5853	76.8	63.3	S.W.	11.08	8.0	10	4	10	0.00	....	0.00	27
28	72.42	80.5	60.5	14.0	29.9372	29.965	29.877	.088	.5782	73.3	63.2	N.W.	4 88	4.2	7	0	75	....	....	....	28
29	74.98	84.3	64.4	19.9	29.9243	30.016	29.811	.205	.5950	69.2	63.7	S. W.	7.79	2.5	10	0	82	0.00	....	0.00	29
30	73.53	83.1	63.5	19.6	29.7362	29.805	29.637	.169	.6418	75.7	65.8	S. W.	14.04	6.2	10	0	73	1.12	....	1.12	30
31	62.62	68.6	55.6	13.0	30.0052	30.103	29 912	.191	.2802	50.0	47.2	N.W.	14.54	0	0	0	98	0.01	....	0.01	31
Means	68.57	76.82	60 79	16.03	29.9323	30.0200	29.8369	.1831	.5182	73.58	59.46	S. 55¼° W.	13.01	4.93	8.44	1.32	57.2	4.84	....	4.84	... . Sums
22 Years means for and including this month	68.74	77.22	60 63	16.59	29.8943	....	.....	.142	.4984	71.1	....	.....	∫13.15	5.4	..	..	¶58.8	4.05	....	4.05	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	238	608	400	25	1077	5073	1172	1087	
Duration in hrs..	28	61	25	6	101	335	95	86	7
Mean velocity....	8.50	9.97	16.00	40.17	10.66	15.14	12.34	12.64	

Greatest mileage in one hour was 32 on the 26th.

Greatest velocity in gusts, 36 miles per hour on the 16th.

Resultant mileage, 5690.
Resultant direction, S. 55¼° W.
Total mileage, 9680.
Average velocity, 13.01 miles per hour.

*.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. ∫ Eleven years only.

The greatest heat was 89.3° on the 2nd; the greatest cold was 51.3° on the 16th, giving a range of temperature of 38.0 degrees.

Warmest day was the 29th. Coldest day was the 4th. Highest barometer reading was 30.338 on the 18th. Lowest barometer was 29.458 on the 15th, giving a range of .880 inches. Maximum relative humidity was 99.0 on the 4th. Minimum relative humidity was 33.0 on the 31st.

Rain fell on 21 days.

Auroras were observed on 1 night on the 11th.

Thunder storms on 4 days, on the 13th, 15th, 22nd and 30th.

Errata for May and June, 1896:—22 years monthly mean of Barometer for May, 29.9345; for June, 29.9058.

ABSTRACT FOR THE MONTH OF AUGUST, 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	66.27	73 2	52.5	20.7	29 9960	30.141	29.822	.319	.3427	56.8	48.5	S.W.	10.46	3.2	7	0	81	....	....	....	1
SUNDAY.........2	....	76.1	61.1	15.0	....	.....	......	....	....	....	....	S.W.	10.92	....	...	....	68	....	....	....	2.........SUNDAY
3	71.68	81.4	58.4	23.0	29 8865	29.937	29.832	.105	.5283	69.3	60.3	S.W.	12.25	1.5	4	0	94	....	....	....	3
4	74.92	82.5	67.8	14.7	29.8443	29.936	29.768	.168	.6132	70.2	64.8	S.W.	17.25	4.5	10	0	09	....	....	....	4
5	61.95	69.0	58.0	11.0	29.9693	29.989	29 944	.045	.4993	90.3	58.8	N.	12.88	10.0	10	10	00	0.54	....	0.54	5
6	62.98	66.4	58.4	8.0	29.9593	29.997	29.939	.058	.5547	96 2	61.8	N.	3.63	10.0	10	10	00	0.04	....	0.04	6
7	74.08	83.6	62.3	21.3	29.9095	29.935	29.861	.074	.6927	82.3	67.8	W.	9.50	5.3	10	1	58	Inap.	....	Inap.	7
8	76.68	85.1	66.0	19.1	29.9243	29.997	29.843	.154	.6175	68.0	65.5	S.W.	5.79	2.7	10	0	83	....	....	....	8
SUNDAY........9	.....	85.7	70.7	15.0	......	......	......	....	....	....	....	S.W.	14.58	....	.....	....	63	0.02	....	0.02	9..........SUNDAY
10	77 92	87.7	68.0	19.7	29.8458	29.890	29.803	.087	.7208	76.2	69.5	S.W.	10.25	3.7	10	0	68	....	....	....	10
11	81.15	89.7	74.1	15.6	29.8837	29.914	29.852	.062	.7698	73.0	71.7	S W.	16.96	2.5	7	0	86	....	....	....	11
12	77.47	86 1	70.1	16.0	29.9805	30.061	29.932	.129	.6340	67.2	65.3	S.W.	13.88	1.8	8	0	85	....	....	....	12
13	67.67	76.7	58.5	18.2	30.0643	30.135	29.999	.136	.4717	69.8	57.3	N.	9.21	2.5	8	0	64	....	....	....	13
14	71.45	80.2	61.8	18.4	30.0613	30.107	30.033	.074	.4097	54.3	53.3	S.W.	8.38	0.7	4	0	95	....	...	....	14
15	71 78	83.1	58 8	24.3	30.0545	30.142	29.969	.173	.4623	59.2	56.3	S.W.	7.13	1.0	3	0	92	....	....	....	15
SUNDAY.......16	.....	75.1	62.8	12.3	....	......	.....	....	....	....	....	S.W.	14.83	....	....	....	11	1.54	....	1.54	16..........SUNDAY
17	62 57	69.6	56.1	13.5	29.9112	29.946	29.889	.057	.3460	61.2	48.8	W.	15.00	2.2	7	0	96	....	....	....	17
18	56.57	63.2	52.5	10.7	29.9435	29.985	29 891	.094	.3443	75.8	48.7	N.W.	7.13	7.3	10	0	32	0.52	....	0.52	18
19	57.28	65.0	51.1	13.9	30.1272	30.178	30.039	.139	.3155	68.2	46.3	N.W.	13.25	7.0	10	2	85	Inap.	....	Inap.	19
20	63.12	71.9	56.4	15 5	30.1338	30.212	30.066	.146	.3675	63.8	50.3	S.W.	15.66	3.7	10	0	79	....	....	....	20
21	62 73	74.4	53.1	21.3	29.9643	30.060	29.900	.160	.4355	77.2	55 0	S.	8.90	7.7	10	0	48	0.64	....	0.64	21
22	65.77	74.1	56.8	17.3	29 9190	29 941	29 880	.161	.5266	83 8	60.3	S.	7.33	5.7	10	1	64	0.08	....	0.08	22
SUNDAY........23	.....	74.0	66.2	7.8	......	......	......	....	.....		....	S.	19.55	....	...	...	3	1.07	....	1.07	23..........SUNDAY
24	64.68	73.9	56 0	17.9	29.9290	30.054	29.881	.173	4267	69.7	54.5	S.W.	16.42	1.7	5	0	97	....	....	....	24
25	59.45	67.5	50.0	17 5	30.0867	30.146	30.020	.126	.3537	70.8	49.3	S.W.	5.04	0.0	0	0	92	....	...	....	25
26	67.37	77.4	53.3	24.1	29.9443	30.035	29.844	.191	.4438	66.5	55.5	S.	16.95	4.7	10	0	55	....	...	....	26
27	61.97	66.8	57.3	9.5	30.0422	30.147	29.886	.261	.4022	73.0	52.7	W.	10.50	6.7	10	3	76	0.81	....	0.81	27
28	60.20	67.5	54.3	13.2	30.2510	30.300	30.198	.102	.3408	64.5	48.0	W.	10.08	5.3	10	0	82	Inap.	....	Inap.	28
29	59.58	63.5	47.8	20.7	30.1808	30.300	30.035	.265	.3705	73.3	50.8	W.	8.96	1.0	4	0	85	....	....	....	29
SUNDAY........30	.....	75.7	54.2	21.5	....	....	......	..	.....	....	....	S.	13.54	....	....	....	65	0.02	....	0.02	30..........SUNDAY
31	58.08	62.7	53.5	9.2	29.7745	29.898	29 646	.252	.3848	78.9	51.3	W.	9.75	9.7	10	3	26	0.07	....	0.07	31
Means	66.75	75.28	58 96	16.32	29.9841	30.053	29.914	.139	.4759	71.52	56.63	......	11.48	4.3	7 9	1.2	64.6	5.35	....	5.35	... . Sums
22 Years means for and including this month	66.71	75.04	58 71	16.37	29.9405	......	......	.134	.4808	73.0	....	S. 56¾° W.	ƨ12.7	5.3	....	..	¶55.3	3.67	....	3.67	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	741	8	11	202	1353	4023	1583	621	
Duration in hrs .	82	2	2	13	111	313	147	67	7
Mean velocity....	9.04	4.00	5.50	15.54	12.19	12.85	10.79	9.27	

Greatest mileage in one hour was 27 on the 4th.

Greatest velocity in gusts, 36 miles per hour on the 23rd.

Resultant mileage, 5672.
Resultant direction, S. 56¾° W.
Total mileage, 8542.
Average velocity, 11.48 miles per hour.

* 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. ƨ Eleven years only.

The greatest heat was 89.7° on the 11th; the greatest cold was 47.8° on the 29th, giving a range of temperature of 41.9 degrees.

Warmest day was the 11th. Coldest day was the 18th. Highest barometer reading was 30.300 on the 28th. Lowest barometer was 29.646 on the 31st, giving a range of .654 inches. Maximum relative humidity was 99.0 on the 5th, 6th, and 22nd. Minimum relative humidity was 39.0 on the 14th.

Rain fell on 14 days.

Auroras were observed on 2 nights, on the 9th and 17th.

Thunder storm on the 9th.

ABSTRACT FOR THE MONTH OF SEPTEMBER, 1896.

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.	Percent. of possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	53.93	61.3	48.2	13.1	30.1075	30.238	29.977	.261	.2960	71.5	44.7	W.	13.30	3.0	9	0	72	....	....	....	1
2	56.57	63.8	46.5	17.3	30.1520	30.301	29.945	.356	.3215	70.3	46.8	S.W.	8.25	7.5	10	0	30	0.00	....	0.00	2
3	58.47	64.2	50.7	13.5	29.2922	29.975	29.704	.271	.4412	88.3	55.0	N.W.	16.20	7.3	10	0	00	0.39	....	0.39	3
4	50.53	56.8	45.5	11.3	30.1380	30.206	30.049	.157	.2582	70.5	41.3	N.W.	10.58	2.8	8	0	78	....	....	....	4
5	53.78	62.5	41.1	21.4	30.0895	30.209	29.958	.251	.3150	76.7	46.0	S.E.	10.38	6.7	10	0	39	0.09	....	0.09	5
SUNDAY........6	.....	65.4	51.4	14.0	....	.....	......	....	.....	....	....	S.E.	14.59	....	....	....	09	0.55	....	0.55	6..........SUNDAY
7	59.32	64.5	55.1	9.4	29.9680	30.119	29.791	.328	.3843	76.3	51.7	S.W.	15.67	4.7	10	0	81	....	....	....	7
8	59.45	69.6	49.7	19.9	30.1978	30.241	30.169	.072	.4155	82.8	53.8	S.W.	3.75	0.3	1	0	80	....	....	....	8
9	62.40	71.6	52.4	19.2	30.0800	30.188	29.962	.226	.4452	79.8	55.5	N.E.	6.13	0.0	0	0	83	....	....	....	9
10	66.23	75.6	55.1	20.5	29.8463	29.918	29.803	.115	.5048	78.0	59.0	S.W.	7.63	0.0	1	0	96	....	....	....	10
11	74.18	83.8	61.5	22.3	29.8916	29.963	29.827	.136	.6008	72.0	63.5	S.W.	16.13	0.0	0	0	87	....	....	....	11
12	66.33	71.9	61.4	10.5	30.1918	30.312	30.050	.262	.4903	75.5	58.3	N.E.	15.80	4.8	10	0	61	....	....	....	12
SUNDAY........13	.....	65.9	56.5	9.4	......	......	......	....	....	...	....	N.E.	20.82	....	.....	...	69	....	....	....	13..........SUNDAY
14	61.15	68.0	51.6	16.4	30.0333	30.175	29.908	.267	.4455	81.6	55.2	S.W.	8.80	9.2	10	5	27	0.06	...	0.06	14
15	58.28	65.7	48.5	17.2	29.9822	30.058	29.926	.132	.3612	72.6	49.2	N.W.	12.62	5.7	10	0	47	0.01	....	0.01	15
16	52.30	60.2	45.2	15.0	29.9452	30.051	29.824	.227	.2933	74.8	44.3	W.	6.96	2.8	10	0	84	....	....	....	16
17	55.75	61.8	50.9	10.9	29.6425	29.746	29.521	.225	.4067	91.0	53.2	S.	7.50	8.2	10	0	00	0.35	...	0.35	17
18	56.35	63.7	49.8	13.9	29.8373	30.895	29.748	.147	.3597	80.2	50.0	W.	13.79	5.3	10	0	67	0.00	....	0.00	18
19	55.18	57.1	52.4	4.7	29.6155	29.786	29.489	.297	.4088	93.8	53.5	S.W.	10.92	10.0	10	10	00	0.41	...	0.41	19
SUNDAY........20	.....	54.0	41.4	12.6	....	......	.....	....	....	....	....	W.	20.33	....	....	...	97	0.02	....	0.02	20..........SUNDAY
21	55.47	62.8	47.8	15.0	29.8997	29.927	29.816	.111	.3370	76.7	48.0	S.W.	16.00	6.0	10	0	64	....	....	....	21
22	44.45	49.0	39.0	10.0	29.9357	30.073	29.824	.249	.2252	75.8	37.2	N.W.	16.79	8.2	10	0	05	0.11	...	0.11	22
23	42.62	47.8	34.3	13.5	30.1495	30.236	30.073	.163	.1693	61.7	30.0	N.W.	13.83	3.7	10	0	97	....	....	....	23
24	51.17	59.5	43.6	15.9	30.1065	30.210	30.013	.197	.3047	81.2	45.3	S.W.	11.30	8.0	10	3	34	0.22	....	0.22	24
25	58.32	66.1	49.0	17.1	30.1395	30.230	30.066	.164	.3810	78.7	51.7	S.	13.17	9.5	10	7	48	0.00	...	0.00	25
26	61.70	67.5	54.4	13.1	30.1067	30.136	30.081	.055	.4747	86.2	57.3	S.W.	13.67	7.2	10	0	30	0.28	...	0.28	26
SUNDAY........27	.....	62.5	54.3	8.2	......	......	......	....	.....	.	....	W.	12.21	....	....	..	00	0.18	.....	0.18	27..........SUNDAY
28	48.75	54.3	44.0	10.3	30.2487	30.306	30.200	.106	.2285	66.8	38.0	S.W.	6.83	0.5	3	0	92	....	....	....	28
29	53.72	64.3	38.2	26.1	30.1033	30.230	29.918	.312	.3533	83.8	48.7	S.E.	12.21	6.3	10	0	48	0.01	....	0.01	29
30	60.70	69.2	54.3	14.9	29.6187	29.780	29.527	.253	.4453	84.0	55.7	W.	15.04	7.3	10	3	49	0.43	....	0.43	30
31	.....	.....	.....	.....	....	.....	......	..	.....	....	....	....	....	....	....	....	....	....	....	....	31
Means	56.81	63.68	49.13	14.55	29.9930	30.965	29.8911	2.054	.3718	78.10	49.72	......	12.37	5.19	3.15	1.08	52.46	3.11	....	3.11	... . Sums
22 Years means for and including this month......	58.52	66.58	50.76	15.69	30.0139	......	.....	.180	.3829	75.59	....	S. 73¾° W.	ƨ12.69	5.5	...	..	¶53.9	3.14	....	3.14	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	412	950	194	656	837	2719	1540	1648	
Duration in hrs..	43	65	18	51	67	200	135	138	3
Mean velocity....	9.58	14.62	10.78	12.86	12.50	13.59	11.41	11.94	

Greatest mileage in one hour was 34 on the 20th.

Greatest velocity in gusts, 60 miles per hour on the 17th.

Resultant mileage, 3435.
Resultant direction, S. 74¾° W.
Total mileage, 8956.
Average velocity, 12.44 miles per hour.

* 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. ƨ Eleven years only.

The greatest heat was 83.8° on the 11th; the greatest cold was 34.3° on the 23rd, giving a range of temperature of 49.5 degrees.

Warmest day was the 11th. Coldest day was the 23rd. Highest barometer reading was 30.312 on the 12th. Lowest barometer was 29.489 on the 19th, giving a range of .823 inches. Maximum relative humidity was 97.0 on the 8th, 19th, 26th and 29th. Minimum relative humidity was 50.0 on the 23rd.

Rain fell on 17 days.

Lunar halo on one night. Lunar corona on one night. Hoar frost on one day.

Thunder and lightning on two days, the 6th and 17th.

ABSTRACT FOR THE MONTH OF OCTOBER, 1896.

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. of possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	52.85	58.3	51.0	7.3	29.8337	29.989	29.690	.299	.3560	88.5	49.5	W.	16.33	8.5	10	2	03	0.34	....	0.34	1
2	44.10	52.1	41.8	10.3	30.1124	30.145	30.090	.055	.2478	85.4	40.0	N.	20.79	10.0	10	10	00	0.02	....	0.02	2
3	44.77	49.2	40.9	8.3	30.1703	30.229	30.112	.117	.2657	89.3	41.7	N.	8.21	9.7	10	9	07	0.03	....	0.33	3
SUNDAY. 4	.....	50.9	44.7	6.2	....	....	......	....	.....	....	....	N.	2.54	....	....	....	06	Inap.	....	Inap.	4.......... SUNDAY
5	46.65	51.8	43.4	8.4	30.2178	30.283	30.150	.133	.2550	80.3	40 8	N.	6.75	6.7	10	0	33	Inap.	....	Inap.	5
6	43.85	47.6	39.8	7.8	30.0928	30.156	29.985	.171	.2487	86 7	40.3	N.	9.92	10.0	10	10	00	....	....	....	6
7	43.73	46.6	41.5	5.1	29.8452	29.932	29.793	.139	.2668	93.3	42.2	N.	9.58	9.7	10	8	00	0.62	....	0.62	7
8	40.42	45.8	37.3	8.5	30.1002	30.296	29.901	.395	.2100	84.2	35.8	W.	18.00	9.7	10	8	26	0.22	....	0.22	8
9	39.33	44.9	33.3	11.6	30.4717	30.549	30.378	.171	.1572	64.8	28.7	W.	9.00	0.5	2	0	98	....	....	....	9
10	39.70	46.5	32.0	14.5	30.5727	30.638	30.485	.153	.1615	68.8	29.8	N.	9.08	0.0	0	0	92	....	....	....	10
SUNDAY........11	.....	52.5	33.0	19.5	......	......	......	....	....	...	....	N.	11.17	....	......	....	93	....	....	....	11...........SUNDAY
12	44.43	54 5	35.5	19.0	30.3233	30.398	30.213	.185	.2122	73.2	35.8	N.	20.50	1.7	9	0	84	....	....	....	12
13	44.88	53.6	37.4	16.2	30.0075	30.179	29.816	.363	.2030	69.2	34.8	N.	20.62	4.7	9	0	55	....	....	....	13
14	48.00	55.6	41.0	14.6	29.8188	29.856	29.795	.061	.2240	67.5	37.5	N.	11.25	5.2	8	2	35	....	...	....	14
15	49 37	57.8	41.0	16.8	29.7008	29.795	29.586	.209	.2325	66.5	38.2	W.	8.42	2.8	6	0	85	....	....	....	15
16	39.40	43.0	35.5	7.5	29.6085	29.739	29.539	.200	.2203	90.3	37.0	W.	13.96	7 5	10	2	00	0.19	....	0.19	16
17	35.15	39.0	29.6	9.4	29.9440	30.019	29.820	.199	.1448	71.0	26.5	W.	6.79	7.3	10	4	48	....	...	....	17
SUNDAY........18	.....	44.8	33.3	11.5	....	......	......	....	... .	....	....	N.E.	7.50	...	..	..	30	0.11	....	0.11	18.......... SUNDAY
19	36.27	42.2	31.8	10.4	29.9767	30.071	29.857	.214	.1512	70.8	27.3	N.W.	17.17	5.0	10	0	56	Inap.	Inap.	Inap.	19
20	40.38	48.2	31.5	16 7	29.8923	30.016	29.776	.240	.1953	75.5	33.2	S.W.	17.75	8.7	10	3	16	0.10	Inap.	0.10	20
21	44.20	54.1	35.2	18.9	29.7807	29 868	29.677	.191	.2430	80.7	38.8	S.W.	18.50	6.7	10	0	04	0.22	...	0.22	21
22	37.88	44.8	32.4	12.4	29.9263	29.957	29 867	.090	.1667	74.2	30.0	S.W.	18.00	6.8	10	4	73	....	....	....	22
23	40.68	48.2	36.4	11.8	29.7685	29.924	29.579	.345	.1822	72.2	32.2	S.W.	8.63	8.7	10	2	28	....	....	....	23
24	39.42	47.7	36.0	11.7	29.5877	29.739	29.523	.216	.1947	81.0	33.8	S.W.	15.50	5.5	10	0	53	0.03	....	0.03	24
SUNDAY........25	.....	35.3	29.9	5 4	......	......	......	....	.....		....	N.W.	17.04	....	...	....	19	..	Inap.	Inap.	25...........SUNDAY
26	42.97	50.6	31.4	19.2	29.9793	30.071	29.906	.165	.2023	71.7	34.3	S.W.	15.12	5.7	10	0	33	....	...	....	26
27	44.43	51.7	35.8	15.9	30.2132	30.358	30.096	.262	.2057	70.2	35.0	N.W.	8.50	4.8	10	0	58	Inap.	....	Inap.	27
28	38.32	47.5	30.2	17.3	30.3328	30.421	30.210	.211	.1753	75.8	31.5	N.E.	11.92	3.3	10	0	88	....	....	....	28
29	47.15	54.0	38.1	15.9	30.1127	30.177	30.077	.100	2995	95.5	44.2	N.W.	11.37	10.0	10	10	00	0.38	....	0.38	29
30	45.80	49.8	43.6	6.2	29.9073	30.078	29 737	.341	.2993	97.0	45.2	N.E.	9.42	10.0	10	10	00	0.08	....	0.08	30
31	48.70	57.1	41.8	15.3	29.7912	29.828	29.751	.077	.2698	96.5	42.3	S.W.	11.63	4.8	10	0	50	0.14	....	14.0	31
Means	43.07	49.21	36.97	12.24	30.0033	30.1004	29.9040	.1964	.2219	79.26	36.53	N. 50° W.	12.61	6.44	9.04	3.11	37.8	2.48	Inap.	2.48	.... Sums
22 Years means for and including this month......	45.25	52.26	38.46	13.71	29.9956	......	......	.213	.2426	76.62	....	......	ƨ13.71	6.44	....	....	¶40.27	3.06	1.25	3.19	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	3016	943	34	426	106	2307	1509	1042	
Duration in hrs..	241	103	13	31	10	151	111	76	8
Mean velocity....	12.51	9.16	2.62	13.74	10.60	15.28	13.52	13.71	

Greatest mileage in one hour was 30 on the 21st.
Greatest velocity in gusts, 48 miles per hour on the 21st.

Resultant mileage, 3740.
Resultant direction, N. 50° W.
Total mileage, 9383.
Average velocity, 12.61 miles per hour.

* 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. ƨ Eleven years only.

The greatest heat was 58.3° on the 1st; the greatest cold was 29.6° on the 17th, giving a range of temperature of 28.7 degrees.

Warmest day was the 1st. Coldest day was the 17th. Highest barometer reading was 30.638 on the 10th. Lowest barometer was 29.523 on the 24th, giving a range of 1.115 inches. Maximum relative humidity was 99.0 on the 30th. Minimum relative humidity was 51.0 on the 10th, 19th and 23rd.

Rain fell on 17 days. Snow fell on 3 days.
Rain or snow fell on 18 days.
Hoar frost on 6 days.
Solar corona on the 13th.
Fog on 3 days.

ABSTRACT FOR THE MONTH OF NOVEMBER, 1896.

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.	Percent. of possible sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
SUNDAY........1	....	54.7	39.9	14.8	......	....	......	....	....	....	....	S.W.	13.37	....	....	....	72	0.00	....	0.00	1 .... SUNDAY
2	45.62	48.9	42.5	6.4	30.1188	30.277	30.001	.276	.2258	73.7	37.7	W.	15.58	5.2	10	0	16	....	....	....	2
3	40.77	46.0	36.3	9.7	30.3598	30.398	30.323	.075	.2098	82.7	35.8	N.E.	9.46	3.0	8*	0	42	....	....	....	3
4	44.63	53.0	31.6	21.4	30.1333	30.301	29.958	.343	.2468	81.7	39.2	S.E.	20.46	6.0	10	0	43	0.00	....	0.00	4
5	52.07	55.4	49.9	5.5	29.6452	29.929	29.398	.531	.3657	93.2	50.3	S E.	26.70	10.0	10	10	00	0.93	....	0.93	5
6	42.85	52.1	40.5	11.6	29.6050	29.749	29.547	.202	.2172	78.3	36.3	S.W.	30.68	10.0	10	10	00	0.09	....	0.09	6
7	40.45	43.6	36.7	6.9	29.8627	29.919	29.780	.139	.1927	76.3	33.7	S.W.	16.58	8.3	10	5	55	0.00	....	0.00	7
SUNDAY..........8	.....	44.8	32.0	12.8	......	......	......	....	.....	...	....	S.W.	15.33	....	....	....	00	0.15	0.00	0.15	8..........SUNDAY
9	35.95	41.8	31.0	10.8	29.9372	30.060	29.868	.192	.1663	79.5	30.2	S.W.	13.21	5.3	10	0	93	....	....	....	9
10	36.12	39.4	32.8	6.6	30.2727	30.329	30.200	.129	.1572	73.8	28.7	S.W.	10.88	7.5	10	0	18	0.00	....	0.00	10
11	42.10	50.3	34.8	15.5	29.8547	30.130	29.661	.469	.2178	79.8	36.2	S.	21.21	7.2	10	0	00	0.26	....	0.26	11
12	41.45	45.7	35.5	10.2	29.9607	30.008	29.935	.073	.1870	71.3	32.8	S.W.	18.29	8.8	10	8	20	0.00	....	0.00	12
13	30.43	33.5	25.8	7.7	29.9890	30.014	29.933	.081	.1370	80.5	25.2	N	10.47	8.0	10	2	12	....	0.00	0.00	13
14	27.43	30.8	25.0	5.8	30.1147	30.183	30.016	.167	.1112	72.8	20.5	N.W.	10.79	9.8	10	9	00	....	0.00	0.00	14
SUNDAY........15	.....	41.2	25.5	15.7	......	......	.....	....	.....	...	....	S.W.	19.54	....	...	...	00	0.40	1.70	0.57	15 ....SUNDAY
16	28.12	30.9	25.5	5.4	30.0620	30.158	29.887	.271	.1440	93.5	26.3	N.E.	10.33	10.0	10	10	00	....	1.20	0.12	16
17	44.67	57.6	30.9	26.7	30.0722	30.350	29.837	.513	.2353	72.2	36.3	S.W.	23.96	7.8	10	2	35	0.02	....	0.02	17
18	38.33	57.3	28.1	29.2	29.9347	30.340	29.569	.771	.2172	82.0	33.5	E.	19.37	10.0	10	10	00	0.54	....	0.54	18
19	28.37	57.6	18.0	39.6	30.1930	30.454	29.834	.620	.1127	68.3	19.7	N.W.	22.04	2.3	7	0	90	0.01	....	0.01	19
20	16.63	19.4	11.4	8.0	30.5957	30.652	30.541	.111	.0643	69.0	8.5	N.W.	8.58	3.5	10	0	46	....	0.00	0.00	20
21	24.05	27.7	17.0	10.7	30.2233	30.504	30.007	.497	.1117	85.8	20.3	S.E.	11.33	8.3	10	0	00	....	0.70	0.07	21
SUNDAY........22	.....	25.5	12.5	13.0	......	.....	......	....	.....	....	....	N.W.	11.25	....	...	...	95	....	0.40	0.04	22..........SUNDAY
23	23.07	36.3	8.8	27.5	30.5310	30.774	30.182	.592	.1132	80.8	18.2	S.E.	12.64	6.5	10	0	04	0.00	....	0.00	23
24	37.30	44.5	29.4	15.1	30.3010	30.683	30.080	.603	.1980	87.5	33.7	N.W.	15.33	5.2	10	0	13	0.22	....	0.22	24
25	22.62	26.0	20.8	5.2	30.5857	30.667	30.433	.234	.0985	81.3	18.2	N.E.	11.37	8.3	10	0	00	....	1.10	0.23	25
26	25.40	29.5	23.1	6.4	30.1388	30.258	29.983	.275	.1295	93.7	23.8	N.E.	8.96	10.0	10	10	00	0.48	0.30	0.51	26
27	38.73	51.8	23.0	28.8	29.8332	29.859	29.781	.078	.2432	96.5	37.7	S.W.	19.25	10.0	10	10	00	0.14	....	0.14	27
28	38.45	55.0	31.8	23.2	30.0812	30.221	29.798	.423	.1905	77.3	32.0	S.W.	18.33	10.0	10	10	00	0.24	....	0.24	28
SUNDAY........29	.....	30.5	22.6	7.9	....	......	.....	....	.....	..	....	W.	11.29	...	......	...	08	....	0.00	0.00	29.......... SUNDAY
30	24.28	28.7	21.3	7.4	30.2867	30.375	30.215	.160	.1078	82.3	19.7	S.W.	10.00	8.3	10	0	03	....	0.50	0.05	30
Means	34.79	41.98	28.13	13.85	30.1077	30.2637	29.9507	.3130	.1760	80.55	29.38	S. 45° W.	15.55	7.57	9.8	3.8	22.2	3.48	5.90	4.19	... . Sums
22 Years means for and including this month	32.56	38.99	26.57	12.98	30.0171	......	......	.2664	.1604	79.72	....	......	§16.40	7.38	...	...	¶28.63	2.39	12.47	3.65	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	289	1184	253	1830	498	4804	746	1594	
Duration in hrs..	26	108	29	97	38	244	56	122	
Mean velocity....	11.12	10.96	8.76	18.86	13.11	19.68	13.32	13.07	

Greatest mileage in one hour was 40 on the 17th.

Greatest velocity in gusts, 48 miles per hour on the 17th.

Resultant mileage, 4115.
Resultant direction, S. 45° W.
Total mileage, 11198.
Average velocity, 15.55 miles per hour.

* 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. § Eleven years only.

The greatest heat was 57.6° on the 17th and 19th; the greatest cold was 8.8° on the 23rd, giving a range of temperature of 48.8 degrees.

Warmest day was the 5th. Coldest day was the 20th. Highest barometer reading was 30.774 on the 23rd. Lowest barometer was 29.398 on the 5th, giving a range of 1.376 inches. Maximum relative humidity was 100 on the 15th. Minimum relative humidity was 57.0 on the 1st and 20th.

Rain fell on 18 days. Snow fell on 12 days.

Rain or snow fell on 27 days.

Lunar halo on 1 night on the 17th.

Lunar coronas on 2 nights on the 19th and 20th.

Fog on 5 days on 1st, 3rd, 24th, 26th and 27th.

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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.)

THE

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Note on Cryptozoon and other Ancient Fossils.

By Sir William Dawson, F.R.S., F.G.S., &c.

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 Salterella." 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.

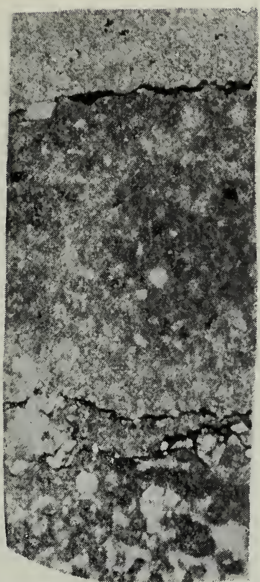

FIG. 2. FIG. 3.

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. 107′ N. Long. 8° 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 Archæozoon. 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, Palæontology, 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 Archæocyathus 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 Archæocyathus 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 Jonrnal 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 (*Eupatorium 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. hydropipex*) 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.

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 above-mentioned 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 Varisca, 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-day 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 Ilé 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 whieh 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.	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.	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	0.00	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
SUNDVY........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	.1932	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 16 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.
January	12.36	+ 0.42	35.3	−21.2	10.83	30.1906	30.675	29.431	222	.0742	88.5	9.4
February	14.75	− 0.59	41.5	−23.4	14.76	29.8314	30.601	28.786	.339	.0915	90.3	12.4
March	19.65	− 4.42	45.6	− 3.2	14.96	29.9339	30.682	29.039	.295	.0995	84.5	15.5
April	41 48	+ 1.41	77.0	17.6	16.92	30.0685	30.586	29.419	.157	.2008	74.6	33.1
May	57.66	+ 2.92	88.7	36.0	20.10	29.9588	30.408	29.493	.199	.3319	67.2	45.9
June............	64.59	− 0.42	86.4	44.2	17.73	29.9208	30.276	29.478	.154	.4031	65.7	52 3
July	68.57	− 0.17	89.3	51.3	16.03	29.9323	30.338	29.458	.183	.5182	73.6	59.5
August	66.75	+ 0.04	89.7	47.8	16.32	29.9841	30.300	29.646	.139	.4759	71.5	56.6
September	56.81	− 1.71	83.8	34.3	14.55	29.9923	30.312	29.489	.205	.3718	78.1	49.7
October	43.47	− 2.18	58.3	21.6	12.24	30.0033	30.638	29.523	.195	.2279	79.3	36.5
November	34 79	+ 2.23	57.6	8.8	13.85	30.1077	30.774	29.398	.313	.1760	80.6	29.4
December	17.78	− 1.12	42.0	− 6.9	13.26	30.1605	30.935	29.362	.283	.0873	82.4	13.3
Sums for 1896 ...	..	...	....	....	....	.	....	....	....	....		....
Means for 1896 ..	41.52	−0.299	....	....	15.13	30.0070	....	....	.2237	.2548	78.03	34.47
Means for 22 years ending Dec. 31. 1896	41.82	....	...	....	...	29.9795	....	....	....	.2521	74.88	....

Month.	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	N. 20° W.	14.5	60	39.4	....	..	20.7	17	2.11	..	17	January..........
February	N. 30¾° W.	20.0	60	40.7	0.35	1	25.9	17	3.34	..	18	February.........
March	N 51¼° W.	19.2	55	41 0	2.13	7	39.5	18	6.97	4	21	March ....
April	S. 44¾° W.	18.2	47	55.3	0.85	12	3.2	6	1.20	2	16	April...... ....
May	S. 33¾° W.	11.5	44	59.5	2.74	16	....	..	2.94	..	16	May......... ....
June............	S. 63½° W.	12.0	32	64.6	4.06	11	....	..	4.06	..	11	June...... ......
July	S. 55¼° W.	13 0	49	57.2	4.84	21	....	..	4.84	..	21	July........ .....
August	S. 56¾° W.	11.5	43	64.6	5.35	14	...	..	5.35	..	14	August.... ....
September	S. 73¾° W.	12.4	52	52.5	3.11	17	....	..	3.11	.	17	September......
October	N. 50° W.	12.6	64	37.8	2.48	17	Inap.	3	2.48	2	18	October... .....
November	S. 45° W.	15.6	76	22.2	3.48	18	5.9	12	4.19	3	27	November......
December	S. 69½° W.	15.6	53	34.1	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 ..	N. 84¾° W.	14.68	52.9	47.41	....	....	....	..	3.47	..	17	Means for 1896
Means for 22 years ending Dec. 31. 1896	....	*a* 16.13	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 per hour	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	....	0.6	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	.0630	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	30.288	.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	15.0	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.	7.25	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	30.338	.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 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	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.

§ 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.	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	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	88	....	....	....	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	33.12	35.1	30.2	4.9	29.8321	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	64	....	....	...	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 perhour	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	29.829	.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	.5.6	.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	11 5	30.2592	30 305	30.232	.073	.1290	58.0	23.7	S.W.	14.46	1.8	5	0	98	....	....	....	29
30	39.45	46.2	32.0	14.2	30.2752	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.

ε 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 28th.

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

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

Earthquakes on 23rd and 27th.

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THE

CANADIAN RECORD

OF SCIENCE.

VOL. VII. JANUARY, 1897. No. 5.

Contributions to Canadian Botany.

By James M. Macoun.

X.

Ranunculus Lapponicus, L.

Shore of Seal Lake, Northern Labrador, 1896. (*A. P. Low.*) Not before recorded east of Lake Nepigon, Ont.

Anemone Richardsoni, Hook.

Along the Ungava River, Labrador. (*A. P. Low.*) Not before recorded from Labrador.

Berberis nervosa, Pursh.

Pend d'Oreille River, about 20 miles east of the Columbia River, B.C., 1896. (*Jas. McEvoy.*) Eastern limit.[1]

Nelumbium luteum, Willd.; Macoun, Cat. Can. Plants, Vol. I, pp. 31 and 484.

In abundance in Lake Erie at Port Rowan, Ont. (*John Macoun, W. Scott, J. M. Dickson.*)

[1] The geographical limits given in these papers refer to Canada only.

NASTURTIUM ARMORACIA, Fries.

Old fields at Prince Albert, Saskatchewan. (*John Macoun.*) Not before recorded west of Ontario.

CARDAMINE DIGITATA, Rich. in Frank. I. Journ., ed. 2 app. p. 26.

Near the mouth of the Mackenzie River, 1893. (*Rev. J. D. Stringer.*) Not rare between Lake Athabasca and Chesterfield Inlet. 1893. (*J. W. Tyrrell.*) Referred to *C. pratensis* by later American botanists. Easily separated from that species by its creeping, stoloniferous underground-stem, thinner, generally digitate leaves and smaller flowers. Not collected in America since first found by Richardson, but recorded from St. Lawrence Bay, Behring's Straits, by Chamisso and Eschscholtz. Fruiting specimens have never been collected.

LOBULARIA MARITIMA, Desv.

Alyssum maritimum, Lam.

Near the outer wharf, Victoria, Vancouver Island. (*John Macoun.*) Probably established in other parts of Canada, but not before recorded.

ALYSSUM INCANUM, DC.

Cultivated fields, Wallbridge, Hastings Co., Ont. (*A. Y. Massey.*) Not before recorded in Canada.

THELOPODIUM (?) SALSUGINEUM, Robinson, Syn. Fl. N. Amer., p. 175.

Sisymbrium salsugineum, Pall.; Macoun, Cat. Can. Plants, Vol. I., p. 47.

By a saline lake, Park-beg, west of Moose Jaw, Assiniboia, June 23rd, 1896. (*John Macoun.* Herb. No.

14, 292).[1] This interesting little Crucifer has been rarely collected, and there is still some uncertainty as to its true place among the Cruciferæ. It has already been referred to several genera, and Dr. Robinson has only doubtfully named it *Thelopodium*. He says: "The problematic *S. salsugineum*, Pall. with glabrous entire cordate-clasping leaves, purplish flowers and undivided stigma, may well be referred to *Thelopodium*, from which it appears to be distinguished only by its small size and slender habit." (Syn. Flora, p. 137). Its range in America, according to Dr. Robinson, is "Rocky Mountains from Colorado at South Park, *Porter*, to British America and shores of the Arctic Sea, *Richardson*, according to Hooker, l.c.," but it has never been found in our Rocky Mountains so far as we know.

Capsella elliptica, C. A. Meyer.

C. divaricata, Walp.; Macoun, Cat. Can. Plants, Vol. I., p. 56; Can. Rec. Science, Nov., 1894, p. 147.

Damp places near a saline lake, Park-beg, Assa., 1896. (*John Macoun*. Herb. No. 12,390.) Not before recorded between Labrador and British Columbia.

Viola rotundifolia, Mx.

Moose Creek, Can. Atlantic Ry.; Jordan, Welland Co., Ont. (*John Macoun*.) Niagara Falls, Ont. (*R. Cameron*.) 20-mile Creek, west of St. Catharines, Ont. (*J. Dearness*.) Not before recorded from Ontario.

Arenaria macrophylla, Hook.

Dr. Robinson in Proc. Amer. Acad. of Arts and Sciences, Vol. XXIX., p. 290, gives as the range of this species "eastward to Isle St. Ignace, Lake Superior."

[1] Whenever herbarium numbers are given, they are the numbers under which specimens have been distributed from the herbarium of the Geological Survey of Canada.

Specimens collected in 1894 by Mr. A. P. Low at Lake Michikamow, Labrador, and in 1896 along the Koaksoak River, Northern Labrador, have been doubtfully referred here.

SAGINA NIVALIS, Lightf.

Along the Ungava River, Northern Labrador, 1896. (*A. P. Low.*) New to Canada.

HYPERICUM PROLIFICUM, L.

Sandy plains, along fence rows and in woods Caradoc township south of Strathroy, Ont., Aug., 1888. (*J. Dearness.*) New to Canada.

HYPERICUM NUDICAULE, Walt.

H. Sarothra, Mx.: Macoun, Cat. Can. Plants, Vol. I., p. 85.

Sandy fields south of Sandwich, Ont., 1892. (*John Macoun.*) Only authentic Canadian record.

GERANIUM BICKNELLII, N. L. Britton, Bull. Torr. Bot. Club, Vol. 24, p. 92.

"Similar to *G. Carolinianum*, but taller, the stems usually more slender, loosely pubescent. Leaves slender-petioled, somewhat angulate in outline, the segments oblong or linear-oblong, mostly narrower; peduncles slender, two-flowered, the inflorescence loose; sepals lanceolate, awn-pointed; ovary lobes pubescent; persistent filaments longer than the carpels: beak about 1′ line long, long-pointed, its tip 2″-3″ long; seeds reticulated."

"Nova Scotia (?) Maine to Western Ontario and Southern New York."

In the February number of the Bulletin of the Torrey Botanical Club, Dr. Britton describes *G. Bicknellii* as one of "two undescribed eastern species." Our herbarium sheets of *G. Carolinianum* have long been separated into two forms, both of general distribution from Ontario westward. Our herbarium specimens of *G. Bicknellii* give this plant a much wider range than is indicated by Dr. Britton. They are from Bedford, N.S.; Nepigon, Lake Superior; Killarney, Man.; Prince Albert, Saskatchewan; Banff, Rocky Mountains; Ainsworth, Kootanie Lake, B.C.; Spence's Bridge, B.C. (*John Macoun.*) Ottawa, Ont.; Observation Point, Lake Winnipeg. (*J. M. Macoun.*) North Shore of Lake Athabasca. (*J. W. Tyrrell.*) Arctic North America. (*Dr. Richardson.*) All the specimens from the above localities are separable at a glance from true *G. Carolinianum* by the much longer and very slender tip of the beak.

The specimens from Kootanie Lake were found growing with *G. Carolinianum* and were named var. *longipes*, Wat., a variety that must approach very closely *G. Bicknellii.*

Geranium Carolinianum, L.

Not represented in the herbarium of the Geological Survey from eastern provinces. Belleville, Ont.; Cypress Hills, Assa.; Sproat, Columbia River, B.C.; Ainsworth, Kootanie Lake, B.C.; Mt. Finlayson, Victoria Arm, and Comox, Vancouver Island. (*John Macoun.*) Walpole Island, Lambton Co., Ont. (*C. K. Dodge.*)

We have no intermediate forms between *G. Bicknellii* and *G. Carolinianum.*

Lupinus littoralis, Dougl.

Sandy soil at Point Holmes near Comox, Vancouver Island, 1893. (*John Macoun.*) New to Canada.

Amorpha fruticosa, L.; Macoun, Cat. Can. Plants, Vol. I., p. 109.

In thickets by the Red River at Morris, Man., and at

River Park, Winnipeg, Man., 1896. (*John Macoun.* Herb. No. 12511.) Not reported since found by Douglas.

DESMODIUM CANADENSE, DC.

In thickets at Morden, Man., 1896. (*John Macoun.* Herb. No. 12525.) Western limit.

DESMODIUM ILLINOENSE, Gray.

Komoka, Ont., 1888. (*J. Dearness.*) New to Canada.

LATHYRUS LITTORALIS, Endl.

Ahousset, west coast of Vancouver Island. (*J. R. Anderson.*) New to Canada.

VICIA HIRSUTA, Koch.

In cultivated fields, Olds, Alberta. (*T. N. Willing.*) Not before recorded from prairie region.

AMPHICARPÆA MONOICA, Ell.

In thickets near the Assiniboine River at Brandon, Man.; thickets by the Red River, Winnipeg, Man., 1896. (*John Macoun.*) Not before recorded west of Lake Superior.

SAXIFRAGA REFLEXA, Hook.

Near the mouth of the Mackenzie River, 1893. (*Rev. J. D. Stringer.*) The reflexed calyx-segments, the two orange spots on the petals and the petaloid filaments are conspicuous characters of the fine specimens collected by Mr. Stringer. Herb. No. 14300.

PARNASSIA CAROLINIANA, Mx.

Boggy places near Stony Mountain, Man., 1896. (*John Macoun.* Herb. No. 12660.) Western limit in Canada.

DROSERA INTERMEDIA, Hayne, var. AMERICANA, DC.

In a muskeg north of Prince Albert, Saskatchewan, 1896. (*John Macoun.* Herb. No. 12669.) Western and northern limit.

DROSERA LINEARIS, Goldie.

In a muskeg north of Prince Albert, Saskatchewan, 1896. (*John Macoun.* Herb. No. 12668.) Not before recorded between Manitoba and Rocky Mountains.

LUDWIGIA POLYCARPA, Short & Peter.

First recorded from Canada in Part I. of these papers. Since collected by Mr. J. Dearness near Comber, Ont., and by Mr. C. K. Dodge near Sarnia, Ont.

LONICERA GLAUCESCENS, Rydberg, Bull. Torr. Bot. Club, Vol. XXIV., p. 90.

L. Sullivantii, Macoun, Cat. Can. Plants, Vol. I., pp. 197, 539.

L. glauca, Macoun, Cat. Can. Plants, Vol. I., p. 197, in part, and Vol. I., p. 539.

L. hirsuta glaucescens, Rydberg, Contr. U. S. Nat. Herb. III., 503.

From North-Western Ontario to the Rocky Mountains. Our herbarium specimens are from Manitoba House, Lake Manitoba; Fort Ellice, Assiniboine River, Man.; West Selkirk, Man. Herb. No. 12805; Rat River, Otterburne, Man.; Brandon, Man. Herb. No. 12804; Moose Jaw, Assa. Herb. No. 12803; Prince Albert, Saskatchewan, Herb. No. 12806; Banff and Kananaskis, Rocky Mountains; Waterton Lake, South Kootanie Pass, Rocky Mountains. Herb. No. 10802. (*John Macoun.*) Doghead, Lake Winnipeg. (*J. M. Macoun.*) Indian Head, Assa. (*W. Spreadborough.*) Milk River Ridge, Alta. (*Dr. G. M. Dawson.*) Red Deer River, Alta. (*H. H. Gaetz.*) Fort

Smith, Great Slave River. (*Miss E. Taylor.*) Additional Canadian localities given by Mr. Rydberg are River That Turns, Assa. (*John Macoun.*) Ontario (*Dr. and Mrs. Britton and Miss Timmerman ; T. J. W. Burgess.*) Saskatchewan. (*E. Bourgeau.*)

LIATRIS SCARIOSA, Willd.

Since the publication of No. 9 of these papers, Dr. T. J. W. Burgess has written me that he collected this species at Leamington, Ont., in 1886, and Mr. J. Dearness reports it from Port Frank and Point Edward, Ont.

LIATRIS SPICATA, Willd.

Leamington, Ont. (*Dr. T. J. W. Burgess.*) The only other Canadian locality known to us is the vicinity of Sarnia, Ont., where this species is common.

RUDBECKIA COLUMNARIS, Pursh, var. PULCHERRIMA, Torr. & Gray ; Macoun, Cat. Can. Plants, Vol. I., p. 243.

Near the Government Experimental Farm, Brandon, Man., 1896. (*John Macoun.* Herb. No. 12243.) The dark brown-purple rays of this beautiful plant separate it from *R. columnaris.*

BÆRIA MARITIMA, Gray.

On Bird Island, Barclay Sound, west coast of Vancouver Island. (*Chas. F. Newcombe.*) New to Canada. Only other known place of occurrence, Farallones Islands, off San Francisco.

ANTHEMIS ARVENSIS, L.

On ballast at Nanaimo, Vancouver Island, 1887. (*John Macoun.*) Common around Victoria, Vancouver Island. (*J. R. Anderson.*) Not before recorded west of the Maritime Provinces.

Chrysanthemum arcticum, L.

Shore of Larcomb Island, Observatory Inlet, B.C. (*J. McEvoy.*) Southern limit on Pacific Coast.

Chrysanthemum Parthenium, Pers.

On ballast heaps, Nanaimo, Vancouver Island, 1893. (*John Macoun.*) Not before recorded west of Ontario.

Artemisia glauca, Pall. ; Macoun, Cat. Can. Plants, Vol. I., p. 255, and Vol. II., p. 335.

Common in Manitoba from Brandon southward. (*John Macoun.* Herb. Nos. 12257 and 12426.)

Artemisia norvegica, Fries, var. Pacifica, Gray.

Mount O.K., near Alaskan boundary, B.C. (*H. W. E. Canovan.*) Yukon River. (*W. Ogilvie.*)

Artemisia vulgaris, L.

Along the C. P. Ry. at Brandon, Man. ; waste places, Sicamous, B.C. ; ballast heaps, Nanaimo, Vancouver Island. (*John Macoun.*) Not recorded west of Ontario.

Artemisia vulgaris, L. var. Californica, Bess.

Specimens collected by Mr. Jas. Fletcher near Victoria, Vancouver Island, in 1883, were doubtfully referred here by Prof. Macoun. (Cat. Can. Plants, Vol. I., p. 258.) It has since been collected at Burrard Inlet, B.C., and at Sooke, Saanich Arm, and Qualicum, Vancouver Island, by Prof. Macoun.

Petasites palmata, Gray.

Revelstoke, Columbia River, B.C. ; Port Moody, B.C. ; Comox, Sooke and Victoria, Vancouver Island. (*John Macoun.*) Nanaimo River, Vancouver Island. (*J. R. Anderson.*) Not before recorded west of the Selkirk Mountains.

CNICUS ALTISSIMUS, Willd., var. DISCOLOR, Gray.

In thickets, River Park, Winnipeg, Man. (*John Macoun.* Herb. No. 12292.) Not before recorded west of Sarnia, Ont.

CNICUS EDULIS, Gray.

Thickets, Sicamous, Shuswap Lake, B.C., and Ainsworth, Kootanie Lake, B.C. (*John Macoun.*) Not before recorded from interior of British Columbia.

ONOPORDON ACANTHIUM, L.

Waste grounds, Nanaimo, Vancouver Island, 1887. (*John Macoun.*) Not before recorded west of Ontario.

CENTAUREA CYANUS, L.

Waste places, Kootanie Lake, B.C. (*Dr. G. M. Dawson.*) Goldstream, Vancouver Island. (*John Macoun.*) Not before recorded west of Ontario.

CALENDULA ARVENSIS, L.

On ballast, St. John, N.B. (*G. U. Hay.*) New to Canada.

ECHINOPS GLOBIFER, Janka.

Escaped from cultivation and well established at Beeton, Ont. (*J. M. Dickson.*)

LAMPSANA COMMUNIS, L.

North Saanich, Vancouver Island. (*J. R. Anderson.*) Roadsides, Comox and Victoria, Vancouver Island. (*John Macoun.*) Not before recorded from Vancouver Island.

CREPIS OCCIDENTALIS, Nutt. var. GLANDULOSA, Torr.; Macoun, Cat. Can. Plants, Vol, I., p. 556.

Prairies, Farewell Creek, Cypress Hills, Assa. (*John Macoun.* Herb. No. 11709.) Eastern limit.

Hieracium gracile, Hook.

Mount Mark, Vancouver Island. Alt. 3,000 ft. (*John Macoun.*) Not before recorded from Vancouver Island. New stations for this species from interior of British Columbia are Queest Creek, Shuswap Lake, alt. 5,000 ft.; mountains north of Griffin Lake, alt. 6,000 ft.; Toad Mountain, Kootanie Lake, alt. 6,000 ft. (*J. M. Macoun.*)

Hieracium aurantiacum, L.; Macoun, Cat. Can. Plants, Vol. I., p. 557, and Vol. II., p. 336.

Since first collected at London by Mr. Dearness and near Lake Magog, Que., by Mr. Giroux in 1889, this plant has become a troublesome weed in parts of Quebec and Ontario. Our herbarium specimens are from Lake Memphremagog, Que. (*Dr. Ells.*) Mer Bleue, near Ottawa, Ont. (*Dr. Jas. Fletcher.*) Port Colborne, Ont. (*John Macoun.*)

Lactuca Canadensis, L.

Damp thickets, Sicamous, and Revelstoke, B.C. (*John Macoun.*) Not before recorded from west of prairie region. Prof. Macoun (Cat. Can. Plants, Vol. I., p. 280) says that this species is quite common in thickets in the western prairie region, but our only herbarium specimens from the prairie were collected at Morden, Man., by Prof. Macoun in 1896. *L. leucophæa,* Gray, is common throughout the prairie region.

Lactuca hirsuta, Muhl.

Alluvial soil near the Pembina River, three miles north of Killarney, Man., 1896. (*John Macoun.* Herb. No. 12346.) Not before recorded west of Ontario. Sandy woods near Ottawa and thickets west of Leamington (*John Macoun*) are new stations for Ontario.

LACTUCA LEUCOPHÆA, Gray; Macoun, Cat. Can. Plants, Vol. I, pp. 281, 559.

Additional western stations for this species are Sicamous, B.C.; Revelstoke, B.C.; Stanley Park, Vancouver, B.C., and Qualicum, Vancouver Island. (*John Macoun.*)

PRENANTHES ALATA, Gray; Macoun, Cat. Can. Plants, Vol. I., p. 283.

Shake River, Burrough Bay, Lat. 56° near Alaskan boundary. (*H. W. E. Canavan.*) Alberni Canal and Barclay Sound, Vancouver Island. (*John Macoun.*) Not rare on the west coast of Vancouver Island, collected at Muir Creek and Port San Juan. (*J. R. Anderson.*)

PRENANTHES RACEMOSA, Michx var. PINNATIFIDA, Gray.

Near Windsor, Ont. (*Wm. Scott.*) Walpole Island, Lambton Co., Ont. (*C. K. Dodge.*) New to Canada.

SONCHUS ARVENSIS, L.

In the C. P. Ry. station yard at Brandon, Man. (*John Macoun.*) Not before recorded west of Ontario.

TRAGOPOGON PORRIFOLIUS, L.

Waste places, Spence's Bridge, B.C. (*John Macoun.*) Not before recorded between Ontario and Vancouver Island.

LOBELIA DORTMANNA, L.

Shawnigan Lake, Vancouver Island. (*John Macoun.*) Not before recorded from any part of British Columbia.

VACCINIUM CANADENSE, Kalm.; Macoun, Cat. Can. Plants, Vol. I., pp. 290 and 560.

Revelstoke, B.C., and Craigellachie, B.C. (*John Macoun.*) Western limit.

VACCINIUM OVALIFOLIUM, Smith.

Revelstoke, B.C.; Ainsworth, Kootanie Lake, B.C.; Sicamous, B.C.; Comox and Mount Mark, Vancouver Island. (*John Macoun.*) Head of Bennett Lake, Lat. 61°, north of B.C. (*Dr. G. M. Dawson.*) Quesnel Lake, B.C. (*A. Bowman.*) Mount Chean, B.C. (*J. R. Anderson.*) Not before recorded in Canada west of the Selkirk Mountains, but evidently common throughout British Columbia.

ARCTOSTAPHYLOS ALPINA, Spreng.; Macoun, Cat. Can. Plants, Vol. I., p. 294.

Cross Portage, Sepawisk Lake, Nelson River, Kewatin, 1896. (*Jos. Tyrrell.*) Southern limit in Central Canada.

CHIOGENES HISPIDULA, T. & G.

Mossy woods, Sicamous, B.C. (*John Macoun.*) Western limit in Canada.

GAULTHERIA OVATIFOLIA, Gray.

In woods at Revelstoke, Columbia River, B.C. (*John Macoun.*) Eastern limit in Canada.

GAULTHERIA MYRSINITES, Hook.

Alpine summits, Ainsworth, Kootanie Lake, B.C., and north of Griffin Lake, B.C. (*John Macoun.*) Western limit in Canada.

LEDUM GLANDULOSUM, Nutt.; Macoun, Cat. Can. Plants, Vol. I., p. 562 and Vol. II.,p. 339.

Additional stations for this species are Mount Aylmer, Devil's Lake, Rocky Mountains, alt. 6,000 ft., 1891. (*John Macoun.*) Mountains west of Okanagan Lake, B.C. (*Jas. McEvoy.*) Mr. McEvoy reports this to be common at between 5,000 and 6,000 ft. altitude on most of the mountains between Nicola River and Lake Okanagan, B.C. In the Rocky Mountains it seems confined to the vicinity of the Bow River.

RHODODENDRON ALBIFLORUM, Hook.

Additional stations for this species are Queest Creek, Shuswap Lake, B.C., alt. 5,000 ft.; mountains north of Griffin Lake, B.C., alt. 5,000 ft.; mountain woods, Ainsworth, Kootanie Lake, B.C. (*Jas. M. Macoun.*) Mountains south of Tulameen River, B.C., alt. 5,000 ft. (*Dr. G. M. Dawson.*) Alpine woods, Mount Arrowsmith, Vancouver Island. (*John Macoun.*) Not before recorded from Vancouver Island.

MONOTROPA UNIFLORA, L.; Macoun, Cat. Can. Plants, Vol. I., p. 307.

Not recorded by Prof. Macoun west of Lake of the Woods. Norway House, Lake Winnipeg. (*Dr. Richardson.*) Great Slave River. (*Miss E. Taylor.*) Sicamous, B.C.; between Qualicum and Alberni, Vancouver Island. (*John Macoun.*)

PTEROSPORA ANDROMEDA, Nutt.; Macoun, Cat. Can. Plants, Vol. I., p. 307.

Not recorded by Prof. Macoun, east of Quebec or west of the Saskatchewan. Pine woods, Prospect Creek, Prince Edward Island; Nanaimo, Vancouver Island. (*John Macoun.*) Mountains west of Lake Okanagan, B.C. (*Jas. McEvoy.*)

TRIENTALIS AMERICANA, Pursh.

In thickets north of Prince Albert, Sask. (*John Macoun.*) Black River, east of Lake Athabasca. (*J. W. Tyrrell.*) Northern and western limits in Canada.

DOUGLASIA ARCTICA, Hook.

A few specimens of this beautiful little plant were collected along the coast between the mouth of the Mackenzie River and Herschel Island by Rev. J. D. Stringer, May 25th, 1893. It has not been found since collected by Dr. Richardson to the east of the Mackenzie River. Herb. No. 14298.

ANAGALLIS ARVENSIS, L.

In waste places and on ballast heaps, Nanaimo, Vancouver Island. (*John Macoun.*) Not before recorded west of Ontario.

FRAXINUS VIRIDIS, Michx.

South of Moose Jaw, Assa., 1896, and Old Wives Lakes, Assa., 1895. (*John Macoun.*) Western limit in Canada.

VINCETOXICUM NIGRUM, Mœnch.

In cultivated grounds, Victoria, Vancouver Island, 1888. Adventitious. (*Dr. Jas. Fletcher.*) Only Canadian record.

GENTIANA ANDREWSII, Griseb.

Rich moist ground, Selkirk, Man. (*Jas. M. Macoun.*) Griswold, Man. (*Rev. W. A. Burman.*) Western limit in Canada.

PHLOX HOOKERI, Dougl.

Gilia pungens, var. *Hookeri,* Gray, Syn. Fl., p. 141.

Kettle River, east of Okanagan Lake, B.C. (*J. R. Anderson.*) New to Canada. First found by Douglas on Okanagan River a little south of the international boundary.

COLLOMIA GRANDIFLORA, Dougl.

Dry, rocky banks, Botanie Creek, near Lytton, B.C. (*Jas. McEvoy.*) Eastern limit in Canada.

GILIA LINIFLORA, Benth. var. PHARMACEOIDES, Gr.

Depressions on the prairie, Police Point, Medicine Hat, Assa., and near Cypress Lake, Assa. Herb. No. 5546. (*John Macoun.*) Not before recorded east of British Columbia.

PHACELIA TANACETIFOLIA, Benth.

A weed on the Experimental Farm, Brandon, Man., 1896. (*John Macoun.*) New to Canada.

CYNOGLOSSUM OFFICINALE, L.

Along an old road near the railway bridge, Brandon, Man., 1896. (*John Macoun.*) Not before recorded west of Ontario.

PHYSALIS PHILADELPHICA, Lam.

In a ravine, S.W. of Komoka, Ont. (*J. Dearness.*) New to Canada.

PHYSALIS VIRGINIANA, Mill. var. AMBIGUA, Gray ; Macoun, Cat. Can. Plants, Vol. I., p. 350.

Sandy hillside, shore of Lake Huron, Sept., 1891. (*J. Dearness.*) Not before recorded from Ontario, though some of the references under *P. Virginiana*, Macoun, Cat. Can. Plants, Vol. I. p. 350, are probably this variety.

GRATIOLA VIRGINIANA, L. ; Macoun, Cat. Can. Plants, p. 359.

Comox, Vancouver Island, 1893. (*John Macoun.* Herb. No. 706.) Distributed as *G. ebracteata.* Credited by Gray to British Columbia, but not before found by Canadian collectors.

MARTYNIA PROBOSCIDEA, Glox.

Niagara Falls, Ont., 1892. (*R. Cameron.*) Hamilton, Ont. (*J. M. Dickson.*) Not known to occur elsewhere in Canada.

PHRYMA LEPTOSTACHYA, L.

Damp thickets by a brook at Morden, Man. (*John Macoun.* Herb. No. 12431.) Not recorded west of Ontario.

TEUCRIUM CANADENSE, L.; Macoun, Cat. Can. Plants, Vol. I., p. 380 in part, and Vol. II., p. 349.

Apparently much rarer than *T. occidentale* even in Ontario. Our herbarium specimens are from Pt. Pelee, Essex Co., Ont. (*Dr. Burgess.*) Brampton, Ont. (*Jas. White.*) In thickets by the Assiniboine River at Brandon, Man. (*John Macoun.* Herb. No. 12416.) Not before recorded west of Ontario.

TEUCRIUM OCCIDENTALE, Gray; Macoun, Cat. Can. Plants, Vol. I., p. 574 and Vol. II., p. 349.

Our herbarium specimens are from Ottawa, Ont.; Belleville, Ont.; Bird's Hill, near Winnipeg, Man. Herb. No. 12288; Cypress Lake, Cypress Hills, Assa. Herb. No. 12890; Kamloops, B.C. (*John Macoun.*) London, Ont. (*Dr. Burgess.*) Burlington Beach, Hamilton, Ont. (*J. M. Dickson.*) Not before recorded from the prairie region.

ABRONIA MICRANTHA, Choiss.

Abundant in dry sand at the crossing of Many Berries Creek, north of Milk River, Assa., July 9th, 1895. (*John Macoun.* Herb. No. 12902.) New to Canada.

ANYCHIA DICHOTOMA, Mx.; Macoun, Cat. Can. Plants, Vol. I., p. 396.

Near Leamington, Ont., 1890. (*J. Dearness.*) Sandy fields near Leamington, Ont., 1892. (*John Macoun.*) Only once before collected in Canada.

AXYRIS AMARANTOIDES, L.: Macoun, Cat. Can. Plants, Vol. II., p. 352.

First collected in 1886, in Manitoba, by Dr. Fletcher, now common along the line of the Can. Pac. Ry. west to Medicine Hat, Assa., and in cultivated fields and waste places throughout Manitoba. Our herbarium specimens are from Winnipeg and Brandon, Man.; Indian Head, Moose Jaw and Medicine Hat, Assa.

ERIGONUM UMBELLATUM, Torr.; Macoun, Cat. Can. Plants, Vol. I., p. 406.

Additional stations for this species are Milk River Ridge, Alta.; Vermillion Mountain near Banff, Rocky Mountains; Lake Louise, Rocky Mountains; Sproat, Columbia River, B.C. (*John Macoun.*) Big Horn Mountains, west of Lake Okanagan, B.C. (*Jas. McEvoy.*) Not before recorded east of Rocky Mountains.

ERIGONUM HERACLOIDES, Michx.

Deer Park, Lower Arrow Lake, B.C. (*John Macoun.*) Eastern limit in Canada.

ERIGONUM OVALIFOLIUM, Nutt.; Macoun, Cat. Can. Plants, Vol. I., p. 407.

Big Horn Mountains, west of Okanagan Lake, B.C. (*Jas. McEvoy.*) Along Waterton Lake and on Sheep Mountain, South Kootanie Pass, Rocky Mountains. (*John Macoun.* Herb. No. 12948.)

ERIGONUM MULTICEPS, Nees; Macoun, Cat. Can. Plants, Vol. I., p. 407.

Wood Mountain, Assa. Herb. No. 12949; dry rocks along Waterton Lake, South Kootanie Pass, Rocky Mountains, 1895. (*John Macoun.*) Eastern limit in Canada.

ERIGONUM NIVEUM, Dougl.

Dry ground, Lake Okanagan, B.C., Sept. 15th, 1890. (*Dr. G. M. Dawson.*) New to Canada.

ERIGONUM CERNUUM, Nutt.

Sand hills at the crossing of Many Berries Creek near Milk River, Assa. Herb. No. 12947; on the banks of the South Saskatchewan at Police Point, Medicine Hat, Assa. Herb. No. 12946. (*John Macoun.*) New to Canada.

POLYGONUM BISTORTOIDES, Pursh.

On the summit of Sheep Mountain, Waterton Lake, Rocky Mountains, alt. 7,500 ft., July 31st, 1895. Herb. No. 12989. (*John Macoun.*) New to Canada. Arctic American specimens referred to *P. Bistorta* seem to be intermediate between that species and *P. bistortoides.*

SASSAFRAS OFFICINALE, Nees.

Near Sarnia, Lambton Co., Ont. (*C. K. Dodge.*) Northwestern limit in Ontario.

QUERCUS ALBA, L.

Elevated shore of Rainy Lake, Ont., 1896. (*W. McInnes.*) Western limit in Canada.

CYPRIPEDIUM ACAULE, Ait.; Macoun, Cat. Can. Plants, Vol. II., p. 22.

Dry hillock of sand and boulders. Lat. 57° 30′, Long. 107°. (*Jas. W. Tyrell.*)

UVULARIA PERFOLIATA, L.; Macoun, Cat. Can. Plants, Vol. II., p. 44.

Near Niagara, Ont., 1890. (*J. Dearness.*) Jordan Station, near Niagara, Ont., 1892. (*John Macoun.*) Very rare and not collected for many years.

ALETRIS FARINOSA, L.; Macoun, Cat. Can. Plants, Vol. II., p. 23.

Common at Sandwich, Ont. (*John Macoun.*) Near Sarnia, Lambton Co., Ont. (*C. K. Dodge. J. Dearness.*) Only recorded before from Leamington, Ont.

ERYTHRONIUM ALBIDUM, Nutt.; Macoun, Cat. Can. Plants, Vol. II., p. 41.

Stag Island in St. Clair River, 5 miles below Sarnia, Ont. (*C. K. Dodge.*) North-western limit.

SCIRPUS CAMPESTRIS, Britton.

S. maritimus, Macoun, Cat. Can., Vol. II., p. 100 in part.

Common throughout the prairie region. Our herbarium specimens are from Red River, Man. (*Douglas.*) File Hills, Assa.; Thunder Creek, Moose Jaw, Assa.; Park Beg, Assa. Herb. No. 16411; Milk River, Alberta. Herb. No. 16412. (*John Macoun.*)

SCIRPUS SMITHII, A. Gray.

In wet sand, Toronto Island, Ont., 1886. (*Wm. Scott.*) New to Canada.

SCIRPUS DEBILIS, Pursh.

Muddy places, Queenston Heights, Ont., 1896. (*Wm. Scott.*) New to Canada.

FIRMBRISTYLIS CASTANEA (Michx.), Vahl.

Walpole Island, Lambton Co., Ont., 1894. (*C. K. Dodge.*) New to Canada.

ELEOCHARIS MUTATA (L.), R. & G.

E. quadrangulata, R. & S.

Sarnia Bay, near Sarnia, Ont., 1896. (*C. K. Dodge.*) New to Canada.

Description of a New Genus and Species of Cystideans from the Trenton limestone at Ottawa.[1]

By J. F. Whiteaves.

Astrocystites Ottawaensis.

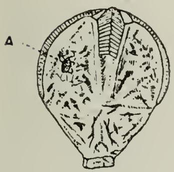


Fig. 1.

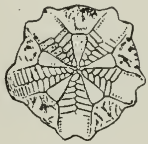


Fig. 2.

Fig. 3.

Figs. 1–3. *Astrocystites Ottawaensis.* Fig. 1. Side view of a nearly perfect specimen, shewing the small plates surrounding and perhaps covering the anus, on the left side of one of the ambulacral areas, at A, and the peculiar sculpture of part of the calyx, natural size. Fig. 2. Summit view of the same specimen, also of the natural size. Fig. 3. Radial plate on the left of the anal region of another specimen, twice the natural size, to shew the peculiar shape and sculpture of this plate, also the overlap by the distal portion of one of the ambulacral areas above, and the modification of the upper margin of the plate on the anal side : A—relative position of the anus.

Body or "crown" of the organism globose, almost spherical but narrowing rapidly below into a very short, slender column or stem, and somewhat five-sided as seen from above.

Calyx or dorsal cup broadly conical and entire below the midheight, but divided above into five large, pointed and slightly incurved, sepaloid lobes, with rather oblique and slightly convex sides, by the decurrent portions of the ambulacral areas. The greater part of one of these lobes, as seen at A, in Fig. 1, is occupied with a cluster of minute plates, which surround and either partially or wholly cover the anal opening.

[1] Communicated by permission of the Director of the Geological Survey.

Surface of the calyx marked by small, short, branching grooves, which radiate from the centre and anastomose at the margins of large plates of irregular shape. The exact outlines of some of these plates are not clearly defined in any of the three specimens that the writer has seen, but two of the latter have part of the calyx crushed in such a way as to shew parts of the margins of at least two of the radials and of one of the basals. Judging by these indications of the outlines of the plates and by the peculiar sculpture of others, the composition of the calyx would seem to be essentially as follows. In the undivided and lower moiety of the divided portion there appears to be a circlet of large, subpentagonal and presumably basal plates, immediately above the column. On the surface of these plates the branching grooves radiate upward and outward, but not backward, and, consequently, only the front and part of the lateral margins of each of these plates is minutely sinuated. Next to these supposed basal plates and alternating with them there is a circlet of five large radials. These radials are irregular in outline, but their margins are minutely sinuated all round, except in the middle of the summit, where each of these plates is overlapped by the distal portion of the ambulacral area, as shewn in Fig. 3. On each side of the anal region the upper and inner portions of the margin of each of the two radials that partially bound it, are slightly modified, as also shown by Fig. 3, in which A represents the relative position of the middle of the anal region. In the upper and lobate portion of the calyx there appears to be a comparatively small and presumably interradial plate, whose outline it is not yet possible to define precisely, in or near the middle of each of four of the lobes, the corresponding part of the fifth lobe being occupied by the group of small plates which surround and apparently cover the anus.

The summit, or entire upper surface above the calyx, is exclusively occupied with five large linear lanceolate, radiating ambulacral areas, which extend a little beyond and below the midheight and alternate, at and near the centre, with five small narrowly elongated, subtriangular, almost bottle-shaped plates. The ambulacral areas consist of well defined grooves, which are partially and perhaps in perfect specimens were wholly roofed over with two rows of small, transversely elongated and alternately arranged covering plates, from the centre of the summit, where they interlock and probably cover the presumably subtegminal mouth. In the only specimens known to the writer these plates roof over the ambulacral grooves, from the middle of the summit, for distances varying from one-half to fully two-thirds of the entire length of each groove, but always, at least, as far outward as to the bases of the small alternating subtriangular plates. On some of the ambulacral grooves only eight covering plates can be counted on each side, in a longitudinal direction, but on others there are as many as fourteen on each side. In the latter case the circumstance that several of the outermost covering plates are crushed down into the ambulacral grooves leads to the inference that the grooves may have been almost or completely roofed over in perfect specimens. A central area at the summit, in which the ambulacral areas or covered inner ends of the ambulacral grooves are everywhere in close contact with the small alternating subtriangular plates, is bounded by the bases of the latter. Outside of this area the ambulacral areas suddenly become more widely divergent, and their grooves are bordered on each side by a prominent raised rim. At the outer end of each of the ambulacral areas, where the covering plates have been removed or are absent, there is a longitudinal row of marginal pores on the inner surface of the raised rim which bounds the groove on both sides, as shewn in

Fig. 3, and the whole of the outer declivity or downward slope of the rim is transversely corrugated or ribbed.

When examined with a lens, the whole surface of the calyx, of the covering plates of the ambulacral grooves and of the small subtriangular plates which alternate with the inner ends of the ambulacral areas at the summit, is seen to be densely pitted or perhaps perforated.

Two specimens of this species, both collected by Mr. John Stewart in 1886 from the Trenton limestone at Division street, Ottawa, are in the Museum of the Geological Survey of Canada, and an imperfect specimen from the same locality has been kindly lent to the writer by Mr. Walter R. Billings. All three of these specimens, when found, were almost completely covered with a very tenacious shaly limestone, and although they have been both carefully and skilfully cleaned, it is just possible that some of the covering plates of the ambulacral grooves may have been accidentally removed in the cleaning. At present, also, it is not possible to ascertain from either, whether the dense pitting of so large a portion of their surface is caused by "conjugate" pores or not. It is only proper to add that the general outlines of the plates of which the calyx is composed in this species, were first suggested to the writer by Mr. W. R. Billings, who, as is well known, has devoted much time to the study of the crinoids and cystideans of the Trenton limestone of the Ottawa valley.

Astrocystites would seem to be most nearly related to *Asteroblastus*, Eichwald, and is probably referable to the same family, though it clearly differs from that genus in several important particulars. Thus, a comparison of the plates of which the calyx is composed in these two genera shews that, although they have much the same shape and style of sculpture, yet those of *Asteroblastus* are both small and very numerous, while those of *Astrocystites* are large and comparatively few in number. The anal region of *Astrocystites*, too, is lateral and well defined, but no indications of any such region have yet been observed in *Asteroblastus*. The summit, also, is very differently constructed in these two genera. In *Asteroblastus* there is a central oral aperture, immediately surrounded by five apical plates, and the ambulacral areas, which are comparatively broad and short, do not reach to the centre. No traces of the oral aperture are visible anywhere on the summit of *Astrocystites*, the mouth in that genus being apparently subtegminal, and the ambulacral areas, which are long and narrow, extend to the centre, where their covering plates interlock.

The ambulacral areas of *Astrocystites* are somewhat like those of *Blastoidocrinus*, but, in the latter genus (which is still known only from the few fragments collected by E. Billings from the Chazy limestone of the Island of Montreal and its immediate vicinity, and from the imperfect specimens from the "Orthoceratitenkalk" of Pulkowa, Russia, described and figured by Friedrich Schmidt) the spaces between them are completely filled with the large deltoids, which, according to E. Billings, "extend the whole length of the pseudambulacra."

There are, also, apparently, some points of resemblance between *Astrocystites* and *Cystoblastus*, Volborth, but in Zittel's description of the latter genus, which is the only one that the writer has access to, there are said to be two pectinated rhombs in the calyx, whereas no traces of such structures have been observed in the dorsal cup of *Astrocystites*.

In 1874[1] Schmidt expressed the opinion that *Blastoidocrinus*, *Asteroblastus*, *Mesites* and *Cystoblastus* are all cystidea which may be regarded as intermediate in their characters between that class and the blastoids, and it

[1] "Memoirés de l'Académie Impériale des Sciences de St.-Pétersbourg, VIIe Série, tome XXI., p. 25."

is quite clear that these are the genera to which *Astrocystites* is most closely allied, "Blastoids," writes Dr. Charles Eastman, in the first volume of his translation of Zittel's Text-book of Palæontology, published in 1896, "have not been recognized, as such, up to the present time, in strata lower than the Silurian ; but it is possible that several genera occurring in the Ordovician of North America and Russia (*Blastoidocrinus, Asteroblastus,* etc.), which are now referred to the Cystids, may eventually be transferred to the Blastoidea." In that event, *Astrocystites* would, of course, have to be included in the same category. On the other hand, Etheridge & Carpenter, on page 129 of their "Catalogue of the Blastoidea in the Geological Department of the British Museum," published in 1886, say distinctly, "we have no certain evidence of the existence of true Blastoidea anterior to the Upper Silurian period. For we much doubt, as we have explained in the previous chapter, whether the problematical *Blastoidocrinus* from the Lower Silurian of Canada and Russia can properly be referred to this group." Nicholson & Lyddeker, in the first volume of their "Manual of Palæontology," published in 1889, follow Johannes Muller's classification of the Cystoidea, and divide the class "into the three orders of the Aporitidæ Diploporitidæ and Rhombiferi, according as the calycine plates are imperforate, are pierced by yoked pairs of pores indiscriminately distributed, or have their pores arranged in pore-rhombs." Of these three orders, *Astrocystites* would seem to be most probably referable to the Diploporitidæ. In conclusion, the writer begs to tender his cordial thanks to his friend and colleague, Mr. L. M. Lambe, F.G.S., for the accurate and original drawings which are reproduced in this paper.

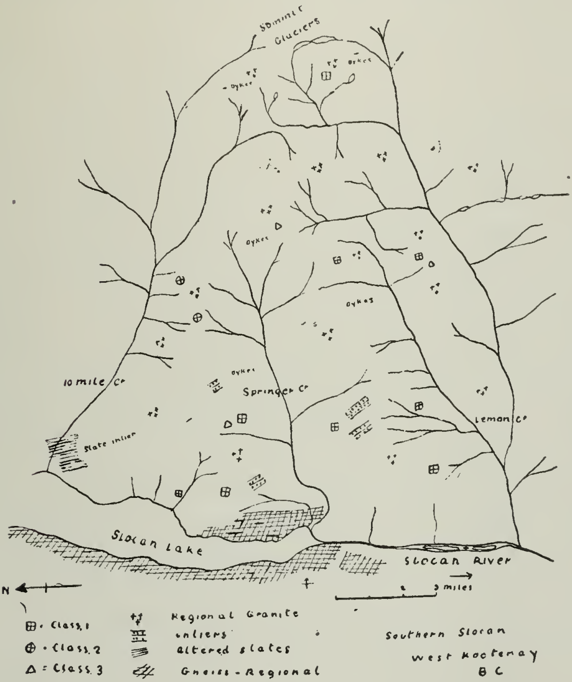
Ottawa, April 28th, 1897.

Some Ores and Rocks of Southern Slocan Division, West Kootenay, British Columbia.

By J. C. Gwillim, B.A.Sc., and W. S. Johnson, B.A.Sc.,
Slocan City, B.C.

The section of country taken up by this paper is a part of the Slocan Mining Division of West Kootenay, British Columbia.

As may be seen from the accompanying sketch map, this particular area lies in the drainage basins of Ten



Mile, Springer and Lemon Creeks, west of the divide between Kootenay Lake and Slocan Lake and River.

This area, therefore, lies immediately south of the rich silver-lead district of the Slocan proper, and it is, in itself, a richly mineralized district. In the study of the characteristic rocks of this district the writers were much aided by the kindness of Dr. F. D. Adams, of McGill University, to whom they are indebted for the microscopical examination of a number of rock sections and as well as for suggestions upon the nature and origin of various specimens sent to him.

The country rock of this district is a granite. It is bounded to the north, some six miles above Ten Mile Creek, by the Slocan Slates of McConnell, in which occur the rich silver-lead mines now being so extensively and profitably worked.

To the west there is a contact with a great region of gneissoid rocks and dark schists, which, for the most part, lie west of the great trough formed by Slocan Lake and Slocan River, but which also cross over to the east side of the Lake at a point somewhat south of Twelve Mile Creek, and continue along the east shore, at least, until Springer Creek is reached, and probably occur along the lower slopes of the mountains further south. To the south and east the characteristic granite continues towards Kootenay Lake and the western arm of Kootenay Lake.

The contact of the gneissoid rocks with the mineral-bearing granites to the east of it is not well defined, excepting the fact that the block of gneiss and schists which lies east of the Lake forms a low bench, and the hills which rise above this bench are of a different nature and are *well mineralized*, which cannot be said of any portion of the gneisses so far prospected.

Between the gneiss and the granite proper, however, there usually intervenes a wide band of a highly silicious somewhat cleavable rock, which may possibly be a felsite. This band is mineralized, but is considerably broken.

With the exception of a few isolated patches of a highly silicious metamorphic rock of a dark color, the district under consideration is composed of a granite having the following characters.

This granite is of a dark grey color and is composed of quartz, feldspars, biotite and hornblende, with a good deal of accessory sphene.

Its striking visible feature, however, is the occurrence in it of large crystals of impure orthoclase, giving it a porphyritic appearance. These crystals are usually a half to one inch long, and are commonly twinned parallel to the orthopinacoid. Small scales of biotite are scattered through the crystals, and the analysis, as here given, shows a good deal of lime and soda for an orthoclase.

SiO_2	59·86
$Al_2 + Fe_2O_3$	20·26
K_2O	12·39
Na_2O	5·76
CaO	2·90
MgO	0·78
Total	101·95

The lime is probably present as calcium carbonate.

An analysis of the granite gave :—

SiO_2	60·09
Al_2O_3	17·20
Fe_2O_3	6·73
CaO	8·24
Na_2O	2·45
K_2O	6·23
MgO	·47
Total	101·41

A microscopical examination of a specimen of this granite, taken from within a few feet of a quartz vein, was made by Dr. Adams. It was found to be a crushed biotite granite containing a good deal of plagioclase. The quartz and feldspar show marked indications of great pressure. Much biotite, partially altered to chlorite is present and is associated with epidote, perhaps also an alteration product, having, however, in one case a core of allanite.

This specimen was considerably decomposed, being from near a vein and also near the surface. Two other specimens, one of them from a granite horse in a quartz vein, and the other from a cross-cut tunnel several miles distant, showed much the same characteristics, especially in the evidence of great crushing. The hand specimens do not show this crushing to any great extent, though the feldspar crystals are not very regular in outline at times. In this granite, which by the way, differs a good deal from the intrusive granites which break through the Slocan Slate series, near Three Forks, to the north, there are several distinct classes of mineral-bearing veins. These classes of veins differ both in origin and in the nature of the material filling them, but all occur in this typical porphyritic granite.

Class I. The most common and the most characteristic consists of irregular veins of coarsely crystallized opaque quartz. They vary quite rapidly in width, both laterally and in depth; their usual width is under four feet; their dip is very low, being from 10° to 50° from the horizon. No one of these veins has yet been explored to a greater depth than 100 feet. Hence all observations are confined to little more than surface showings.

Where shafts have been sunk a good deal of displacement is revealed along slickensided planes, more or less parallel to the strike of the vein, *i.c.*, usually parallel to the hill-slope wherever it may be.

The displacements are seldom more than a few feet, and the plane of faulting carries a good deal of gouge or selvage matter. Where the vein ends abruptly it is commonly found again by following the rule of normal faulting. The broken off, or rather the abrupt endings of the quartz veins, have a smooth and rounded appearance, which is hardly warranted by the slight throw, and, moreover, the vein when found again does not always correspond in thickness to where last seen.

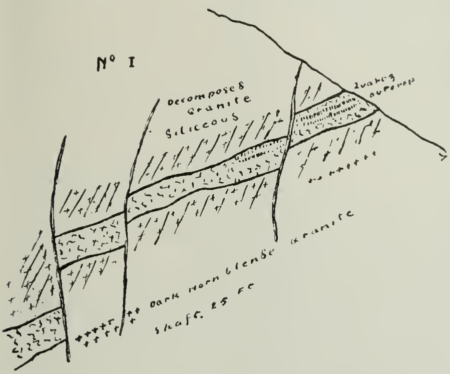
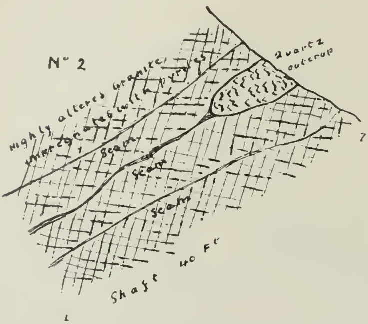


Figure 1 illustrates this faulting. It represents an actual section, as seen in a prospect shaft. A curious feature of these veins is the general tendency to pitch in towards the centre of any given mountain, ridge or range from all sides of that mountain. Possibly this may be only a result of easier discovery of veins so situated, and there may be other ones dipping outwards with the mountain slopes, as, indeed, they do in a few cases.

There is no general direction for these veins, this being a distinction from the silver lead veins, immediately north of this district, which have some tendency toward a north-easterly strike. Generally speaking, the veins are free from the granite walls and have more or less selvage matter along these walls, but it is not uncommon to find the decomposed granite and quartz firmly "frozen" or cemented together even on walls which, in other places, are quite free along the vein.

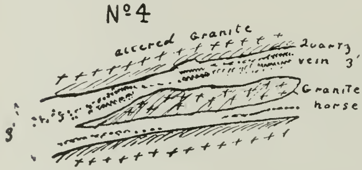
Figure 2 illustrates the sudden pinching out of a quartz vein. The quartz, which carries a high value in gold, suddenly rounds off like a boulder, and only a seam of selvage matter is left, whilst on either side of the seam the granite has been decomposed to a soft greenish silicious matter, which is impregnated with large crystals of pyrite. In all faulting and sudden ceasing of the ore bodies there is little evidence of dragging aside of the vein matter or other indication of which way the continuation may be found.



Aside from displacements and rapid variations in width, these quartz veins show great persistence both in reappearance and in mineralization.

The mineralization of these veins is sporadic, or chute-like, with a tendency to banding where the ore body is of regular width. Usually the enlargements give rise to a more cellular and comb-like structure, and in such places the richest minerals are found.

N° 4



Horses, such as shown in Figure 4, are common. The one figured shows marked evidence of great crushing, probably anterior to the forming of the vein matter. An analysis of this horse gave :—

SiO_2	71·70
Al_2O_3	18·25
Fe_2O_3	3·18
MgO	2·12
CaO	3·36
Total	98·61

The alkalies were not determined, but are evidently much lower than the normal granite.

The precious metals, gold and silver, are found in such veins in a native state. The silver in leaf form along cleavage lines, the gold in coarse particles, sometimes crystallized; also as a natural alloy of gold and silver where the gold and silver are nearly equal in per cent., and associated with the loose granular iron pyrites occurring in these veins. This pyrites often occupies little cells in the apparently massive quartz; when the quartz is broken the pyrites falls out, leaving a clean little cell, with often some black powder, which is probably argentite.

The pyrites contains ½ oz. of gold and 200 oz. of silver, to 2 oz. of gold and 50 oz. of silver. They sometimes present a more massive or crystallized form, being still rich in silver. The locality seems to determine their richness.

The chief mineral distinctive of these veins, however, is argentite, either as a coarse aggregation of crystals, at times weighing over a gramme, which fill interstices in the quartz or as a very finely disseminated powder, which gives the quartz a bluish black appearance. The coarsely crystalline variety is more common where the powdery form is absent. The crystals appear often to fill in the spaces between well developed crystals of quartz.

A good deal of iron oxide, rich in free gold and argentite, occupies the central combed cavities of some of the veins, also iron oxide, as limonite and haematite fills up some of the interstices and cells, appearing thus to be crystallized.

Referring to the map, it will be seen that the veins of Class I. occupy a small area between Twelve Mile and Springer Creeks, nearly all the country between the Springer Creek and first north branches of Lemon Creek, and also in some very typical cases they are found south of these branches.

As one goes to the south, the gold and silver ratios of value change from about 1 to 10 to equality along the north branch of Lemon Creek, and finally further south the gold value becomes the greater.

Although the argentite, as far as known, carries little or no gold, there appears to be a direct ratio between the value of gold and silver in any one vein, or part of it. In the area defined as belonging peculiarly to this class of ores, there are few veins of any other character, save some doubtful replacement zones of low grade galena, and some quartz veins which carry mixed crystallized pyrites and galena; in these the gold and silver values are low, yet they are in the heart of the richer ore bodies.

Class II., of ore bodies, is not largely represented as yet, but it is a very distinct one, and consists of narrow veins dipping at high angles to the horizon. The ore body is mixed quartz and secondary limestone. The ore itself is galena and a very dark zinc blende, both rich in silver, and almost devoid of gold. This ore is singularly well collected along the walls of the vein, the outside slickensided portions of which consist often of the fine grained galena, called steel galena, the inner portions being a coarser galena and dark blende. Usually in this district the zinc blende is low grade in silver; here it is not so.

This class of veins has not been seen in immediate association with those of Class I. It is more distinctive of the Ten Mile slopes. The country rock is the same to all appearances.

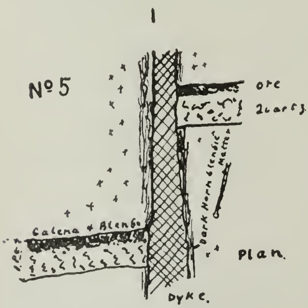


Figure 5 represents one of these veins, also the interference of the vein by a narrow dyke of a soft, soapy and grey matter, probably a micaceous trap. A very dark hornblendic biotite granite occurs in patches along this dyke also.

Class III. Some veins of this class are remarkable for their richness in silver. Though in nature and structure they appear quite common, the veins of this class show evidence of a replacement of the granite country rock by ore. These veins, or ore bodies, are nearly perpendicular.

The replacement seems to have taken place along a line of decomposed granite, often along two parallel seams, which give the impression of being the walls of a vein.

The intervening granite is penetrated by ramifying stringers of quartz and patches of galena and zinc blende. In some cases the galena is exceptionally high grade in silver. When this is the case, argentite is probably present along the cleavages of the galena. At other times the galena is low grade, far below the general average of Slocan galenas, which is somewhat over 100 oz. per ton. The blende is low grade. A case of dyke interference also occurs with one of these ore bodies. This is a narrow band of rock very similar to the one described before, only of a darker color. Under the microscope it shows itself to be a much decomposed basic "mica trap" allied to the minettes.

Such dykes, together with others rich in hornblende, are common in all this district.

An assay of rock from this dyke gave 4 oz. silver to the ton. This may have been accidental, being from an exposure in a tunnel. An analysis gives :—

SiO_2	39·38
CaO	13·44
Al_2O_3	22·94
Fe_2O_3	11·33
MgO	9·93
K_2O	Not det.
Na_2O	"
Total	97·02

On passing through this dyke, which cuts the ore body at right angles, no more ore is found. It may be that the dyke appeared before the ore did, though at first sight this seems unlikely. The dyke walls are slickensided.

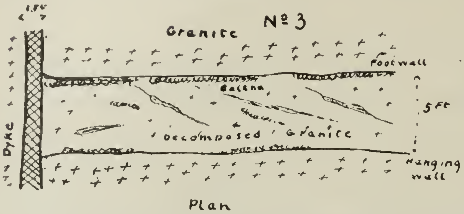


Figure 3 illustrates this occurrence.

In addition to these three main classes of ore bodies there are many modifications in filling material and in structure. These, however, are not important, with the exception of a widely represented class, which occurs along the upper waters of Lemon Creek. They are low grade, patchy galena bodies in a silicious gangue. At times these may be very rich in silver also. They have little or no gold.

Another more important class is a sugar grained quartz vein, which carries some pyrites and galena as well as a fair proportion, say, 40% of free milling gold. These ore bodies are physically like Class I. They occur south of Lemon Creek. In one place on Lemon Creek there is an occurrence of free gold and galena intimately associated, but this is rare.

Concerning the small areas of dark cleavable rock, microscopical examination goes to show that they are very finely grained, altered sedimentaries. An analysis of one gave :—

SiO_2	61·74
Al_2O_3 and Fe_2O_3	19·66
CaO	14·00
MgO	2·28
K_2O	Not det.
Na_2O	"
Total	97·68

Iron pyrites is also present.

The Gohna Landslip.[1]

By Prof. W. M. Davis, Harvard University.

A remarkable instance of foresight in averting disaster is found in an account of the Gohna landslip on a head branch of the Ganges, in the Garhwal Himalaya, and of the flood that followed on the overflow of the resulting lake, as published by the Public Works Department of the Government of India (Calcutta, 1896). The slip occurred in September, 1893, continuing three days with deafening noise, darkening the air with the dust from shattered rocks, and clogging the narrow valley with 800,000,000 tons of detritus. The fall descended about 4,000 feet, spreading about two miles along the valley and rising 850 feet above the former stream level. It resulted from the undercutting of strata that dipped into the valley, and hence should be classed with those slides that follow the erosion of narrow valleys in uplifted masses; as such, being a characteristic of vigorous young mountains.

Careful study of the ground made it clear that no artificial discharge could be made for the rising lake. As the impending flood could not be controlled, every effort was made to insure the safety of the people in the valley below by timely warning of the disaster. A telegraph line was constructed from Hardwar, on the Ganges at the edge of the plains, to Gohna, 150 miles within the mountains. In April, 1894, August 15th was set as the probable date of the flood. A number of suspension bridges were dismantled and removed. Safety pillars were set up on the valley slopes, at intervals of half a mile, and at heights of from 50 to 200 feet above the ordinary river level, thus indicating the probable limit of the flood, above which there would be no danger.

The lake back of the dam grew to be four miles

[1] Reprinted from Science for March 12th, 1897.

long and half a mile wide. At midnight of August 25th–26th, during a heavy rainfall, the flood began. In four hours the lake was reduced to two miles in length and a quarter of a mile in breadth; 10,000,000,000 cubic feet of water were discharged, cutting down the barrier 390 feet; advancing at a rate of twenty miles an hour at first, and ten miles an hour further down the valley, sweeping away many miles of valley road, completely destroying two bridges that had been left standing, because of remonstrances from local authorities against their removal, and leaving no vestige of many villages and three considerable towns; yet so fully was the danger announced that not a single life was lost.

On the Origin and Relations of the Grenville and Hastings Series in the Canadian Laurentian.

By Frank D. Adams and Alfred E. Barlow, with Remarks by R. W. Ells.[1]

As the exploration of the more remote portions of the great Canadian protaxis of the North American continent progresses, accompanied by the detailed mapping of its more accessible parts, the true character, structure and origin of the Laurentian System is being gradually unfolded. The work of Logan during the early years of the Canadian Geological Survey, though excellent in the main, is being supplemented and, in certain directions corrected; and as the work is now being pushed rapidly forward, it is believed that the time is not far distant when, difficult as the study is, we shall possess as complete a knowledge of these ancient rocks as we now do of many more recent formations. In a paper which appeared in 1893,[2] it was demonstrated that Logan's "Upper

[1] Published by permission of the Director of the Geological Survey of Canada.

[2] Adams, F. D.—Ueber das Norian oder Ober-Laurentian von Canada, Neues Jahrbuch für Mineralogie. Beilage Band viii, 1893.

Laurentian" does not exist as an independent geological series, the anorthosites, which were considered as constituting its main feature, being in reality great intrusive or batholitic masses; while in a subsequent paper,[1] it was shown that in the remaining portion of the Laurentian, two distinct classes of rocks could be distinguished, the first being beyond all doubt igneous rocks, and the second consisting of highly altered rocks of aqueous origin. In addition to these two classes of rocks of which the origin could be recognized, there was yet a third class, concerning the genesis of which there remained some doubt.

Since the appearance of these papers, the present writers have been working together in mapping a large area (about 4,800 square miles) of the Laurentian in Central Ontario, comprising map-sheet No. 118, and a portion of 119, of the Ontario series of geological maps, the district lying to the north of Lake Ontario, along the margin of the Protaxis, and being especially well suited for purposes of study. Portions of three summers have already been spent in the district, and as two years more must probably elapse before the work can be completed, it is desired here to present a general outline of the results so far obtained, indicating certain conclusions which seem likely to be reached concerning the origin of the rocks in question.

The Fundamental Gneiss, as shown by the work of the Canadian Geological Survey, occupies by far the larger portion of the protaxis as a whole; while the Grenville Series has probably its principal development along the south-eastern margin, although as the exploration of this vast area is continued, new and possibly more extensive areas of these rocks may yet be found. Strata, belonging to this series, are already known to occur on the upper Manicuagan River, the lower Hamilton River, on the

[1] Adams, F. D.—A Further Contribution to our Knowledge of the Laurentian, Am. Journal of Science, July, 1895.

Manouan Branch of the Peribonka and on the lower part of the Ungava River, in the Labrador peninsula; while similar rocks, which would seem to belong to this series, but which have not as yet been thoroughly examined, have been met with about southern Baffin's Land, and possibly about Baker Lake near the head of Chesterfield Inlet, as well as on the west coast of Hudson Bay and also at Cross Lake on the Nelson River.

The Fundamental Gneiss consists of various igneous rocks closely allied in petrographical character to granites, diorites and gabbros, and which almost invariably have a more or less distinct foliation. Where this foliation is scarcely perceptible it becomes very difficult to decide whether the rock is an intrusive granite or diorite, or a very massive form of the gneiss in question. The different varieties of gneissic rock alternate with or succeed one another across the strike, or sometimes cut one another off, suggesting a complicated intrusion of one mass through the other, but there is usually a general direction of strike to which, in any particular district, the foliation of all the varieties conform. The associated basic rocks are very dark or black in color and are usually foliated, but sometimes this foliation is absent and the rock occurs in masses of all sizes and shapes scattered through the acid gneisses, and in the great majority of cases so intimately associated with the latter that it is impossible to separate the two in mapping. The smaller of these masses can be distinctly seen to have been torn from the larger, which latter are often of enormous size. This process can be observed in all its stages. The granitic gneiss invades the great basic masses, sending off wedge-like arms into them, which tear them apart and anastomose through them in the most complicated manner. These smaller masses can then be observed to be separated into still smaller fragments, which either from the fact that they split most readily in the direction of their foliation or owing to subsequent movements, when the rock was in a more or less plastic condition, often assume long ribbon-like forms. That great movements have taken place in the whole series during or after this invasion is shown by the complicated twisting of these darker bands and masses into all manner of curious and intricate forms, as well as in the frequent rolling out of great blocks of the amphibolite, after having been penetrated in all directions by small pegmatite veins, resulting in masses of a dark basic gneissoid rock, filled with strings, bunches, separated fragments or grains of quartz or feldspar, giving to the mass a pseudo-conglomeratic appearance.

There can be but little doubt that the various gneissic rocks, constituting the more acid part of the series, are of truly igneous origin ; and there is no evidence whatever of their having ever formed part of a sedimentary series.

The true character of the more basic members is more uncertain, but they are probably closely related to the pyroxene granulites of Saxony, and doubtless represent either differentiation-products of the original magma, or basic intrusions whose structural relations and characters have been largely masked by the great movements which have taken place in the whole series at a later date.

The Grenville Series differs from the Fundamental Gneiss in that it contains certain rocks whose composition marks them as highly altered sediments. These rocks are chiefly limestones, with which are associated certain peculiar gneisses, rich in sillimanite and garnet, having a composition approaching ordinary shale or slate, or else very rich in quartz and passing into quartzite, having thus the composition of sandstone. These rocks, as has been shown in one of the papers before referred to, usually occur in close association with one another, and are quite different in composition from any igneous rocks hitherto described. They are considered as constituting the essential part of the Grenville series. They usually, however, form but a very small proportion of the rocky complex in the areas in which they occur, and which, owing to their presence, is referred to the Grenville series. They are associated with and often enclosed by much greater volumes of gneissic rocks, identical in character with the Fundamental Gneiss. The limestones are also almost invariably penetrated by masses of coarse pegmatite, and occasionally large masses of the limestone are found embedded in what would otherwise be supposed to be the Fundamental Gneiss. The whole thus presents a series of sedimentary rocks, chiefly limestones, invaded by great masses of the so-called Fundamental Gneiss, and in which, possibly, some varieties of the gneissic rocks present may owe their origin to the partial commingliug of the sedimentary material with the igneous rocks by actual fusion. There is, however, no reason to believe from the evidence at present available, that any considerable proportion of the series has originated in the last mentioned manner.

It will be readily seen that an exact delimitation of areas of the Grenville series is thus sometimes a matter of great difficulty, as they often appear to shade away into the Fundamental Gneiss, and it has hitherto been difficult in the case of the Grenville series to account for the existence of such a comparatively small proportion of sedimentary strata, intimately associated with such great volumes of igneous gneisses.

The relations of the two series, as determined by the investigations of the last two seasons, throws new light upon the subject, and indicates the probable explanation of the difficulty.

The north-western half of the more restricted area at present under consideration is underlain by Fundamental Gneiss, presenting the characters described above. A smaller area of the same gneiss occurs at the south-western corner of the area, in the townships of Lutterworth, Snowdon and Glamorgan, while in the southern and south-eastern portions of the area there are other occurrences, which, however, present a more normally granitic character.

The south-eastern portion of the area is underlain by rocks of the so-called Hastings Series, consisting chiefly of thinly-bedded limestones, dolomites, etc., cut through by great intrusions of gabbro-diorite and granite. These limestones and dolomites are usually fine-grained and bluish or greyish in color, with thin interstratified layers, holding sheaf-like bundles of hornblende crystals. As compared with the limestones of the Grenville series they are comparatively unaltered. They form beyond all doubt a true sedimentary series, and in the south-eastern corner of the area are associated with conglomerates or breccias of undoubtedly clastic origin. Between the great area of Fundamental Gneiss in the north-west, and the Hastings series in the south-east of the sheet, there lies an irregular-shaped belt of rocks, presenting the characters of the typical Grenville series as above described, the limestones having in all cases the form of coarsely crystalline, white or pinkish marbles, although more or less impure. The strike of the foliation of the Grenville series follows in a general way the boundaries of the Fundamental Gneiss, and is seen in an especially distinct manner to wrap itself around the long and narrow development of the gneiss exposed in the south-west corner of the area. Isolated masses of the limestone and gneiss characteristic of the Grenville series are also found in the form of outlying patches about its margin, as, for instance, in the townships of Lutterworth and Stanhope. The relations of the Grenville series to the Fundamental Gneiss are such as to suggest that in the former we have a sedimentary series later in date than the Fundamental Gneiss, which has sunk down into and been invaded by intrusions of the latter series when this was in a semi-molten or plastic condition. The limestones, while themselves rendered more or less plastic by the same heat which softened the lower gneisses, do not show any distinct evidence of absorption or solution by the invading rocks, unless some of the highly garnetiferous gneisses usually associated with the limestones are formed by a commingling of the two rocks. Masses of the highly crystalline limestone or marble in some cases lie quite isolated in what are, to all appearances, the lower gneisses, as if they had been separated from the parent mass, and had passed outward or downward into the gneissic magma.

The contact of the Fundamental Gneiss and the Grenville series would appear therefore to be a contact of intrusion, in very many cases at least.

The question of the relations of the Grenville series to the Hastings series then presents itself. Although repeated traverses have been made from one series into the other, no sharp line of division has been found. Towards the south-east the limestones of the Grenville series in many places, though still highly crystalline, seem to be less highly altered, and finally, as the Hastings series is approached, present in places the bluish color of the limestones of the latter series; so that it is often impossible to determine to which series they should be referred. The limestones of both series also have the numerous small interstratified gneissic inclusions or bands so frequently referred to in the descriptions of the limestones of the Grenville series, making the resemblance still more complete. In fact, although the true relations of the two series are obscured by the presence of numerous great intrusions of granitic and basic pyroxenic rocks, and can only be determined with absolute certainty by the completion of the mapping, the investigations so far indicate that in the region in question the Hastings series would seem to represent the Grenville series in a less altered form. In other words, the Hastings series, when invaded, disintegrated, fretted away and intensely metamorphosed by and mixed up with the underlying magma of the Fundamental Gneiss, constitutes what has elsewhere been termed the Grenville series. The Grenville series may, however, represent only a portion of the Hastings series, and the work so far done in this district has not been sufficient to determine the stratigraphical position of this portion.

Concerning the age of the Hastings series but little is known as yet. To the south-east of the area under consideration, however, its clastic character is well marked, breccias and conglomerates, often greatly deformed by pressure, being present as well as certain fine-grained and comparatively unaltered limestones, in which a very careful search may yet be rewarded by the discovery of fossils. Both lithologically and stratigraphically the rocks bear a striking resemblance to rocks mapped as Huronian in the region to the north and north-east of Lake Huron, and it seems very likely that the identity of the two series may eventually be established. The two areas, however, are rather widely separated geographically, so that the greatest care will have to be exercised in attempting such a correlation.

Like the Grenville series, the rocks of the Hastings series are unconformably overlain by and disappear beneath the flat-lying Cambro-Silurian rocks of the plains, which limit the protaxis on the south and are separated from it in time by an immense erosion interval. Further investigation in this area, as well as in that adjoining to the east, now being mapped by Dr. R. W. Ells, will, however, it is hoped, before long throw additional light on the age of this very interesting and important series of rocks. If further investigation proves that the relations of the several series have been correctly diagnosed, and that the explanation of these relations as given above is correct, the Laurentian system of Logan will resolve itself into an enormous area of the Fundamental Gneiss, which is essentially of igneous origin and which there is every reason to believe forms part of the downward extension of the original crust of our planet, perhaps many times remelted and certainly in many places penetrated by enormous intrusions of later date; into which Fundamental Gneiss, when in a softened condition, there have sunk portions of an overlying series, consisting chiefly of limestones.

Farther east, in that portion of the Province of Quebec where the Grenville series was first studied by Logan, the rocks of the Hastings series proper have not been recognized. The Lower Paleozoic strata rest directly upon the Grenville series and would cover up the Hastings series to the south should it extend as far east as this. The limestones of the Grenville series, moreover, here extend much farther back from the edge of the protaxis in bands and streaks conforming to the strike of the underlying gneissic rocks, so that the origin of the series and its relations to the Fundamental Gneiss is not so clearly indicated. When, however, its relations here are interpreted in the light of the Ontario occurrences, there seems to be no reason why the same explanation might not be offered to account for its origin also. The bands of limestone, which often vary in thickness from place to place, and are frequently interrupted in their course or abruptly cut off, might be considered as having taken their form from long folds in the series from which they were derived as it settled down into the magma beneath, or as having been separated by great lateral intrusions of the gneissic magma. Their original shape and character has, however, without doubt been greatly altered by the enormous movements to which both series of rocks have been subsequently subjected.

If again this proves to be the true explanation of the relations of these series, the Grenville series will cease to be an anomaly among our Archæan formations and will, so far as its mode of occurrence is concerned, bear the same relation to the Fundamental Gneiss as the Huronian does farther west in the Lake Superior and Huron district, as shown by Lawson and Barlow; the similarity in position, however, not implying identity in age.

The recognition of the Grenville series as consisting of a series of sedimentary rocks, largely limestones, invaded by igneous material which now makes up by far the greater portion of the series and consists largely of extravasations of the Fundamental Gneiss, is now pretty certainly established by the field evidence. Its recognition as a portion of the Hastings series which has been intensely metamorphosed, will probably be more clearly established as the field work progresses. Since subordinate areas of the Grenville series also occur to the south of the St. Lawrence in the Adirondack region, and are now being mapped, it will be of great interest to ascertain whether the same relations do not also exist in that area, and whether a continuation of the Hastings series to the south cannot be recognized in the "Huronian Schist" of St. Lawrence and Jefferson counties, shown upon the Geological Map of the State of New York, which has just been issued by the Geological Survey of this State.

It is perhaps unnecessary to draw attention to the fact that the recent investigations of Messrs. Wolff, Brooks, Nason, Kemp, Westgate and others on the crystalline limestones of New Jersey have a certain bearing on this subject.

Remarks by R. W. Ells:

In connection with the statements advanced in the preceding paper by Dr. Adams and Mr. Barlow, it is but right that the conclusions arrived at from the study of the similar rocks in their eastern and northern extension should be stated. The investigations in this quarter have now been carried on for six years, and have extended over a very large area to the north of the Ottawa, in which is included the typical Grenville series of Sir W. E. Logan, and extending far up the Gatineau River; while to the westward, the work has been carried on till the vicinity of the area, described in the accompanying paper, has been reached. It may be said therefore that the detailed examination of the rocks which make up the Grenville and Hastings series has extended over an area about 250 miles in length by 75 miles in breadth.

In the early days of the study of these rocks much difficulty was experienced. Firstly there was a great and almost inaccessible wilderness, the only available means of travel over the greater portion being by canoes; and in the second place there was an almost entire lack of trained observers to carry on the work. Add to this the entire absence of microscopical determinations, and one can readily comprehend the difficulty experienced in the attempt to solve this most difficult of the problems in Canadian geology.

Foliation and stratification were considered conclusive evidence of sedimentation, and as most of the rocks of the great Laurentian complex gave evidence of these forms of structure, the inference naturally followed that the greater portion of the gneissic, granitic and anorthositic rocks were of sedimentary origin. So far was this sedimentary theory carried out that, in the earlier reports of the Geological Survey, even the masses of binary granite and many of the pyroxenic rocks were included in the same category. This was at the time a very natural conclusion, since many of these masses have a regular bedded structure and conform, over very considerable areas, to the regular stratification of the rocks, either gneiss or crystalline limestone. As the country became more accessible the field investigations showed very clearly in the intrusive nature and later age of many of these masses, while the aid of the microscope fully established the non-clastic and igneous character of the great bulk of the gneisses. The more recent and probably sedimentary origin of the limestones and associated gneisses of the Grenville series, as distinct from the great mass of the underlying Laurentian Fundamental Gneiss, was pointed out some years ago in a paper by the author, read before the Geological Society of America. The subsequent investigations on these rocks, to the west and south-west, showed that the conclusions then presented were correct, but that as the work extended westward to the south side of the Ottawa the character of the various groups of rocks gradually changed. The areas of limestone became much more extensive, and there was a large development of hornblende and other dark-colored rocks, rarely seen to the north of the Ottawa. The limestones also were very often highly dolomitic, and in certain areas were blue and slaty, with but little of the aspect of the Grenville limestones, except where they were in close contact with masses of intrusive granite or diorite. There is also in the rocks of this group to the south of the Ottawa, where they have been styled the Hastings series, from the fact that they were first studied in the county of Hastings, a very considerable proportion of schists, micaceous, chloritic and hornblendic, with certain regugularly slaty beds, and others of true conglomerate containing quartz pebbles. In certain portions the lithological resemblances between the Grenville and Hastings rocks are very close, and they may, for all practical purposes, be regarded as one and the same series. From a number of sections made in the counties of Renfrew on the south of the Ottawa, and in Pontiac, to the north of that river, it would appear that the original Grenville limestones and associated grey and rusty gneiss from the lower part of the series, since it is only on their development westward towards the typical Hastings locality that the characteristic Hastings schists and associated strata are met with.

In character and general aspect these rocks of the Hastings series are almost identical with many of those which in the Eastern Townships and in New Brunswick have been regarded as probably Huronian for many years; and so marked is the resemblance that the author, in presenting his summary report for 1894, referred the rocks seen near the Bristol iron mines to that division. It now appears very conclusively established that both in the eastern and western areas we have a well developed series of rocks, including limestones, gneiss and schists, which are of undoubted sedimentary origin, but which have been enormously acted upon by great intrusive masses as well as by other dynamic agencies, so that in many parts their original characters have almost entirely disappeared.

Note on Carboniferous Entomostraca, from Nova Scotia, in the Peter Redpath Museum, Determined and Described by Prof. T. Rupert Jones, F.R.S., and Mr. Kirkby.

By Sir William Dawson, LL.D., F.R.S.

Having had occasion recently to look over some specimens of these interesting animals in the Peter Redpath Museum, it occurs to me as likely to be useful to collectors and geological workers to summarize in the *Record of Science* what is known of them as occurring in Nova Scotia.

When preparing my Acadian Geology, and especially the second edition of that work,[1] as well as later papers

[1] 1868.

supplementary to it, I took advantage of the kindness of Prof. Rupert Jones, F.R.S., the highest authority in the study of the Palæozoic Entomostraca, to place in his hands for determination the specimens which I had collected. The material thus submitted to Prof. Jones, between the years 1855 and 1884, was eventually in the latter year published in a collected form in a paper contributed by him to the *London Geological Magazine*, with a page of excellent illustrations, some of which are copied, by permission, in the present note. A little later, in 1889, Prof. Jones published in the same magazine an additional note on specimens collected by Mr. Foord, F.G.S., in the coal-formation at Mabou, Cape Breton, and which were communicated to him by Mr. Whiteaves, F.G.S., Palæontologist to the Geological Survey of Canada. These, however, added no new species to those previously known. Still later, in one of his reports to the British Association, he notices an example of *Estheria Dawsoni*, collected by Mr. Fletcher of the Geological Survey, at Five Islands.

The specimens described or noticed in the paper of 1884[1] were partly from the Horton series of the Lower Carboniferous, at Lower Horton, Horton Bluff and the Strait of Canseau, and partly from the Middle Coal-formation of Cumberland, Colchester, Pictou and Cape Breton; and in order to indicate their stratigraphical positions, it may be best to take them here in the order of time, as constituting two groups, one Lower Carboniferous (Sub-Carboniferous of Dana, Tweedian and Calciferous of Great Britain and Culm of the continent of Europe), the other belonging to the time of the Middle or Productive Coal-Measures.

Carboniferous Entomostraca from Nova Scotia, by T. Rupert Jones and James W. Kirkby, Geological Magazine, August, 1884. Some of the species had been separately mentioned or described in the same journal in 1870, 1878 and 1881.

I.—LOWER CARBONIFEROUS.

The Lower Carboniferous collections belong to the beds holding plants and fish remains which locally underlie or replace the marine limestones, and which I have called the Horton Series, from their great development and good exposure at Lower Horton and Horton Bluff, where they were examined and recognized as the equivalent of the lowest member of the Carboniferous in Scotland, by both Lyell and Logan. In specimens collected in these beds and the corresponding beds on the Strait of Canseau and in Pictou, the following species have been recognized by Prof. Jones.

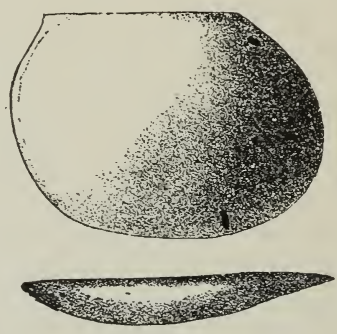


Fig. 1. Left Valve. 1*b*. Valve edgewise, x 25.

1. *Leperditia Okeni*, Munster (Fig. 1) and its variety *L. Scotoburdiegalensis* of Hibbert, a very widely distributed species and characteristic of the Lower Carboniferous in Russia, Bavaria and Scotland. In the latter it occurs abundantly in the shale and limestone of Burdiehouse, near Edinburgh, celebrated for fish remains; and in which I first saw this fossil in my student days in Edinburgh; before I had collected it in Nova Scotia. Prof. Jones remarks: "It is of especial interest to meet with so old a friend, so abundantly and with so robust a habit, for we have not seen larger examples of it in Scotland, in

Carboniferous rocks on the American side of the Atlantic." I may add that in Nova Scotia, as in Scotland, it is associated with fishes of Carboniferous genera and with Lepidodendra and Ferns of Lower Carboniferous types, the whole being, as I have shown in "Acadian Geology" and in my report on the Flora of the Lower Carboniferous in Nova Scotia,[1] a very precise equivalent of the European beds representing this interesting formation, the earliest precursor of the conditions of the Coal-Measures.

I have specimens of this Leperditia less perfectly preserved, from the Lower Carboniferous shales of the East Branch of the East River of Pictou.

Fig. 2. Right and Left Valves, x 25.

2. *Beyrichia Nova Scotica,* Jones and Kirkby (Fig. 2.) This seems to be a new species, but is very near to one found by Eichwald in Russia—*B. Colliculus,* Eichwald. This species is less plentiful in my collections than the previous one.

Fig. 3, x 25.

3. *Beyrichia* Sp. (Fig. 3.) A single small valve from Horton represented this species in the collections sub-

1 "Acadian Geology," p. 252, *et seq.* Report on Fossil Plants of Lower Carboniferous, etc., Geol. Survey of Canada, 1873.

mitted to Prof. Rupert Jones. It seems very rare, and may be merely a depauperated variety or immature state of the last mentioned.

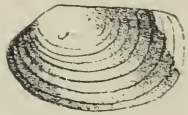


Fig. 4, x 5.

4. *Estheria Dawsoni*, Jones[1] (Fig. 4.) The specimen described by Prof. Jones is from Horton but the same species has more recently been collected by Mr. Fletcher, of the Geological Survey, at Five Islands, and was identified by Prof. Jones on being submitted to him. It has also been found in Scotland. I have either the young of this species or a similar one of smaller size from the East River of Pictou.

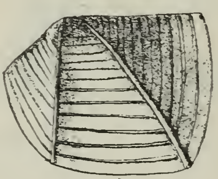


Fig. 5, x 5.

5. *Leaia Leidyi*, Jones (Lea Sp.), var. *Salteriana*, Jones (Fig. 5.) This species, unique in my collections, from the Lower Carboniferous of the Strait of Canseau, is widely distributed in the Carboniferous on both sides of the Atlantic. It was first discovered in Pennsylvania, but a second species or variety of larger size has been found in Illinois. (*L. tricarinata*, Meek & Worthen.) It seems to be rare in Nova Scotia, which is unfortunate, as it is so

[1] Geol. Mag., 1870, p. 220, Pl. IX., Fig. 15.

well marked a species, and so useful as an indicator of the Lower Carboniferous in disturbed districts.

Fig. 6, x 25.

6. *Cythere* (Species), (Fig. 6.) Valves, apparently representing two species, occur in the Horton shales, but have not been identified as yet with any known species.

II.—COAL FORMATION.

Small bivalve Entomostraca are very abundant in some carbonaceous shales and bituminous limestones at the South Joggins, Chiganois River, East River of Pictou, Glace Bay, Cape Breton, Sydney, C.B., Mabou, C.B., &c., where they seem to bave swarmed in the lagoons of the coal swamps, as Cyprids do in some modern ponds, but the species do not seem to be numerous. Those noticed in the paper in question are the following:—

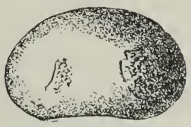


Fig. 7, x 25.

1. *Carbonia fabulina,* Jones & Kirkby (Fig. 7.) This is one of the most abundant species at all the localities, and sometimes covers the entire surfaces of layers of shale

and shaly limestone. It is also a characteristic British species.

Fig. 8, x 25.

2. *Carbonia bairdioides*, J. & K. (Fig. 8.) Less abundant than the preceding, at the Joggins and also at Mabou, where it was collected along with the preceding by Mr. Foord, but it is abundant in the Upper Coal Formation of Smelt Brook, East River, Pictou. It is also a common Scottish species.

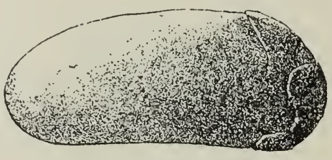


Fig. 9, x 25.

3. *Candona elongata*, J. & K. (Fig. 9.) Larger and more elongated than the preceding forms, but much less abundant. It attains the length of $\frac{1}{14}$th of an inch.

Prof. Jones has some interesting remarks on the very wide distribution of all these species in the Northern Hemisphere, in connection with the fact that they were probably shallow-water, or even brackish-water species. This indicates means of transit for such animals, by shallow areas either now oceanic or now land. It concurs with many other facts in showing that the comparative rarity of great ocean depths and high mountain ranges in the Carboniferous period had important connection with its equable climate and uniform animal and vegetable life over vast areas. Prof. Jones's discussion of this subject shows how much can be learned from the careful study of very minute and inconspicuous animal remains.

Note.—All the figures, except Nos. 4 and 5, are magnified about 25 diameters.

Our Record of Canadian Earthquakes.

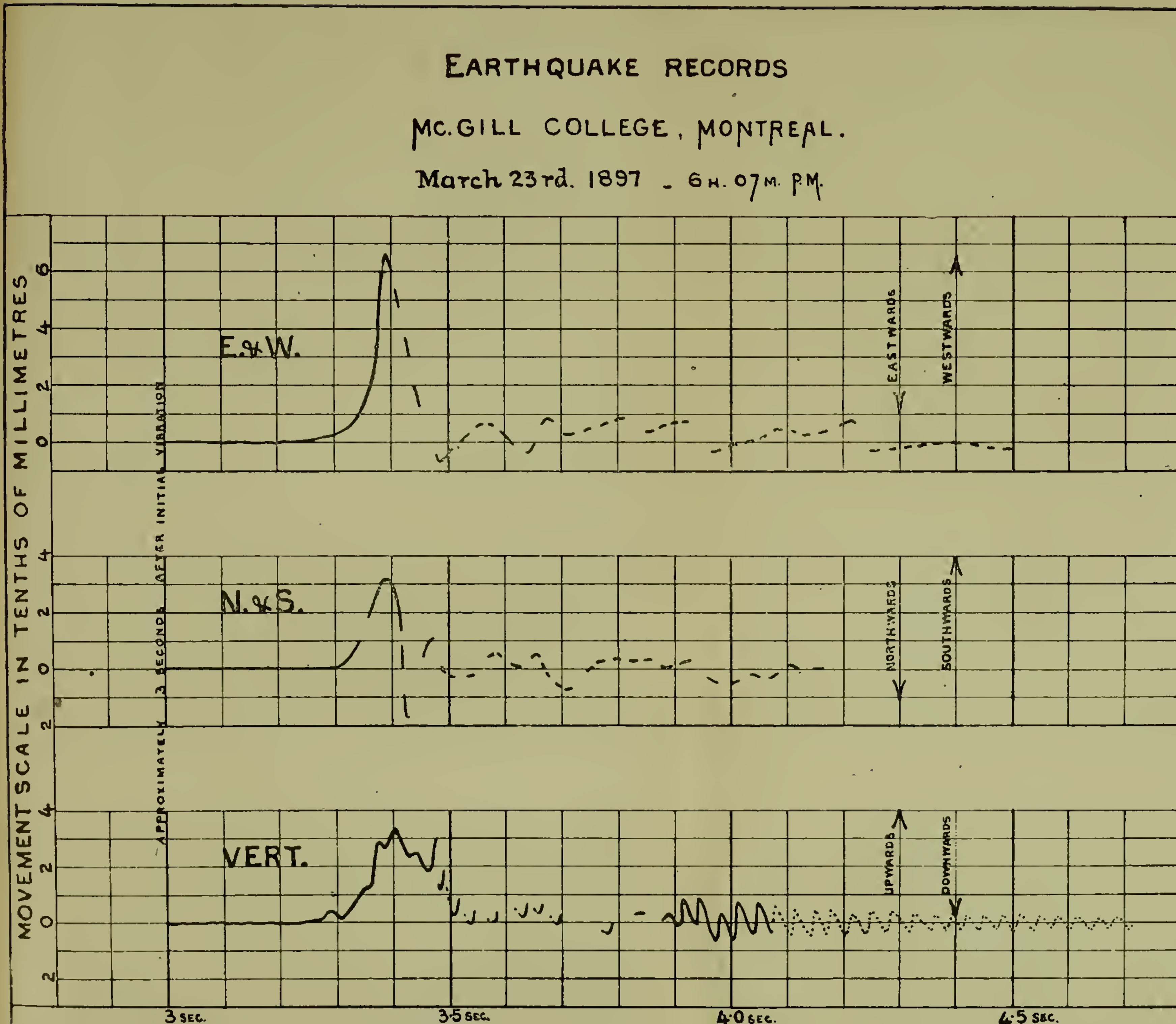
By Prof. C. H. McLeod and Prof. H. L. Callendar.

In *The Canadian Record of Science* for January, 1894, will be found a very complete account of recorded Canadian earthquakes, by Sir J. William Dawson. This record includes a slight shock felt in the neighborhood of Toronto on Feb. 23rd, 1894. The first record following that date was on August 27th, 1894, at Montreal, at 0h. 44m. a.m., a slight rumbling sound following the principal shock, which was of moderate intensity. In 1895 the following records are given :—April 17th, Richmond, Brome, St. Hyacinthe and Montreal. At Montreal the shock lasted about 10 seconds, general direction towards the south-east, and the time of its occurrence was 11h. 15m. a.m. On October 25th a shock was recorded at several points on the British Columbia coast and in Vancouver Island. On December 9th, at 0h. 25m. a.m., a shock, with a rumble lasting 18 seconds, was noted at Montreal. In 1896 portions of British Columbia (records at Esquimalt and Keeper Island), experienced shocks on Jan. 3rd, and again on Oct. 29th (record at Rivers Inlet.) In 1897 shocks have up to this date been observed on four days, all of which were in the month of March. On the 7th records were had at Pont de Mont, Thorold, St. Catharines, Lewiston and Niagara. On the 23rd a shock, which although falling short of the destructive class, was probably amongst the most severe which have visited this portion of Canada in recent years, was recorded at Montreal and throughout Quebec Province and Eastern Ontario. The disturbance covered an area measuring approximately 300 miles by 100 miles, having its major axis along the St. Lawrence Valley and the Island of Montreal at its centre. On the 25th of March a shock was recorded at Esquimalt. On the 26th Montreal and parts of Quebec and Eastern Ontario were again visited by a slight but sharply distinct earthquake. The main shock occurred at 0h. 4m. 20s., Eastern standard time, at McGill College, being preceded and followed by a distinct tremor of buildings with the usual rumbling noise. The tremor was first observed at 5 seconds before the main shock, and lasted for about 10 seconds after it. This earthquake is a somewhat exceptional one in Canadian records, as it seems to have been heralded by a slight tremor at about midnight, and to have been followed by another similar tremor at about 5 o'clock a.m.

The earthquake of March, the 23rd, is of interest locally, not only on account of its severity, but also as it was the first of which a record was obtained in Canada.

A set of Ewing Seismographs had recently been set up in the Physics Building which, although frequently deranged by the engineering operations in the vicinity, fortunately happened at the time to be in adjustment and on the look out for a chance earthquake.

The object of these instruments is to record the actual extent, direction and velocity of the movement of the ground at any time during the shock. It has been abundantly shown of the researches of Ewing and others, especially in Japan, that no adequate record can be obtained by any of the older methods, which, at best, give only the direction or amplitude of the principal movement,



EARTHQUAKE RECORDS
MC.GILL COLLEGE, MONTREAL.
March 23rd. 1897 - 6H. 07M. P.M.
MOVEMENT SCALE IN TENTHS OF MILLIMETRES
APPROXIMATELY 3 SECONDS AFTER INITIAL VIBRATION
E.&W.
EASTWARDS
WESTWARDS
N.&S.
NORTHWARDS
SOUTHWARDS
VERT.
UPWARDS
DOWNWARDS
3 SEC.
3·5 SEC.
4·0 SEC.
4·5 SEC.

and are in general quite misleading. Moreover, the destructive effect of an earthquake depends quite as much on the velocity as on the amplitude of the motion.

In the Ewing Seismographs the actual movement of the ground in an earthquake is recorded by means of three delicately balanced pendulums, to which light styles are attached, tracing the relative movements of the pendulums on a revolving plate of glass covered with a thin film of smoke black. Two horizontal pendulums are used for recording the movements in the east and west and north and south directions respectively. The traces made by these pendulums magnify the actual movement five times. A third pendulum gives the vertical movement on a scale magnified twice. By combining the three records, the actual movement of a point of the earth's surface at any time may be obtained. In general, the earth movement is extremely complicated, and lasts for a considerable time, consisting of irregular vibrations, which have no relation to the direction of propagation or the origin of the disturbance, and cannot be specified as a single shock of definite direction.

The accompanying figures represent the record of the earthquake of Tuesday, March 23rd, 1897, 6 hrs. 7 min. p.m., at the McDonald Physics Building. The apparatus was started by means of a delicate seismoscope, making an electric contact, three seconds before the main shock which, in this instance, consisted practically of a single movement followed by small subsidiary oscillations. The seismoscope starts a clock, which records the time of the shock, and also marks the time in half seconds on the revolving plate.

The records obtained on the glass plate have been enlarged to forty times the actual earth movement and are drawn to a uniform scale. The scale of tenths of a millimetre shows the actual extent of the movement of the earth's surface. As compared with the horizontal, the vertical movement was unusually violent and rapid. As a consequence of this, the record for one or two seconds after the main shock is dotted.

The minuteness of the motion of the ground in an earthquake is at first sight rather surprising. There can be no doubt, however, that these instruments record the movement correctly, as they can be very easily tested, and the theory is very simple. The profound impression on the senses produced by an earthquake shock is due to the irresistible nature of the motion and the immense masses of matter affected by it. In the earthquake of March 23rd, the maximum extent of the movement of the ground is seen by the records to have been only about one-fortieth of an inch. That of the very similar shock of March 26th, midnight, was only one-hundredth of an inch. These movements appear at first sight excessively minute, but it appears from records of many other earthquakes taken in a similar way that a vibration of only a tenth of an inch, if sufficiently rapid and long continued, may be exceedingly destructive, especially to solidly founded buildings.

Book Notices.

Lakes of North America, a Reading Lesson for Students of Geography and Geology.—By Israel C. Russell, Professor of Geology, University of Michigan. Ginn & Company, Boston and London, 8vo., pp. 125.

Mr. Russell, who, for thirteen years, was connected with the Geological Survey of the United States, and thus had ample opportunity of carefully studying the topographical features of various parts of the continent, including Alaska, has, in this book, given in popular form a description of lakes and their various relations, illustrating his descriptions chiefly from the wealth of examples afforded by the lakes of North America.

Mr. Russell's original contributions to this field are extensive and of the highest order, the most notable being his "Geological History of Lake Labontan," which appeared as one of the monographs of the United States Geological Survey, and his personal studies thus render him eminently fitted to treat the subject as a whole. A companion volume on the Glaciers of North America by the same author, has just been announced.

The subject is discussed under the heads of the Origin of Lake Basins, the Geological Functions of Lakes, the Topography of Lake Shores, the Relation of Lakes to Climatic Conditions, the Life History of Lakes, and concludes with a special study of the history of three important lake systems, namely, the Pleistocene Lakes of the St. Lawrence Basin, Lake Agassiz and the Pleistocene Lakes of the Great Basin. The numerous illustrations add greatly to the interest of the book.

The subject of the Origin of Lakes is one which has been much discussed by various writers, and on certain minor points there are still differences of opinion. But certain great types of lakes can be selected, concerning whose origin there can be no question.

Thus there are the lakes which occupy depressions in what was the old sea bottom, in tracts of country recently elevated above sea level. These are not common in America, for the reason that while large portions of our coast are sinking new land areas are rare. The lakes of Florida, however, are good examples of this class. Other lakes of this type, whose present positions, however, have been partly determined by the rising or sinking of great blocks of the earth's crust along extended lines of fracture, are the lakes of the Great Basin, that vast area of interior drainage between the Sierra Nevada and the Rocky Mountains. Many of these, though still large in size, are mere remnants, left by the evaporation of the very much larger lakes which, in the Pleistocene age, were found in this region. Thus Great Salt Lake and Sevier Lake, Utah, are the remnants of a great inland sea which has been named by Gllbert, Lake Bonneville, while Pyramid, Walker and other lakes in Nevada mark the position of another great body of water which Mr. Russell has called Lake Labontan.

Another class of lakes are the "Ox-box" Lakes, which represent portions of former river courses which have been cut off by rivers straightening their channels as they wander through a wide flood plain. Such crescent-shaped lakes are found in many places along the course of the Lower Mississippi. Then, again, there are lakes which owe their origin to glacial agencies, and which, owing to the fact that so large a portion of North America was formerly covered with ice, are extremely abundant. These, in some cases, occupy actual rock basins, scooped out by moving ice, while in other cases they lie in the morainic deposits left by the ice upon its retreat. Such lakes, ranging in size from mere pools up to splendid water sheets, many square miles in extent, are so abundant over the formerly ice-covered portion of North America that the position of the southern boundary of the old ice sheet may be approximately traced on an accurate map by noting the southern limit of the lake-strewn portion. In the country south of the glacial limit, lakes are almost entirely absent. The "Finger Lakes" of the central part of New York probably belong to this class.

Lakes due to volcanic action, although by no means so numerous, have an especial interest. Of these perhaps Crater Lake, in North-Western Oregon, which has been described by Dutton and more recently by Diller, is the most remarkable, and is situated 30 miles north of Klamath Lake at an elevation of over 6,000 feet above sea level. It is six miles in diameter, and is surrounded by precipitous cliffs, rising from 900 to 2,200 feet above the lake and plunging down into the deep water of the lake without leaving even a margin wide enough to walk upon. This is also the deepest lake in North America, the sounding line striking bottom at 2,000 feet. The lake marks the site of an old volcano, whose summit was either blown away by a mighty series of explosions like those which blew 5,000 feet from the summit of Krakatoa some few years since, or else the mountain was melted from within, its summit sinking down into the gulf, giving rise to the depression now partially filled by the placid and mysterious waters.

Lakes, like all other things in nature, have their life history. Their period of birth, youth, maturity, decadence and old age leading to extinction. The tracing out of such histories is one of the most fascinating tasks of the geologist, and the last chapter, in which the histories of several of the great lakes of North America are given, is perhaps the most interesting in the book, and will serve to bring clearly before the general reader the great changes which have passed over the face of the continent in comparatively recent times.

Mr. Russell's book, while not containing very much new matter, is interesting and well written, and affords a valuable addition to our literature.

FRANK D. ADAMS.

McGill University.

SUMMARY REPORT OF THE GEOLOGICAL SURVEY DEPARTMENT FOR THE YEAR 1896.

Not the least interesting or instructive of the many valuable volumes issued by this important branch of the Civil Service of Canada is the summary report of its proceedings, which is presented by the Director at the close of each year. This gives a brief but comprehensive account of the work of all divisions of the Geological Survey, not only of the explorations and discoveries made, but also of the work done in the chemical and petrographical laboratories, the publications and their distribution, and the important questions of the care of the museum and the financial statement of the Department.

The present report, which has recently appeared, contains 144 pages, and can be obtained from the Librarian of the Geological Survey Department for the sum of 10 cents.

In conciseness of form and arrangement of details, it is marked by the clearness and precision which characterize the reports of the able Director of the Geological Survey.

During the year 1896 the field work was of the usual extensive and practical character. Investigations were made in the most important gold mining regions, viz., Kootanie, Rainy River, the Eastern Townships and Nova Scotia, a deep boring was made in the petroleum district of Athabasca, while questions of less immediate economic importance, but of equal scientific and ultimate value, were studied in all parts of the Dominion.

In British Columbia Mr. McConnell made a geological examination of the noted mineral region south of the Kootanie River. This whole district is remarkable for the great preponderance of igneous rocks. These are of two distinct series, representing at least two periods of volcanic eruption, the older comprising groups of porphyrites, gabbros and associated eruptives, the latter, an area of granite. The relations of the different members of the older series to one another is best known in the vicinity of Trail Creek. Of these Mr. McConnell says: "At Rossland, the central member of the group is a fine to coarse-grained gabbro, apparently passing in a couple of places into a uralitic granite. The gabbros occupy an irregular shaped area with a length of about four miles and an average width of one mile. * * * The gabbros are fringed with a varying width of augite and uralite-porphyrites and fine-grained green diabases. The passage from the porphyrites to the gabbros is nowhere sharply defined, and the two rocks have apparently originated from the same magma, but have cooled under different conditions. The gabbros and bordering porphyrites are important from an economic standpoint, as most of the ore bodies at present being worked are situated either on or close to their line of junction. The roughly concentric arrangement of the Trail Creek rocks, and the gradual passage outward from a holo-crystalline central area through semi-crystalline rocks to bedded volcanic fragmentals, suggest an ancient (although now deeply eroded) volcanic centre, situated near the site of the present town of Rossland, from which lavas and ashes deluged the surrounding district. The presence of small bands of coral bearing limestones with the agglomerates and tuffs also makes it probable that a shallow sea existed at the time of the outburst, and that the eruptions were intermittent and continued during a lengthened period."

The ores contained by these rocks were fonnd to be of a rather low grade, but with better facilities for smelting and transportation, the number of paying lodes would be greatly increased and the value of all enhanced. Mr. McConnell believes that the greater number of the ore deposits occur in the form of replacement veins.

The newer series of eruptive rocks consists chiefly of granite in varied forms, but owing to its less complex nature the detailed structure is not so important.

In the Shuswap district of the same province, Mr. McEvoy completed the investigation necessary for the geological map sheet of that area. This work was begun by Dr. Dawson, now Director of the Survey, with the assistance of Mr. McEvoy, in the summer of 1890.

In the North-West Territories and Keewatin, Mr. Tyrell made a reconnaisance through the country lylng to the north of Lake Winnipeg and between the Nelson and Saskatchewan rivers.

In the course of this journey of about 1,100 miles, the northern limits of the Palaeozoic system were determined and a hitherto unknown area of Huronian rocks was defined. A large section of fertile land was crossed on the western side of the Nelson River. This seems to be well adapted for agricultural purposes and, with proper railway communication, might offer a promising field for settlement.

The work performed in the Lake Superior district was under the direction of Mr. McInnes. Two chief geological systems are recognized in this region, the Laurentian, and Huronian (?) The latter consists of two series, known as the Coutchiching and Keewatin. Through all these intrusions of granite are frequent. After an examination of a large number of mines and mining locations from Rainy Lake to Lake of the Woods, Mr. McInnes says: "Here, as in the Seine River country, gold has been found, in every case of which we have any record, at no great distance from the contact between the Keewatin and intrusive granitoid rocks, which occur most frequently as narrow rims along the edge of the more extensive areas of biotite-gneiss, but which also invade the Keewatin rocks as isolated intrusive masses. I know of no case where gold-bearing veins have been found to occur in the main body of the biotite-gneiss areas which we have classed as Laurentian."

Dr. Adams and Mr. Barlow were associated in an examination of the part of Central Ontario known as the Haliburton Sheet of the Geological Survey's series of maps. The geological divisions here distinguished are the Lower Laurentian (Fundamental Gneiss), the Grenville Series and the Hastings. The investigation of the relatlons of these to one another promises very interesting results. On the north side of the Ottawa River, Dr. Adams has previously shown ("Report on the Geology of a Portion of the Laurentian Area Lying to the North of the Island of Montreal," Geol. Survey of Canada, Vol. VIII. (N.S.)) that the Grenville Series is, in part, a very old altered sediment. In this district this conclusion is corroborated and an intrusive contact between the Grenville Series and the Fundamental Gneiss shown to be probable. The relations existing between the Grenville and the Hastings Series have also received special attention, and, from the examinations thus far made, it seems probable that the Grenville will be ultimately found to represent the more highly metamorphosed portions of the Hastings Series, and these, it is suggested, may be of Huronion age.

In the township of Carlow on this sheet, Mr. Ferrier, in a separate research, found a deposit of Corundum probably of very considerable economic importance.

On the north side of the Ottawa River, Dr. Ells continued the extensive researches in which he has been engaged for several seasons. He has examined the region drained by the Coulonge and Black rivers, and has extended his investigations on the south shore to the region of the Bonnechere, Madawaska and Mississippi. The northern limit of the Hastings Series is noted, the relations of the crystalline limestones observed, and the mineral occurrences recorded.

Dr. Bell and party made a reconnaisance survey from Mattawa to Lake Mistassini and Rupert's River. A part of the limits of the great belt of the Huronian system, which extends from Lake Superior to Lake Mistassini, was traced and a smaller belt of the same horizon was approximately defined. These, with Laurentian Gneiss and Chloretic Schist of an undetermined age, were the chief rocks observed.

The surface geology of the Eastern Townships formed the subject of the researches of Mr. Chalmers. This work is of great economic importance, as it implies the development of the gold mining of the townships of Dudswell and Ditton and in the Chaudiere Valley. Nor has it less of a purely scientific interest. The efforts to trace the auriferous gravels to their origin, the various mining locations, and the conditions that prevailed during the glacial periods, of which Mr. Chalmers distinguishes two, formed the chief topics of this very interesting investigation.

Mr. Low has continued his already well-known explorations in the Labrador peninsula. Here the limits of a large area of rich iron deposits were defined and many other observations of important geological and geographical interest were made.

Three parties were employed in field work in the Province of Nova Scotia under Prof. Bailey and Messrs. Fletcher and Faribault. Prof. Fletcher's work consisted of a general examination of the south-western part of Nova Scotia. Mr. Fletcher continued his examination of the coal fields, while Mr. Faribault was engaged in the investigations necessary for the detailed mapping of the gold-producing localities.

In the Department of Chemistry and Mineralogy six hundred and ninety-seven specimens were received for examination during the year, and the necessary information in all cases was given. Important additions have been made to the Museum, and collections aggregating 5,040 specimens have been given to educational institutions.

In the Department of Mining and Mineral Statistics a complete system of reference to all mineral statistics is being established, so that any desired information within its scope can be promptly communicated.

Important petrographical and palaeontological work has been done and large additions have been made to the Museum.

Four maps were completed during the year 1896, and eleven are expected to be finished in the present year. The Director makes a strong appeal for provincial aid to the Geological Survey in the preparation of topographical maps.

The number of visitors to the Museum for the year 1896 was 31,595, as compared with 26,785 in the previous year, a fact which, in itself, speaks very strongly of the interest felt by the public in this department.

This interest, which is rapidly increasing, must soon become too strong to allow the Geological Survey to remain longer in its present insufficient quarters.

The work of the Survey is a great one, whether we consider the actual amount of work done, its value to the country from an economic standpoint or as a contribution to science. Nor should it be appreciated less highly from the fact that all this work, much of it requiring technical skill of a high order, costs the country scarcely one hundred thousand dollars a year.

And when it is remembered, too, that this work is performed under very disadvantageous circumstances, and that the vast collections in the Museum and the records of half a century of work of inestimable importance to the country are in great and constant danger of destruction by fire, the need of better accommodation is strongly felt. It is, indeed, a poor reward to such an admirably conducted department, and betokens little regard for the important work which it performs and the public interests it subserves, that the Geological Survey has not been provided with a fire-proof Museum and offices and laboratories equipped according to modern requirements and to the needs of the country.

JOHN A. DRESSER.

St. Francis College,
Richmond, P.Q.

ABSTRACT FOR THE MONTH OF APRIL, 1897.

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

DAY.	THERMOMETER.				BAROMETER.				†Mean pressure of vapor.	Mean relative humidity.	Dew point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	Max.	Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	37.73	44.9	30.0	14.9	30.4105	30.543	30.217	.326	.1273	55.2	23.7	S.W.	20.67	3.5	8	0	91	....	....	....	1
2	38.05	45.5	28.6	16.9	30.1938	30.350	30.141	.209	.1118	49.8	20.8	N.E.	19.42	0.5	3	0	97	....	....	....	2
3	28.18	35.5	20.8	14.7	30.4990	30.551	30.443	.108	.1195	75.3	21.5	N.E.	7.88	0.3	2	0	96	....	....	....	3
SUNDAY........4	.....	50.1	26.4	23.7	......	......	......	....	.....	....	....	S.E.	8.54	...	......	..	85	....	....	....	4........ SUNDAY
5	42.10	53.6	37.0	16.6	29.6662	29.795	29.593	.202	.2535	93.7	40.2	S.	11.88	9.2	10	7	9	0.26	....	0.26	5
6	40.73	50.8	35.1	15.7	29.6892	29.868	29.599	.269	.2292	88.8	37.8	S.W.	12.78	10.0	10	10	6	0.04	....	0.04	6
7	33.83	40.2	28.8	11.4	30.0412	30.082	29.956	.126	.1305	66.2	24.0	N.	11.41	3.2	10	0	91	....	....	....	7
8	36.90	46.1	28.1	18.0	30.0413	30.091	29.995	.096	.1660	74.2	29.7	S.W.	8.67	5.5	10	0	34	....	....	....	8
9	36.68	40.6	33.5	7.1	29.8573	29.968	29.725	.243	.1838	84.8	32.5	N.E.	15.42	10.0	10	10	00	0.07	....	0.07	9
10	31.38	33.0	28.5	4.5	29.8775	30.048	29.731	.317	.1623	91.8	29.5	N.E.	17.79	10 0	10	10	00	0.05	1.9	0.30	10
SUNDAY........11	.....	41.5	31.5	10 0	......	......	......	....	...	....	....	W.	8.67	...	...	...	21	....	0.0	0 00	11........ SUNDAY
12	39.35	46.5	34.0	12.5	30.4223	30.499	30.270	.229	.1525	63.2	28 0	S.E.	8.46	0.5	3	0	98	0.04	....	0.04	12
13	43.37	51.5	32.4	19.1	30.2233	30.483	29.949	.534	.1748	62.2	31.2	S.	18.38	8.0	10	0	7	0.04	....	0.04	13
14	44.83	50.5	40.9	9.6	29.8960	29.975	29.844	.131	.2507	84.0	40.2	S.W.	24.46	10.0	10	10	00	0.15	....	0.15	14
15	40.70	45.5	37.4	8.1	29 8703	29.976	29.749	.227	.2307	90.8	38.0	S.W.	11.96	10.0	10	10	00	0.51	....	0.51	15
16	47.00	56.6	39.0	17.6	29.8038	29.846	29.782	.064	.2193	70.2	36.8	S.W.	18 04	4.8	10	0	87	0.11	....	0.11	16
17	40.82	44.0	36.4	7.6	29.7313	29.820	29.630	.190	.2237	87.2	37.3	S.W.	13.33	10.0	10	10	00	0 73	....	0.73	17
SUNDAY........18	.....	53.4	33.1	20 3	....	......	......	....	.....	....	....	S.W.	23.50	....	..	...	95	0.01	....	0.01	18........ SUNDAY
19	33.97	51.3	13.5	37.8	29.8915	30.372	29 574	.798	.1682	78.0	28.0	S.W.	31.88	5.8	10	0	8	0.15	....	0.15	19
20	23.32	32.6	10.9	21.7	30.4743	30.558	30.428	.130	.0957	73.8	16.2	S.W.	21.13	2.2	5	0	94	....	....	....	20
21	39.47	50.0	27.6	22.4	30.4293	30.478	30.397	.081	.1513	64.3	29.2	S.W.	24.58	0.0	0	0	94	....	....	....	21
22	47.57	59.5	32.0	27.5	30.2540	30.384	30.098	.286	.2042	61.5	34.7	S.	19.50	6 7	10	0	12	0.00	....	0.00	22
23	62.07	74.3	49.5	24.8	30.0625	30.134	29.992	.142	3690	66.5	50.2	S.W.	19.83	4.8	10	0	68	0.11	....	0.11	23
24	61.40	69.0	56.2	12.8	29.9947	30.041	29.938	.103	.4470	82.8	55.8	S.W.	13.75	6.5	10	0	50	0.11	....	0.11	24
SUNDAY........25	.....	72.8	49.9	22.9	.	......	......	....	..	....	....	S.W.	21.79	...	....	...	8	0.41	....	0.41	25........ SUNDAY
26	46.62	55.9	38.6	17.3	29.5787	29.736	29.444	.292	.2460	78 3	39.8	S.W.	13.67	6.3	10	0	47	0.07	....	0.07	26
27	39.35	44.0	32.0	12.0	29.7462	29.853	29.564	.289	.1797	74.2	31.8	N.W.	26.71	10.0	10	10	00	0.20	....	0.20	27
28	47.57	55.4	41.4	14.0	29.9588	30.015	29.912	.103	.2380	72.3	38.8	N.	12.58	5.0	10	0	38	0.00	....	0.00	28
29	50.78	62.8	39.0	23.8	30.0062	30.120	29 941	.179	.2835	77 0	43.3	N.E.	9.08	2.8	10	0	49	....	....	....	29
30	50.57	61.2	40.0	21.2	30.0768	30.122	30.036	.086	.2635	70.5	41.2	N.	18.75	3.3	8	0	76	....	....	...	30
31	.....	....	....	....	....	......	......	....	.....	....	....	......	....	....	....	....	....	....	....	....	31
Means	41.71	50.62	33.74	16.88	30.0268	30.1426	29.9211	.2215	.2070	74.49	33.85	S. 56¼° W.	16.48	5.72	8.4	3.0	45.37	3.02	1.9	3.27	... . Sums.
23 Years means for and including this month	40.14	48.67	32.41	16.25	29.9606	......	.....	.204	.1729	67.0	...	......	§16.70	6.1	....	...	¶51.1	1.67	5.8	2.26	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	1324	1319	51	405	1545	5559	376	1288	
Duration in hrs..	92	88	9	47	81	289	35	71	8
Mean velocity....	14.39	14.99	5.67	8.62	19.07	19.24	10.74	18.14	

Greatest mileage in one hour was 53 on the 19th.

Greatest velocity in gusts, 60 miles per hour on the 19th.

Resultant mileage, 4725.

Resultant direction, S. 56¼° W.

Total mileage, 11867.

*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 74°3 on the 23rd; the greatest cold was 10.°9 on the 20th, giving a range of temperature of 63.4° degrees.

Warmest day was the 23rd. Coldest day was the 20th. Highest barometer reading was 30.558 on the 20th. Lowest barometer was 29,411 on the 26th, giving a range of 1,114 inches. Maximum relative humidity was 98.0 on the 5th.

Minimum relative humidity was 36 on the 2nd.

Rain fell on 18 days.

Snow fell on 2 days.

Rain or snow fell on 19 days.

Auroras were observed on 1 night, on the 1st.

Fog on 3 days—on 6th, 9th and 25th.

Thunder storms on 23rd and 25th.

ABSTRACT FOR THE MONTH OF MAY, 1897.

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

DAY.	THERMOMETER.				BAROMETER.				†Mean pressure of vapor	Mean relative humidity.	Dew point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent. possible. Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY
	Mean.	Max.	Min.	Range.	Mean.	Max.	Min.	Range.				General direction.	Mean velocity in miles perhour	Mean.	Max.	Min.					
1	52.58	64.4	41.5	22.9	30.0447	30.061	30.024	.037	.3305	82.3	47.2	N.	12.63	5.0	10	0	25	0.04	....	0.04	1
SUNDAY........2	.....	60.3	43.0	17.3	......	......	......	....	.....	....	....	N.E.	15.17	.	......	...	00	0.08	....	0.08	2........ SUNDAY
3	52.25	60.3	48.5	11.8	29.7968	29.824	29.744	.080	.3583	91.5	49.8	N.E.	14.67	8.5	10	6	18	0.19	....	0.19	3
4	52.28	61.5	45.4	16.1	29.8487	29.913	29.814	.099	.3228	82.7	46.7	N.E.	11.04	6.7	10	0	19	0.03	....	0.03	4
5	57.75	70.3	44.4	25.9	29.9730	30.050	29.915	.135	.3072	61.8	44.2	N.E.	11.09	4.3	10	0	60	....	....	....	5
6	47.75	57.3	40.0	17.3	30.1175	30.176	30.069	.107	.1235	36.5	22.7	N.E.	17.59	0.7	4	0	95	....	....	....	6
7	44.35	54.5	33.8	20.7	30.1895	30.280	30.147	.133	.1432	48.3	25.8	N.	19 92	0.7	2	0	97	....	....	....	7
8	49.03	57.3	33.9	23.4	30.2742	30.395	30.132	.263	.1695	49.2	29.8	S.W.	12.17	4.5	10	0	82	....	....	....	8
SUNDAY.........9	.....	69.0	47.0	22.0	......	......	......	....	...	...	....	S.W.	13.92	...	..	...	45	0 27	....	0.27	9 ....SUNDAY
10	48.82	54.4	46.0	8.4	29.6992	29.781	29.658	.123	.3210	93.3	46.8	N.E.	8.79	9.5	10	7	02	0 05	....	0.05	10
11	58.42	71.5	44.2	27.3	29.8437	29.897	29.802	.095	.3282	69.0	47.3	S.W.	10.38	5.8	10	0	80	Inap.	....	Inap.	11
12	59.35	64.3	55.6	8.7	29.6970	29.820	29.620	.200	.4360	86.2	54.8	S.	16.21	9.5	10	8	00	0.25	....	0.25	12
13	58.70	64.7	51.8	12.9	29.7623	29 817	29.722	.095	.3925	80.5	52.2	S.W.	18.54	7.8	10	0	02	Inap.	....	Inap.	13
14	58.62	72.1	49.0	23.1	29.7457	29.843	29.610	.233	.3967	83.0	52.5	S.W.	16.38	8.8	10	5	45	0.54	....	0.54	14
15	52.23	59.0	47.6	11.4	29 9743	30.132	29.791	.341	.2700	69.7	42.5	S.W.	21.09	4.0	10	0	85	0.06	....	0.c6	15
SUNDAY........16	.....	63.3	42.2	21.1	....	.	.....	....	.....	....	....	N.W.	7.42	....	...	...	96	....	....	...	16.........SUNDAY
17	57.15	67.8	44.7	23.1	30.1755	30.246	30.113	.133	.2713	58.0	42.0	W.	8.25	0.8	2	0	97	....	....	....	17
18	58.92	70.3	48.0	22.3	30.0415	30.160	29.929	.231	.2707	52.2	41.3	S.W.	19.83	3.5	8	0	67	0.02	....	0.02	18
19	48.00	56.2	35.5	20.7	30 2528	30.351	30 121	.230	.1868	54.8	32.5	S.W.	14.75	3.7	10	0	77	....	....	....	19
20	50.50	55.6	46.0	9.6	29.7963	30.073	29.510	.563	.3442	93.0	48.5	N.E.	13.79	10.0	10	10	00	0.39	....	0.39	20
21	50.87	59.1	43.5	15.6	29.6577	29.842	29.475	.367	.3265	85.0	46.7	S.W.	18.25	7.2	10	0	00	0.26	....	0.26	21
22	54.08	65.2	39.8	25.4	29.8460	29.894	29.795	.099	.2195	52.7	36.5	S.W.	17.08	0.5	3	0	92	....	....	....	22
SUNDAY........23	.....	69.4	47.5	21.9	......	......	......	....	...	....	....	S.	15.12	...	....	...	04	0.29	....	0.29	23......... SUNDAY
24	61.22	70.4	55.2	15.2	29.8285	29.938	29.768	.170	.4130	77.0	53.3	W.	14.46	7.5	10	0	59	0.04	....	0.04	24
25	45.62	51.1	41.8	9.3	30.0870	30.180	30.024	.156	2532	82.2	40.5	N.	20.88	8.3	10	0	00	0.43	....	0.43	25
26	51.78	60.6	42.4	18.2	30.2082	30.247	30.165	.082	.2383	62.8	38.8	N.E.	8.00	5.5	10	0	74	Inap.	....	Inap.	26
27	50.00	56.2	42.8	13.4	30.0108	30.171	29.842	.329	.2923	80 5	44.0	N.	12.29	10.0	10	10	00	0.09	....	0.09	27
28	52.43	54.5	49.8	4.7	29.6657	29.762	29.583	.179	.3800	95.8	51.3	N.	8.54	10.0	10	10	00	0.71	....	0.71	28
29	53.38	56.8	50.5	6.3	29.6105	29.682	29.575	.107	.3698	90.5	50 7	S.W.	18.54	9.0	10	5	01	Inap.	....	Inap.	29
SUNDAY........30	.....	68.5	50.0	18.5	....	......	......	....	.....	....	....	S.W.	16.04	....	..	....	69	....	....	....	30 .... SUNDAY
31	54.85	60.7	48.7	12.0	29.7528	29 797	29.729	.068	.2940	67.8	44.0	S.W.	22.38	4.0	10	0	69	Inap.	....	Inap.	31
Means	53.11	62.15	45.16	16.99	29.9192	30.0128	29.8338	.1790	.2984	72.55	43.55	S. 67¼° W	14.68	6.07	8 8	2.3	43.8	3.74	....	3.74	... . Sums.
23 Years means for and including this month	54.67	64.02	45.73	18 73	29.9339	......	...	.170	2891	66 0	...	......	§14.52	6.2	...	..	¶50.6	2.98	....	2.98	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	1395	2009	164	678	915	4148	776	837	
Duration in hrs..	92	148	23	57	66	233	56	69	
Mean velocity....	15.16	13.57	7.13	11.89	13.86	17.80	13.86	12.13	

Greatest mileage in one hour was 33 on the 30th.
Greatest velocity in gusts, 40 miles per hour on the 15th.

Resultant mileage, 2419.
Resultant direction, S. 67¼° W.
Total mileage, 10922.
Average 14.68 miles per hour.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only.

s 11 years only.

The greatest heat was 72°1 on the 14th; the greatest cold was 33.°8 on the 7th, giving a range of temperature of 38.3 degrees.

Warmest day was the 24th. Coldest day was the 7th. Highest barometer reading was 30.395 on the 8th. Lowest barometer was 29,475 on the 21st, giving a range of .920 inches. Maximum relative humidity was 100 on the 4th.

Minimum relative humidity was 27 on the 6th.

Rain or snow fell on 19 days.

Aurora was observed on 1 night; lunar halo on 1 night; lunar corona on 1 night.

Thunder storms on the 20th.

Earthquake shocks on the 27th.

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THE NATURAL HISTORY SOCIETY OF MONTREAL,
AND REPLACING

THE CANADIAN NATURALIST.

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THE

CANADIAN RECORD

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VOL. VII. APRIL, 1897. No. 6.

Notes on the Geology of the Admiralty Group of the Thousand Islands, Ontario.

By Frank D. Adams, McGill University, Montreal.

The Thousand Islands, lying in the River St. Lawrence near its exit from Lake Ontario, and which are so well known as a summer resort, owe their origin to the passage across the river here of a narrow arm of the hard Laurentian rocks which form the great nucleus of the North American continent, which arm nearly connects the main part of the nucleus forming the Canadian Highlands with the outlying area of these rocks in the State of New York, known as the Adirondack Mountains.

The islands, some 1,400 in number, naturally fall into several groups, and that known as the Admiralty Group includes about 150 rocks and islands of various sizes, lying to the south-west of the town of Gananoque.

The Canadian islands, having recently been offered for sale by the Government, have been surveyed and their respective areas determined. The larger islands have retained their names on the Government map, while the smaller islands have been designated by numbers, corresponding numbers having been painted on some conspicuous object on the several islands, thus enabling them to be readily recognized.

A short general account of the geology of these islands was given some years since by Dr. A. P. Coleman,[1] in a paper which appeared in this magazine, and a more recent paper by Dr. C. H. Smythe, Jr.,[2] gives a more detailed description of the diabase dykes which cut the country rock. Some additional information, obtained during a recent visit to the islands, is presented in the present paper.

The prevailing rock is referred to by Dr. Coleman as a granite, but as it usually possesses a more or less distinct foliation it might perhaps be termed a granitoid gneiss. The foliation is, however, usually very indistinct and a true banded arrangement of the constituents was not observed in it. It is composed essentially of quartz and orthoclase with but small quantities of iron magnesia constituents, these consisting of biotite and hornblende. As a much more massive rock which may be classed as true granite occur and is quarried on several of the islands, *e.g.*, Forsyth, Juniper and Grindstone Islands, the relation of this to the granitoid gneiss just referred to is a matter of much interest as bearing upon the problem of the origin of the Laurentian gneisses, the question presenting itself as to whether the granite in question cuts this granitoid gneiss and is later than it, or whether the gneiss is produced from the granite by movements set up in it, either in a plastic or solid state.

The granitoid gneiss composing several of the islands, as, for example, No. 18, No. 16 and Campbell Island (Sagastoweka) often shows a granulated or augen gneiss structure. The granulated structure is well seen in rock

[1] Some Laurentian Rocks of the Thousand Islands. Can. Rec. of Sci., Vol. V., No. 2, 1892.

[2] A Group of Diabase Dykes among the Thousand Islands, St. Lawrence River. Trans. N.Y. Acad. Sci., Vol. XIII., Aug., 1894.

No. 16, which, on large weathered surfaces, exhibits an indistinct gneissic or streaked structure, due to the alternation of rude and ill-defined streaks or bands composed of a very fine-grained mixture of quartz and reddish orthoclase, with others holding a great number of small, irregularly shaped or angular fragments of a very dark-colored feldspar, apparently identical with that seen in the Jupiter Island granite to be mentioned later, and which are embedded in a similar fine-grained ground mass. Narrow strings of translucent quartz, evidently of secondary origin, also occur occasionally running in the same direction. The whole appearance conveys very strongly the idea that the structure of the mass has originated from movements in a softened mass of granite, the finer granulated portions having been produced by this movement and being most abundant where the movements have been greatest.

Of the granites above mentioned, that from Forsyth's Island is rather coarse in grain and although uniform in character and massive in general appearance, still frequently shows, when examined closely, a rather distinct parallel arrangement of the quartz in one direction. It consists of red orthoclase, whose cleavage faces can often be observed to be twisted, with bluish quartz, and a comparatively small proportion of iron magnesia constituents. Under the microscope a specimen of this granite, taken from the quarry near Mr. Forsyth's house, was found to possess the following characters :—

Orthoclase and microcline are abundant, and are often somewhat turbid from the presence of decomposition products, while the lime soda feldspars are represented by a few grains of plagioclase. The quartz, though less abundant than the orthoclase, is present in large amount and shows intense strain shadows. Every grain is twisted or divided up into subordinate areas, ill-defined against one another, but marking the tendency of the individual to break or move along the lines bounding them. The mineral, however, although much distorted, as in all similar rocks, does not show more than traces of actual granulation under the pressure to which it has been subjected, and this only in a few places about the immediate periphery of the grains. Approximately equal amounts of green hornblende and highly pleochroic brown biotite are present, the former largely altered to chlorite and carbonates, and the latter in places decomposed to chlorite. Both of these minerals, however, are present in but small amount. A few grains of sphene and zircon are also present. The rock has evidently been submitted to intense pressure.

The granite on Juniper Island has been extensively quarried. The surface, where stripped for quarrying, is seen to be beautifully smoothed and grooved by the action of the ice, but where it has not been protected by the soil covering, it is considerably weathered and these evidences of glacial action are not so well displayed. The rock is excellently exposed on the face of the quarry. It is dark in color, owing to the dark color of the feldspar rather than from the presence of bisilicates or mica, which are not abundant. It does not show a gneissic structure, but on the glaceated surfaces is seen to be somewhat uneven in character, owing chiefly to the irregular distribution through the rock of rather large and more or less irregular shaped and apparently broken feldspars which are dark in color, while the rest of the feldspar which constitutes the greater part of the rock is red in colour and is apparently in a granulated condition. In places there is also, for a foot or two, a tendency to parallelism among the iron magnesia constituents, a structure which would seem to have resulted rather from primary movements in a highly heated rock than from secondary crushing after the rock had cooled. The structure resembles that described above as occurring in the granitoid gneiss, and, although much less distinct, is suggestive of the derivation of the latter from a similar granitic rock by movements set up in it. Numerous long and narrow patches of very coarsely crystalline granite or pegmatite are also present in the rock. These are composed of quartz, potash feldspar, black mica and schorl, with occasionally a small amount of a yellowish green mineral having the blowpipe characters of scapolite, a mineral which would hardly be expected among such surroundings.

Dr. Coleman also mentions the occurrence of a true gneiss as well as of quartzite on this group of islands. These were observed by me on the two islands known as Aubrey and Lemon Islands, where they were cut by the granite.

Of considerable importance also as serving to correlate these rocks with the Laurentian on the mainland of Ontario and in the Adirondacks, was the discovery of a large exposure of white crystalline limestone which I found on Island No. 18, and which resembles in all respects that of the Grenville Series. It occurs crossing the south-west corner of the island, being exposed for a distance of twenty-five yards along one shore, and for about ten yards on the other side of the island where it is seen beneath the surface of the water. The rest of the island is composed of gneiss, except that portion occupied by a diabase dyke which is exposed for a width of fifteen yards, traversing the island at its south-west corner and being bounded by the crystalline limestone on one side and by the gneiss on the other.

At the west end of Island No. 21, also, slabs of coarsely crystalline limestone were found lying upon the beach. Although this rock was not observed in place, the shape of the fragments indicate its occurrence in the immediate vicinity. The island itself is composed of a white weathering gneissic rock with no iron magnesia constituents, and possessing a structure resembling somewhat that of a fine-grained pegmatite.

No other occurrences of crystalline limestone were observed.

The dykes described by Dr. Smythe are well exposed on many of the islands, as, for instance, on Lemon, Little John, and No. 14. One long dyke starting from Bluff Island can be observed crossing No. 19, which is made up almost entirely of it, and No. 18 to No. 16, where it seems to terminate. There are, however, probably about thirty of these dykes in all, having a general north and south course and a nearly vertical attitude. Taken together they would be equivalent to a sheet of diabase about 300 feet thick. Some of these dykes consist of ordinary diabase and some of olivine diabase. The fact that they are finer in grain toward the sides proves that the gneisses and granites, through which they cut, were cool at the time of their intrusion. They do not cut the Potsdam Sandstone, and are, therefore, older than the Upper Cambrian, while, as Dr. Smythe observes, the absence of any considerable evidences of dynamo-metamorphism in them demonstrates that, during the great length of time which has elapsed since the intrusion of the dykes, the region has not been affected to any great extent by mountain-making forces.

Modern Attainments in Geology.

A Lecture Delivered Before the Natural History Society of Görlitz, by Prof. Edward Suess, of Berlin.

Translated for The Canadian Record of Science by Nevil Norton Evans, M.A.Sc.

Ladies and Gentlemen:

I am to address you upon modern attainments in geology, that is, I am to conduct you to the limits of our science, as only there, where our outposts are, can we see in what direction further advance is being made. Whether I shall be successful, I do not know; but the subject is such a comprehensive one that I must not permit myself a longer introduction.

Let us first glance at the road already trodden. One may say that the geology of to-day started at the great Mining School of Freiberg in the last century. There it was, under the lead of Werner, that deep study was given to the manner in which different rocks were deposited, and where continuous districts were systematically investigated. But not till Cuvier had pointed out in the first decade of this century that the remains of mammals found in the gypsum of Paris really belonged to extinct species; not till the Englishman Smith showed that in the different layers of stratified rocks different fossils occurred and that hence it was possible to classify these strata according to the fossils contained in them; not till Leopold von Buch had given a tremendous impulse to the investigation of the structure of mountains, could one recognize what an extraordinarily wide new field was opened to human investigation.

Further great advances were made in the first half and the middle of the present century. In Freiberg geology was originally studied for the purpose of tracing ores of the noble metals which occurred there in the form of veins. Later it was found that coal and iron possessed a much greater value for a state, and finally people were convinced that a much more insignificant portion of our earth—the soil—was of supreme importance for the well-being of a country.

Thus we have gradually come to the conclusion that the investigation of the geological structure of a country is an important preliminary to the advancement of its agricultural development; and it has therefore come about that not only the countries of Europe, but many countries outside Europe, have conducted or introduced such a study of their lands at the public expense. Not only the United States, but also Canada, Australia, New Zealand, Japan possess such institutions. Where such departments are wanting, enterprising travellers have extended our knowledge; chief of these, Ferdinand von Richthofen in his comprehensive work on China. The English and Russians have explored the high mountains of Central Asia, and one may say that at the present time we possess at least some knowledge of the geological structure of by far the largest part of the surface of the earth.

The government undertakings just referred to generally suffer, however, from the fact that their work leaves off at political boundaries. These political boundaries by no means correspond to natural divisions; frequently they follow a watershed and one side of the mountain range belongs to one country and the other to a neighboring land. So it is, for instance, with the Giant Mountains (Riesengebirge) through which I travelled to-day. Only when the public surveys of the different countries are united, is a correct picture of the real significance of certain details in the structure of the surface of the earth obtained. The picture of such things which we to-day possess is, therefore, not due to the labors of individuals, but is the product of a mass of concerted work.

A special and important branch of geology consists of the studies regarding the origin of the present surface relief. For a very long time every system of mountains was considered as having been formed by the upheaval of a linear zone of the crust of the earth, the so-called axis of the system, the lateral ranges being disposed on either side of this axis and symmetrical to it. The upheaval of the central axis was regarded as having been caused in much the same way as volcanoes were presumed to have been formed. A force, acting from within the earth, was supposed to have elevated the axis of the system, pushing aside the secondary ranges. Thus it was that Leopold von Buch pictured the operation to himself.

Others, in particular the great French geologist Élie de Beaumont, considered it possible that a simple geometrical law could be formulated to account for the arrangement of mountain axes on the surface of the planet. It was supposed that these axes corresponded to the edges of a crystal inscribed in the sphere of the earth.

All these older views which for years formed a fruitful basis for research are, however, no longer in accordance with the knowledge of to-day. Their most important suppositions are now known to be very doubtful. In the first place it has been shown that the structure of the largest mountain systems is not symmetrical, but unsymmetrical and one-sided, and that approach to a symmetrical structure occurs only very exceptionally. Thus, for instance, the mightiest of the so-called "central stocks" of the western Alps, Monte Rosa, does not lie at the centre of the system, but almost on its southern edge.

The idea of Élie de Beaumont, according to which the mountain ranges correspond to the projections of the edges of a crystal on the surface of the earth, is for one reason alone no longer tenable: the great mountain chains, with few exceptions, do not run in straight lines, but take a more or less curved course.

In order to arrive at a correct understanding, it must be remembered that the form of the earth's surface is materially affected by the destructive influence of frost, weathering, and running water. What we see before us as mountains are the more or less demolished ruins of the much mightier heights which Nature first built. If one has learnt to roughly reproduce in his imagination the original form of these ruins, an entirely different and much more magnificent picture is obtained. It is very different from the picture of the landscape painter or the map-maker. But only in this way can a basis be obtained from which it is possible to decide upon the causes of the formation of mountains.

The force concerned in this work seems to be principally a contraction of the outer crust of the earth, connected with a shortening of the diameter caused by the gradual cooling of our planet.

We observe two phenomena through which the contraction is evident: either horizontal movement—that is, folding; or vertical contraction—that is, subsidence.

According to the predominance of one or other of these two movements, we see the surface of the earth laid out in long folds, as in the Alps and the Ural; or we have flat table-lands, as in the Sahara and Central Russia, or lines of subsidence, as in the Dead Sea, or whole regions depressed, as on the western side of the Apennines.

The folds of the mountain ranges run in long lines forming curves and often abut against older fragments by which they are turned aside from their course. They bend like the waves on a disturbed surface of water, and the outer folds which form the edge of the range are sometimes completely overturned, so that along these edges the strata of the folded rocks are met with in reversed order. Thus parts of the surface of the earth appear here as table-lands, there as areas of depression, and in still other places as folded and overturned portions of the crust, in which, as already stated, the more recent foldings have been restricted in their development by the already existing structure of the country.

From this it is, however, seen that the relief of the earth's surface does not by any means always correspond with the deeper structure. Therefore, in order to obtain a correct understanding of the facts, the structure, that is, the lines of folding or the lines of fault, must be kept in view. These lines are the determinants, not the relief.

Take, for instance, the Hartz. According to contour, this mountain system has the longer axis of its ellipse running north-north-west; it consists, however, of folds which strike north-north-east, directly across the relief. If the relief only were considered, the Hartz, with the contour above mentioned, appears as an independent mountain system, and thus it is considered by geographers; the geologist, however, who follows the strike of the strata, sees in it only a continuation of the Rhenish mountains lying to the west, in which the same direction of folding predominates.

The same thing is observed in the Vogesen (Vosges Mountains) and the Black Forest; the direction of the strata is north-north-east, straight across the general direction of the ranges, and finds its continuation on one side in the central plateau of France, and on the other in the Fichtel Mountains. In this way a correct picture of the actual relations of things is obtained, and one is thereby easily convinced that these pieces of mountain ranges, now disconnected, are in reality the remnants of a uniform system of folds, of which large parts have subsided and disappeared. Between the portions which have thus been depressed, the remaining parts stand up, as the Black Forest and the Vogesen, and these elevated parts we call Horsts.

As has already been stated, there was a time when it was thought that the mountain chains of the earth were arranged according to certain geometrical systems, and it was believed that in them the edges of certain crystal forms inscribed in the sphere were to be seen. But the further our knowledge reaches, the further away this idea of any supposed geometrical regularity retreats, and, as is so often the case in nature, we arrive at something entirely unexpected.

If the main lines of the great folded areas, known to us in their entirety or divided up by subsidences into horsts, be laid down on a map, immense wavy curves are generally obtained, and in these curves a convex outer side, frequently with overthrust folds, and a concave inner side, often conspicuous for frequency of subsidences, may be distinguished.

If that part of the earth which is called the "Old World" be studied from this point of view, that is, by searching out the main lines of folding and, when they are fragmentary, reconstructing them in their entirety from the fragments, the general results may be summed up as follows:—

The first system of folding begins at Genoa, runs through the Apennines, through Sicily, Northern Atlas, bends at Gibraltar directly across the Straits, continues through the Cordilleras of Southern Spain and the Sierra Nevadas, and reaches to the Balearic Islands. This great curve we shall call the curve of the Western Mediterranean.

The second curve forms the other side of the Adriatic. It includes Dalmatia, Albania, Greece, stretches then through the Islands of Crete and Cyprus, and finds its continuation in the Taurus. This is the Dinarian-Taurus curve.

The third curve runs along the course of the river Tigris, includes the Zagros chain, stretches along the east coast of the Persian Gulf and then west of the Indus towards the north to within the district north-west of the city of Dera Ismail Khan. This curve includes the whole of the Iranian highlands, and is, therefore, called the Iranian curve.

The fourth curve is short and reaches from Dera Ismail Khan to the river Jhelum. This piece forms the outer boundary of the great Hindoo Koosh mountain system, and this edge is in a remarkably violent way disturbed and overthrust. The edge is called the Salt Range.

The fifth curve is formed by the Himalayas. On the outer edge of these high mountains also the strata lie completely reversed, the older above the more recent. It stretches south-south-east to the point where the Brahmaputra leaves the mountains.

Against this abuts with sharp boundary the greatest of these curves, which we shall call the Burmese. It runs, defined by the course of the Irawady, in an almost meridional direction from Central Asia, and its outer edge runs from Cape Negrais, through the Andaman and the Nicobar Islands, Sumatra and Java, to the Sunda Islands.

A large number of more or less parallel or concentric systems of folds occur in Central Asia along the outer edges of the Burmese curve, the Himalayas, and the Salt Range, and these mighty chains stretched one behind the other, forming the highlands of inner Asia, appear, as far as is known to-day, to be without exception folded to the south, exactly as the curves just mentioned. These southwardly folded chains of inner Asia terminate towards the Pacific Ocean in separate arc-like ends, and in this way form along the east coast of Asia those curious curved series of islands which have frequently been compared to flower garlands.

The first of these arcs is formed by the Loo-choo Islands, the second by Japan, in which in the centre of the island of Hon-Schiu a great cross disturbance or meeting of two curves occurs. The third arc is formed by the Kuriles which run from Yesso to Kamtschatka; Kamtschatka consists partly of a continuation of the Kuriles and partly of a second inner arc. With these arcs, standing in such intimate connection with the east of Asia, is connected as a broader, larger curve the series of the Aleutians and the peninsula of Alaska.

All these curves, beginning with the bend at Gibraltar, that is with the portion lying in Spain, I say all these curves from Gibraltar to Kamtschatka and the Aleutian Islands are distinguished by being folded towards the south. They produce with one another a curiously formed but very sharp boundary against the table-lands, to the north of which they lie. To these table-lands belong all Africa south of the Atlas, Arabia with Palestine and Syria, and the peninsula of East India. The high Drakenberg Mountains of the colony of Natal or the Ghats on the western edge of the Indian Plateau are not true mountains but broken-off table-lands, and when one has ascended them, a more or less flat high table-land is seen.

In this way the old world is divided for us into two parts, the boundaries of which do not coincide with the present divisions of the world. We call all land north of the outer edges of the boundary curves above named, Eurasia, and the table-lands lying to the south are indicated by the word Indo-Africa. Indo-Africa, therefore, extends from the mouth of the Wadi Draha on the Atlantic to the mouth of the Brahmaputra on the Bay of Bengal.

Let us glance for a moment at the other parts of the earth's surface. Both North and South America exhibit the remarkable phenomenon of being in the main folded towards the west, that is towards the Pacific Ocean. At Williams Sound, south of the peninsula of Kenai, there succeed to the arc of the Aleutians the series of the Western system of North American folds, which are continued in Lower California and Mexico. South of the Gulf of Tehuantepec the conditions change and relations appear which exhibit a certain similarity to the curve of the Western Mediterranean. The following is observed :—

In the north of Venezuela series of folds occur which run from east to west and which reach their clearest expression in the contour of the Island of Trinidad. It seems that these folds find their continuation in Tobago and the Lesser Antilles. With approximate certainty one follows through the Lesser Antilles the trace of a mountain system which comes over from the Virgin

Islands to Porto Rico, and in San Domingo splits into two parts. One part finds its continuation in Jamaica and the other in Southern Cuba.

A further curve forms the whole northern part of Cuba, and in Guatemala and Honduras this same series of folds is seen running directly across the contour of Central America from the region of the Caribbean Sea to the Pacific Ocean. In this region, therefore, the direction of the folds runs directly across the contour of the land. It cannot be seen how the series of folds in Honduras are continued, and the Galapagos consist only of volcanic rocks. It may, however, easily be observed that rocks similar to those forming the curve of the Antilles just mentioned occur in Venezuela, and thence form three systems, reaching out toward Ecuador, and finally re-uniting into one, and from there form a single mighty series of folds, giving rise to the high Cordilleras of the Andes, among which the great volcanoes occur like foreign bodies.

A new curve begins at the Bay of Arica, which traces the west coast of Bolivia, runs through Chili and Western Patagonia, and finally bends round Cape Horn and reaches Staten Island with east-and-west strike. All these series of folds are turned to the west with the exception of the above-mentioned distorted curve in the Antilles and the southern portion in Staten Island.

Australia exhibits predominantly eastwardly folding. The westerly part of the Australian continent corresponds to a table-land of similar formation to that of Indo-Africa and is possibly a continuation of it. The eastern edge is bounded by a long series of folds which are continued into Van Diemen's Land. New Zealand and New Caledonia are portions of outlying folds which are to Australia what the mountain ranges of the Salt Range or the Himalayas are to the part of inner Asia farther north.

Let us now return to that part of the earth which we know most accurately, namely, to Europe, or, as we should more exactly call it, to Western Eurasia. The phenomena are here peculiarly complicated, indeed they seem to reach a higher degree of complexity than anywhere else in the world. Whereas all the bounding curves of Eurasia already mentioned are folded towards the south and as also through the whole of Central Asia the southerly direction of folding predominates, the systems of folding in mid-Europe are directed to the north, and, moreover, Europe has been folded over and over again and always towards the north.[1] -

Let us begin in the north-west. Iceland, like Jan Mayen, is of volcanic origin. The Western Hebrides, all Norway, the Lofotens to Magerö, and up to the North Cape consist of primeval gneiss. If one passes over, however, from the islands to North-Western Scotland, rocks are immediately encountered which are completely overturned, which have been thrust up on to the old gneiss area in reversed order, and which form the outer edge of a great series of folds. The general strike of these folds is towards the north-east. The series includes a great part of Ireland and Wales and portions of England, all Scotland, and finds its continuation in the western folds of Norway. This was once a uniformly folded highland, of which we see to-day only remnants, and among these remnants flows the sea. This we call the Caledonian System.

This system of folds is of very great age, and for those who have made a closer study of geology we would add, that in them the Silurian rocks are folded, while the lower Devonian deposits lie horizontally. The age of the Caledonian folds is therefore greater than that of the Devonian deposits.

On the west coast of Ireland, south of the mouth of

[1] See "Geological Structure of Europe," Suess, with map, in last number of Record.—Trans.

the river Shannon, we again meet with the overthrust edge of a series of folds. This overthrust edge stretches directly across the southern part of Ireland, reaches Wales at St. Bride's Bay, and passes straight across the southern peninsula of Wales, through the coal fields of Glamorgan, directly across the Bristol Channel to the Mendip Hills, then, covered by more recent sediments, across the south of England to Calais and the district of Douai and Valenciennes in the vicinity of the boundary between France and Belgium. The overthrust is here very well known, because just on this line in France are important deposits of coal; they are all more or less inverted. The strike of this outer edge and the corresponding folding is in an easy curve from west-north-west to east-south-east.

Everything lying to the south of this line, that is Kerry and Cork, Cornwall and Devon, Normandy and Brittany, as far as Vendée, is made up of folds of the same direction of strike; they were all folded towards the north and later broken down, that is, divided up into horsts. It may also be here remarked that the geological age of this system of folds is known and that it is less than that of the Caledonian. The time of principal folding falls in the later part of the Carboniferous age, because the older members of the coal formation have been concerned in the folding, while the younger members overlap the already denuded folds. We therefore designate the age of this folding as intercarboniferous. The highest mountains of this system seem, as far as we can judge from the remaining fragments, to have been in Brittany, perhaps in Morbihan; and as the peninsula of Brittany was called by the Romans Armorica, we call this system of folds the outer edge of which, as already stated, ran from the Shannon to the Franco-Belgian boundary, the Armorican folds or the Armorican mountain system.

Beginning at the point just mentioned, between Douai and Valenciennes, the direction of the folds changes; they now strike east-north-east. Here again we have to do with a completely overturned and overthrust outer edge, the nature of which may be exactly determined from the structure of the Belgian coal measures. The group of folded horsts, with which we must now deal, is particularly large. The overthrust outer edge is not visible at many places; it is seen, as already stated, in the Belgian coal measures; on the other side the Rhine it disappears and is not again visible till it crops up again far east on the eastern bank of the Sudeten, in the overthrust of the western part of the coal measures of Ostrau.

The horsts of these fragmentary mountains exhibit folds which strike in the west towards the north-east or north-north-east, and further along towards the east, then towards the east-south-east, south-east, and finally towards the south. They thus form a great curve convex towards the north, and the most important horsts are as follows:—First, in the Belgian coal fields, the whole system of folds on the Rhine and as far as the Taunus, further south the Black Forest, the Vogesen (Vosges) and the eastern part of the central plateau of France, then in the east the Hartz, and the series of mountain fragments more or less intimately connected with the Bohemian mass, stretching from the Thuringian Forest to the above mentioned coal fields at Ostrau.

The convexity of this curve is most clearly seen in the relations of the Ore Mountains (Erzgebirge) to the Giant Mountains (Riesengebirge.) In the vicinity of Hof in Bavaria there crops out the Münchberg gneiss, the base of the completely levelled ruins of a particularly important mountain, which was at one time perhaps the highest of this mighty system of folds, and since this country, the Saxon Vogtland, used to be called at one time the land of the Variscians, the name Variscian folds or Variscian Highlands has been selected for the whole curve from the central French plateau to the Sudeten. Nothing but the following up of the structure of the horsts has made it possible to recognize in the present fragmentary relief the unity of the old German mountain system.

The age of the Variscian range is exactly the same as that of the Armorican, that is, the principal epoch of folding belongs to the later Carboniferous.

Proceeding further to the south we easily see that the Alps and the Carpathians are nothing else than a third system of similar curves. With overturned outer edges the folds of the Alps stretch from the Durance through Switzerland, Bavaria and Austria. Their development towards the north has been sharply hemmed in by opposing horsts, the remnants of the Variscian curve. So, for instance, the folds of the Alps abut against the broken-off eastern edge of the central plateau of France, which rises in the neighborhood of Lyons, then against a small gneiss cliff which rises near Dôle in the neighborhood of Besançon, further against the southern edge of the Black Forest, and as soon as they have passed the southern end of the Bohemian mass, they turn towards the north, being no longer hemmed in, forming the great curve of the Carpathians. This system is called the Alpine System of folds. It is much younger than the preceding ones, and the principal epoch of its folding lies in Tertiary times. The folds are continued westwards; towards the north overthrust strata are met with all through Southern France as far as the Pyrenees. And the Pyrenees lie south of Armorica in a way similar to that of the Alps within the Variscian folds.

If we now consider the main features of this picture, the whole middle and north of Europe is seen to consist of a series of folds or scales of the crust of the earth thrust one over the other towards the north in such a way that the northern folds are the oldest, that they were broken down, that this process of degradation was succeeded by new foldings from the south, and that each time the new folds abutted against or were hemmed in by the horsts, that is, the projecting remains of the preceding folds.

The systems of folds, or scales, into which Europe may be divided are therefore :—

1. The Caledonian system, inside the gneisses of the Hebrides and Lofotens ;

2. The Armorican and Variscian curves ;

3. The curve of the Pyrenees and that of the Alps and Carpathians. What the relations of these are to the systems of folds immediately following and directed towards the south, namely, those of the Western Mediterranean and the Dinarian-Taurian curves, which, indeed, form only a continuation of the great series of the Eurasian limit curve, we are to-day not in a position to give any information.

We see how in this way our conceptions with regard to the surface of the earth gradually change. Lines which formerly had almost no significance seem to us now of great importance. In many cases the relief gives us a true picture of the structure, in others we must entirely ignore the relief. To-day the Alps rise to the greatest heights in Europe and present to us all their charms of landscape, but there can be almost no doubt that from the whole structure of the folds there once lay to the north of them on the Armorican and Variscian series of folds eminences of equal importance, and in a still earlier time similar heights probably existed in the Caledonian region. Now we distinguish table-land and folded-land more sharply from one another, and we learn to recognize the significance of subsided areas. The most striking of these are the oceanic depths, and although time will not allow me to go into details with regard to their formation and their probable origin, the following facts may be presented :—

In the first place, one sees that where the Indo-European boundary curves meet the ocean, *i.e.* (with the exception of the Persian Gulf) at the mouth of the Brahmaputra and from there on all along the east coast of Asia and the whole west coast of North and South America, with the single exception of the coast of Guatemala and Honduras, that is, from the Brahmaputra to Cape Horn, all along this coast the direction of the folds is towards the ocean. The Pacific Ocean particularly is almost entirely encircled by folds which run parallel to its coast line. From Cape Horn eastwards to the Brahmaputra, that is, in the Atlantic area and in the area of the western half of the Indian Ocean, the opposite is observed. Either we have table-lands which break off at the sea, like the Drakenberg Mountains in South-east Africa or the Ghats of India, or on the other hand mountain ranges break off at the coast, as was, for instance, the case in the Armorican horst, and only very exceptionally, as in the case of the Antilles and Gibraltar do curves run out into the sea.

The first type of ocean edge in which the shore is parallel to the folds is called the Pacific type; the second type in which there is no such conformity between shore and folding is called the Atlantic type.

We can go still further.

The distribution of stratified deposits permits of our saying, with a high degree of probability, that the Pacific Ocean, taken as a whole, is older than the other oceans, and that at one time a branch of it stretched directly across Indo-Africa to the locality where to-day exist the highest mountains—the Alps. Younger than the Pacific Ocean is the Indian Ocean as a whole, and the middle of the Atlantic Ocean, still considered only in a most general way, must be looked upon as the youngest of these three ocean areas. You see, ladies and gentlemen, to what great conceptions the unifying of the individual investigations carried on in the various countries of the world have led, and how questions and difficulties which were not known ten years ago rise before us. They have attracted in recent times the attention of many investigators. The finding of solutions for them, the amplifying of these solutions and the proving them correct is a great and attractive problem, and it is very probable that in following this line of study further many important views with regard to the formation of our planet will be brought forth.

Of course, potent activity prevails in other directions. In particular, I must not forget to allude to those studies which have arisen from the comparison of meteorites with the peculiarities of our world and which have led to the most surprising results with regard to the probable nature of the interior of our planet. In fact it may be said that most probably iron and magnesium form the principal part.

I must, however, deny myself the pleasure of going further into this subject.

From all these observations, as from all searching study of nature, many general points of view and connections of ideas arise.

The botanist who, in a quiet place observes the drooping branches of the weeping willow, sees in the beautiful tree a product of the art of gardening of ancient days, known only in pistillate individuals, and propagated only by shoots. If to the same student of nature genuine Muskatel be presented at the festive board, he knows that the Muskatel vine is known only in pistillate individuals, and an unsuspected chain of thought leads from the gay company to the quiet abode of the weeping willow, a change of thought quite foreign to his neighbor at the table.

On the map of the world, the geologist sees in Cook Strait, which separates the two islands of New Zealand, the crossing of a line of folding and his eye finds a repetition of the same in Matotchkin Strait in Nova Zembla. He sees in the Gulf of Pegu (Siam) a longitudinal subsidence of the middle part of such a series of folds, and he knows that the city of Vienna is built upon a like smaller depression similar in all its principal characteristics. If he travels from Bohemia to Görlitz, he recognizes in the Giant Mountains a fragment of the great Variscian curve which once stretched to beyond Lyons.

Here also a fresh network of ideas is woven. But this is not the final aim of a great science.

Two things, said Immanuel Kant, above all others, excited his wonder—the starry heavens and the depths of the human mind.

The child is delighted with the many little lights in the skies of night and gazes uncomprehendingly into the immeasurable depths of the universe. Science teaches us the motions of the stars; it teaches how small is our earth and how small we ourselves are ; the boldest fancy shrinks before the sublime reality.

The human mind—each of us guesses its immeasurable depths, but only a few are capable of fathoming these depths, a few to whom earnest studies have granted a true insight into its phenomena. They know more of the inner man than we, we who speak wonderingly of it as a child of the starry heavens. Thrice enviable, however, are those chosen ones to whom it is granted not only to see but to minister to the mind diseased, and who are accompanied to their lives' end by the thanks of saved souls.

A third wonder is proffered us by geology. Beside the microcosm of man, and the macrocosm in the expanses of the firmament, there is opened to you the unlimited horizon of time.

The thousands of years of human tradition vanish as moments. How long frost and rain have gnawed at the mighty Alps, we do not know. How long it is since these mountains were formed, how long before the Alps the Variscian curve was built, how long before this the Caledonian curve, how long before this the gneisses of the Hebrides were folded and rumpled up, no man can say. When, in each of these cases, the foldings and when the great subsidences occurred, when the crust of the earth first solidified around the core of iron, we know not. The distances of the fixed stars, with but few exceptions, we are ignorant of, and here also we lack every measure and comparison.

He who gives himself to such reflections is lifted into a sphere in which not only human measures disappear, but the little human individual too, and he feels himself at the same time melt away like a cloud of mist before the sun, because he is no longer concerned with earthly but with cosmic quantities. Thus we reach not only the limits of our knowledge, the limits of our imagination, but the limits of our faculty of comprehension.

He who returns from such studies to the plane of commonplace daily life is strengthened as one who descends from mountain heights.

I dare not hope, in such a short address, to have awakened in you similar feelings, but will you not at least carry away with you, in opposition to the sickly pessimism which here and there is preached, the remembrance that in our day mankind has risen to views regarding the essence of natural phenomena, which are grander than the race has ever possessed in times past, and that although nations stand armed against nations, there are, nevertheless, in all cultured peoples men who, high above these variances, strive together with the investigators of all peoples of the earth untiringly and without envy, as brothers, towards a truer conception of the facts and laws of Nature.

Some Common Birds in their Relation to Agriculture.[1]

By F. E. L. Beal, B.S.

Introduction.

It has long been known that birds play an important part in relation to agriculture, but there seems to be a tendency to dwell on the harm they do rather than on the good. Whether a bird is injurious or beneficial depends almost entirely upon what it eats, and in the case of species which are unusually abundant or which depend in part upon the farmer's crops for subsistence the character of the food often becomes a very practical question. If crows or blackbirds are seen in numbers about cornfields, or if woodpeckers are noticed at work in an orchard, it is perhaps not surprising that they are accused of doing harm. Careful investigation, however, often shows that they are actually destroying noxious insects, and also that even those which do harm at one season may compensate for it by eating noxious species at another. Insects are eaten at all times by the majority of land birds, and during the breeding season most kinds subsist largely and rear their young exclusively on this food. When insects are unusually plentiful, they are eaten by many birds which ordinarily do not touch them. Even birds of prey resort to this diet, and when insects are more easily obtained than other fare, the smaller hawks and owls live on them almost entirely. This was well illustrated during the recent plague of Rocky Mountain locusts in the Western States, when it was found that locusts were eaten by nearly every bird in the region, and that they formed almost the entire food of a large majority of the species.

[1] Reprinted from Farmers' Bulletin No. 54, U.S. Department of Agriculture, 1897.

Within certain limits, birds feed upon the kind of food that is most accessible. Thus, as a rule, insectivorous birds eat the insects that are most easily obtained, provided they do not have some peculiarly disagreeable property. It is not probable that a bird habitually passes by one kind of insect to look for another which is more appetizing, and there seems little evidence in support of the theory that the selection of food is restricted to any particular species of insect, for it is evident that a bird eats those which by its own method of seeking are most easily obtained. Thus, a ground-feeding bird eats those it finds among the dead leaves and grass ; a flycatcher, watching for its prey from some vantage point, captures entirely different kinds ; and the woodpecker and warbler, in the tree tops, select still others. It is thus apparent that a bird's diet is likely to be quite varied, and to differ at different seasons of the year.

In investigating the food habits of birds, field observation can be relied on only to a limited extent, for it is not always easy to determine what a bird really eats by watching it. In order to be positive on this point, it is necessary to examine the stomach contents. When birds are suspected of doing injury to field crops or fruit trees, a few individuals should be shot and their stomachs examined. This will show unmistakably whether or not the birds are guilty.

In response to a general demand for definite information regarding the food habits of our native birds, the Biological Survey of the Department of Agriculture has for some years past been conducting a systematic investigation of the food of species which are believed to be of economic importance. Thousands of birds' stomachs have been carefully examined in the laboratory, and all the available data respecting the food brought together. The results of the investigations relating to birds of prey, based on an examination of nearly 3,000 stomachs, were published in 1893, in a special bulletin entitled The Hawks and Owls of the United States. Many other species have been similarly studied and the results published, either in special bulletins or as articles in the yearbooks. The present bulletin contains brief abstracts of the results of food studies of about 30 grain and insect eating birds belonging to 10 different families.[1]

These species comprise among others the crow blackbirds and ricebirds, against which serious complaints have been made on account of the damage they do to corn, wheat, rice, and other crops; and also the cuckoos, grosbeaks, and thrashers, which are generally admitted to be beneficial, but whose true value as insect destroyers has not been fully appreciated. The practical value of birds in controlling insect pests should be more generally recognized. It may be an easy matter to exterminate the birds in an orchard or grain field, but it is an extremely difficult one to control the insect pests. It is certain, too, that the value of our native sparrows as weed destroyers is not appreciated. Weed seed forms an important item of the winter food of many of these birds, and it is impossible to estimate the immense numbers of noxious weeds which are thus annually destroyed.

If birds are protected and encouraged to nest about the farm and garden, they will do their share in destroying noxious insects and weeds, and a few hours spent in putting up boxes for bluebirds, martins and wrens will prove a good investment. Birds are protected by law in many States, but it remains for the agriculturists to see that the laws are faithfully observed.

[1] The limits of this bulletin preclude giving more than a very brief statement regarding the food of each bird, but more detailed accounts of some of the species will be found in the following reports of the Biological Survey (formerly Division of Ornithology and Mammalogy): The Crow—Bulletin No. 6, 1895, pp. 1–98; Woodpeckers—Bulletin No. 7, 1895, pp. 1–39; Kingbird—Annual Report Secretary of Agriculture, for 1893, pp. 233–234; Baltimore Oriole—Yearbook United States Department of Agriculture for 1895, pp. 426–430; Grackles—Yearbook for 1894, pp. 233–248; Meadowlark—Yearbook for 1895, pp. 420–426; Cedarbird—Annual Report Secretary of Agriculture, for 1892, pp. 197–200; Catbird, Brown Thrasher, and Wren— Yearbook for 1895, pp. 405-418.

THE CUCKOOS.

(*Coccyzus americanus* and *C. erythrophthalmus.*)

Two species of cuckoos, the yellow-billed and the black-billed, are common in the United States east of the Plains, and a subspecies of the yellow-billed extends westward to the Pacific. While the two species are quite distinct, they do not differ greatly in food habits, and their economic status is practically the same.

An examination of 37 stomachs has shown that these cuckoos are much given to eating caterpillars, and, unlike most birds, do not reject those covered with hair. In fact, cuckoos eat so many hairy caterpillars that the hairs pierce the inner lining of the stomach and remain there, so that when the stomach is opened and turned inside out, it appears to be lined with a thin coating of fur.

An examination of the stomachs of 16 black-billed cuckoos, taken during the summer months, showed the remains of 328 caterpillars, 11 beetles, 15 grasshoppers, 63 sawflies, 3 stink bugs, and 4 spiders. In all probability more individuals than these were represented, but their remains were too badly broken for recognition. Most of the caterpillars were hairy, and many of them belonged to a genus that lives in colonies and feeds on the leaves of trees, including the apple tree. One stomach was filled with larvæ of a caterpillar belonging to the same genus as the tent caterpillar, and possibly to that species. Other larvæ were those of large moths, for which the bird seems to have a special fondness. The beetles were for the most part click beetles and weevils, with a few May beetles and some others. The sawflies were all found in two stomachs, one of which contained no less than 60 in the larval stage.

Of the yellow-billed cuckoo, 21 stomachs (collected from May to October, inclusive) were examined. The contents consisted of 355 caterpillars, 18 beetles, 23 grasshoppers, 31 sawflies, 14 bugs, 6 flies, and 12 spiders.

As in the case of the black-billed cuckoo, most of the caterpillars belonged to hairy species and many of them were of large size. One stomach contained 12 American tent caterpillars; another 217 fall webworms. The beetles were distributed among several families, but all more or less harmful to agriculture. In the same stomach which contained the tent caterpillars were two Colorado potato beetles; in another were three goldsmith beetles and remains of several other large bettles. Besides ordinary grasshoppers were several katy-dids and tree crickets. The sawflies were in the larval stage, in which they resemble caterpillars so closely that they are commonly called false caterpillars by entomologists, and perhaps this likeness may be the reason the cuckoos eat them so freely. The bugs consisted of stink bugs and cicadas or dog-day harvest flies, with the exception of one wheel bug, which was the only useful insect eaten, unless the spiders be counted as such.

THE WOODPECKERS.

Five or six species of woodpeckers are familiarly known throughout the eastern United States, and in the west are replaced by others of similar habits. Several species remain in the northern States through the entire year, while others are more or less migratory.

Farmers are prone to look upon woodpeckers with suspicion. When the birds are seen scrambling over fruit trees and pecking at the bark, and fresh holes found in the tree, it is concluded that they are doing harm. Careful observers, however, have noticed that, excepting a single species, these birds rarely leave any important mark on a healthy tree, but that when a tree is affected by wood-boring larvæ the insects are accurately located, dislodged and devoured. In case the holes from which the borers are taken are afterwards occupied and enlarged by colonies of ants, these ants in turn are drawn out and eaten.

Two of the best known woodpeckers, the hairy woodpecker (*Dryobates villosus*) and the downy woodpecker (*D. pubescens*), including their races, range over the greater part of the United States, and for the most part remain throughout the year in their usual haunts. They differ chiefly in size, for their colors are practically the same, and the males, like other woodpeckers, are distinguished by a scarlet patch on the head.

An examination of many stomachs of these two birds shows that from two-thirds to three-fourths of the food consists of insects, chiefly noxious. Wood-boring beetles, both adults and larvæ, are conspicuous, and with them are associated many caterpillars, mostly species that burrow into trees. Next in importance are the ants that live in decaying wood, all of which are sought by woodpeckers and eaten in great quantities. Many ants are particularly harmful to timber, for if they find a small spot of decay in the vacant burrow of some wood-borer, they enlarge the hole, and as their colony is always on the increase, continue to eat away the wood until the whole trunk is honeycombed. Moreover, these insects are not accessible to other birds, and could pursue their career of destruction unmolested were it not that the woodpeckers, with beaks and tongues especially fitted for such work, dig out and devour them. It is thus evident that woodpeckers are great conservators of forests. To them, more than to any other agency, we owe the preservation of timber from hordes of destructive insects.

One of the larger woodpeckers familiar to everyone is the flicker, or golden-winged woodpecker (*Colaptes auratus*), which is generally distributed throughout the United States from the Atlantic Coast to the Rocky Mountains. It is there replaced by the red-shafted flicker (*C. cafer*), which extends westward to the Pacifi

The two species are as nearly identical in food habits as their environment will allow. The flickers, while genuine woodpeckers, differ somewhat in habits from the rest of the family, and are frequently seen upon the ground searching for food. Like the downy and hairy woodpeckers, they eat wood-boring grubs and ants, but the number of ants eaten is much greater. Two of the flickers' stomachs examined were completely filled with ants, each stomach containing more than 3,000 individuals. These ants belonged to species which live in the ground, and it is these insects for which the flicker is searching when running about in the grass, although some grasshoppers are also taken.

The red-headed woodpecker (*Melanerpes erythrocephalus*) is well known east of the Rocky Mountains, but is rather rare in New England. Unlike some of the other species, it prefers fence posts and telegraph poles to trees as a foraging ground. Its food therefore naturally differs from that of the preceding species, and consists largely of adult beetles and wasps, which it frequently captures on the wing, after the fashion of flycatchers. Grasshoppers also form an important part of the food. The redhead has a peculiar habit of selecting very large beetles, as shown by the presence of fragments of several of the largest species in the stomachs. Among the beetles were quite a number of predaceous ground beetles, and unfortunately some tiger beetles, which are useful insects. The redhead has been accused of robbing the nests of other birds; also of attacking young birds and poultry and pecking out their brains, but as the stomachs showed little evidence to substantiate this charge it is probable that the habit is rather exceptional.

It has been customary to speak of the smaller woodpeckers as "sapsuckers," under the belief that they drill holes in the bark of trees for the purpose of drinking the sap and eating the inner bark. Close observation, however, has fixed this habit upon only one species, the yellow-bellied woodpecker, or sapsucker (*Sphyrapicus varius.*) This bird has been shown to be guilty of pecking holes in the bark of various forest trees, and sometimes in that of apple trees, from which it drinks the sap when the pits become filled. It has been proved, however, that besides taking the sap the bird captures large numbers of insects which are attracted by the sweet fluid, and that these form a very considerable portion of its diet. In some cases the trees are injured by being thus punctured, and die in a year or two, but since comparatively few are touched the damage is not great. It is equally probable, moreover, that the bird fully compensates for this injury by the insects it consumes.

The vegetable food of woodpeckers is varied, but consists largely of small fruits and berries. The downy and hairy woodpeckers eat such fruits as dogwood, Virginia creeper, and others, with the seeds of poison ivy, sumac, and a few other shrubs. The flicker also eats a great many small fruits and the seeds of a considerable number of shrubs and weeds. None of the three species is much given to eating cultivated fruits or crops.

The redhead has been accused of eating the larger kinds of fruit, such as apples, and also of taking considerable corn. The stomach examinations show that to some extent these charges are substantiated, but that the habit is not prevalent enough to cause much damage. It is quite fond of mast, especially beechnuts, and when these nuts are plentiful the birds remain north all winter, instead of migrating as is their usual custom.

Half the food of the sapsucker, aside from sap, consists of vegetable matter, largely berries of the kinds already mentioned, and also a quantity of the inner bark of trees, more of which is eaten by this species than by any other.

Many other woodpeckers are found in America, but their food habits agree in the main with those just described. These birds are certainly the only agents which can successfully cope with certain insect enemies of the forests, and, to some extent, of fruit trees also. For this reason, if for no other, they should be protected in every possible way.

THE KINGBIRD.

(*Tyrannus tyrannus.*)

The kingbird is essentially a lover of the orchard, and wherever the native groves have been replaced by fruit trees this pugnacious bird takes up its abode. It breeds in all of the States east of the Rocky Mountains, and less commonly in the Great Basin and on the Pacific Coast. It migrates south early in the fall, and generally leaves the United States to spend the winter in more southern latitudes.

The kingbird manifests its presence in many ways. It is somewhat boisterous and obtrusive, and its antipathy for hawks and crows is well known. It never hesitates to give battle to any of these marauders, no matter how superior in size, and for this reason a family of kingbirds is a desirable adjunct to a poultry yard. On one occasion in the knowledge of the writer a hawk which attacked a brood of young turkeys was pounced upon and so severely buffeted by a pair of kingbirds, whose nest was near by, that the would-be robber was glad to escape without his prey. Song birds that nest near the kingbird are similarly protected.

In its food habits this species is largely insectivorous. It is a true flycatcher by nature, and takes a large part of its food on the wing. It does not, however, confine itself to this method of hunting, but picks up some insects from trees and weeds, and even descends to the ground in search of myriapods or thousand legs. The chief complaint against the kingbird is that it preys largely upon honeybees; and this charge has been made both by professional bee keepers and others. Many observers have seen the bird at work near hives, and there is no reason to doubt the honesty of their testimony. One bee raiser in Iowa, suspecting the kingbirds of feeding upon his bees, shot a number near his hives, but when the birds' stomachs were examined by an expert entomologist not a trace of honeybees could be found.

The Biological Survey has made an examination of 281 stomachs collected in various parts of the country, but found only 14 containing remains of honeybees. In these 14 stomachs there were in all 50 honeybees, of which 40 were drones, 4 were certainly workers, and the remaining 6 were too badly broken to be identified as to sex.

The insects that constitute the great bulk of the food of this bird are noxious species, largely beetles—May beetles, click beetles (the larvæ of which are known as wire worms), weevils, which prey upon fruit and grain, and a host of others. Wasps, wild bees, and ants are conspicuous elements of the food, far outnumbering the hive bees. During summer many grasshoppers and crickets, as well as leaf hoppers and other bugs, are also eaten. Among the flies were a number of robber flies—insects which prey largely upon other insects, especially honeybees, and which have been known to commit in this way extensive depredations. It is thus evident that the kingbird by destroying these flies actually does good work for the apiarist. Nineteen robber flies were found in the stomachs examined; these may be considered more than an equivalent for the four worker honeybees already mentioned. A few caterpillars are eaten, mostly belonging to the group commonly known as cutworms, all the species of which are harmful. About 10 per cent. of the food consists of small native fruits, comprising some twenty common species of the roadsides and thickets, such as dogwood berries, elder berries, and wild grapes. The bird has not been reported as eating cultivated fruit to an injurious extent, and it is very doubtful if this is ever the case, for cherries and blackberries are the only ones that might have come from cultivated places, and they were found in but few stomachs.

Three points seem to be clearly established in regard to the food of the kingbird—(1) that about 90 per cent. consists of insects, mostly injurious species; (2) that the alleged habit of preying upon honeybees is much less prevalent than has been supposed, and probably does not result in any great damage; and (3) that the vegetable food consists almost entirely of wild fruits which have no economic value. These facts, taken in connection with its well-known enmity for hawks and crows, entitle the kingbird to a place among the most desirable birds of the orchard or garden.

THE PHŒBE.

(*Sayornis phœbe.*)

Among the early spring arrivals at the North, none are more welcome than the phœbe. Though naturally building its nest under an overhanging cliff of rock or earth, or in the mouth of a cave, its preference for the vicinity of farm buildings is so marked that in the more thickly settled parts of the country the bird is seldom seen at any great distance from a farmhouse except where a bridge spans some stream, affording a secure spot for a nest. Its confiding disposition has rendered it a great favorite, and consequently it is seldom disturbed. It breeds throughout the United States east of the Great Plains, and winters from the South Atlantic and Gulf States southward.

The phœbe subsists almost exclusively upon insects, most of which are caught upon the wing. An examination of 80 stomachs showed that over 93 per cent. of the year's food consists of insects and spiders, while wild fruit constitutes the remainder. The insects belong chiefly to noxious species, and include many click beetles, May beetles, and weevils. Grasshoppers in their season are eaten to a considerable extent, while wasps of various species, many flies of species that annoy cattle, and a few bugs and spiders are also eaten regularly. It is evident that a pair of phœbes must materially reduce the number of insects near a garden or field, as the birds often, if not always, raise two broods a year, and each brood numbers from four to six young.

The vegetable portion of the food is unimportant, and consists mainly of a few seeds, with small fruits, such as wild cherries, elder berries, and juniper berries. The raspberries and blackberries found in the stomachs were the only fruits that might have belonged to cultivated varieties, and the quantity was trifling.

There is hardly a more useful species than the phœbe about the farm, and it should receive every encouragement. To furnish nesting boxes is unnecessary, as it usually prefers a more open situation, like a shed, or a nook under the eaves, but it should be protected from cats and other marauders.

THE BLUE JAY.

(*Cyanocitta cristata.*)

The blue jay is a common bird of the United States east of the Great Plains, and remains throughout the year in most of its range, although its numbers are somewhat reduced in winter in the Northern States. During spring and summer the jay is forced to become an industrious hunter for insects, and is not so conspicuous a feature of the landscape as when it roams the country at will after the cares of the nesting season are over.

Ornithologists and field observers in general declare that a considerable portion of its food in spring and early summer consists of the eggs and young of small birds, and some farmers accuse it of stealing corn to an injurious extent in the fall. While there may be some truth in these accusations, they have almost certainly been exaggerated. No doubt many jays have been observed robbing nests of other birds, but thousands have been seen that were not so engaged.

In an investigation of the food of the blue jay 292 stomachs were examined, which showed that animal matter comprised 24 per cent. and vegetable matter 76 per cent. of the bird's diet. So much has been said about the nest-robbing habits of the jay that special search was made for traces of birds or birds' eggs in the stomachs, with the result that shells of small birds' eggs were found in three and the remains of young birds in only two stomachs. Such negative evidence is not sufficient to controvert the great mass of testimony upon this point, but it shows that the habit is not so prevalent as has been believed. Besides birds and their eggs, the jay eats mice, fish, salamanders, snails and crustaceans, which altogether constitute but little more than 1 per cent. of its diet. The insect food is made up of beetles, grasshoppers, caterpillars, and a few species of other orders, all noxious, except some 3½ per cent. of predaceous beetles. Thus something more than 19 per cent. of the whole food consists of harmful insects. In August the jay, like many other birds, turns its attention to grasshoppers, which constitute nearly one-fifth of its food during that month. At this time, also, most of the other noxious insects, including caterpillars, are consumed, though beetles are eaten chiefly in spring.

The vegetable food is quite varied, but the item of most interest is grain. Corn was found in 70 stomachs, wheat in 8, and oats in 2—all constituting 19 per cent. of the total food. Corn is evidently the favorite grain, but a closer inspection of the record shows that the greater part was eaten during the first five months of the year, and that very little was taken after May, even in harvest time, when it is abundant. This indicates that most of the corn is gleaned from the fields after harvest, except what is stolen from cribs or gathered in May at planting time.

The jay's favorite food is mast (*i.e.*, acorns, chestnuts, chinquapins, etc.), which was found in 158 of the 292 stomachs and amounted to more than 42 per cent. of the whole food. In September corn formed 15 and mast 35 per cent., while in October, November and December corn dropped to an almost inappreciable quantity and mast amounted to 64, 82 and 83 per cent., respectively. And yet in these months corn is abundant and everywhere easily accessible. The other elements of food consist of a few seeds and wild fruits, among which grapes and blackberries predominate.

The results of the stomach examination show (1) that the jay eats many noxious insects; (2) that its habit of robbing the nests of other birds is much less common than has been asserted; and (3) that it does little harm to agriculture, since all but a small amount of the corn eaten is waste grain.

THE CROW.

(*Corvus americanus.*)

There are few birds so well known as the common crow, and unlike most other species he does not seem to decrease in numbers as the country becomes more densely populated. The crow is commonly regarded as a blackleg and a thief. Without the dash and brilliancy of the jay, or the bold savagery of the hawk, he is accused of doing more mischief than either. That he does pull up sprouting corn, destroy chickens, and rob the nests of small birds has been repeatedly proved. Nor are these all of his sins. He is known to eat frogs, toads, salamanders, and some small snakes, all harmless creatures that do some good by eating insects. With so many charges against him, it may be well to show why he should not be utterly condemned.

The examination of a large number of stomachs, while confirming all the foregoing accusations, has thrown upon the subject a light somewhat different from that derived solely from field observation. It shows that the bird's-nesting habit, as in the case of the jay, is not so universal as has been supposed; and that, so far from being a habitual nest robber, the crow only occasionally indulges in that reprehensible practice. The same is true in regard to destroying chickens, for he is able to carry off none but very young ones, and his opportunities for capturing them are somewhat limited. Neither are many toads and frogs eaten, and as frogs are of no great practical value, their destruction is not a serious matter; but toads are very useful, and their consumption, so far as it goes, must be counted against the crow. Turtles, crayfishes, and snails, of which he eats quite a large number, may be considered neutral, while mice may be counted to his credit.

In his insect food, however, the crow makes amends for sins in the rest of his dietary, although even here the first item is against him. Predaceous beetles are eaten in some numbers throughout the season, but the number is not great. May beetles, "dor-bugs," or June bugs, and others of the same family, constitute the principal food during spring and early summer, and are fed to the young in immense quantities. Other beetles, nearly all of a noxious character, are eaten to a considerable extent. Grasshoppers are first taken in May, but not in large numbers until August when, as might be expected, they form the leading article of diet, showing that the crow is no exception to the general rule that most birds subsist, to a large extent, upon grasshoppers in the month of August. Many bugs, some caterpillars, mostly cutworms, and some spiders are also eaten—all of them either harmful or neutral in their economic relations. Of the insect diet Mr. E. A. Schwarz says: "The facts, on the whole, speak overwhelmingly in favor of the crow."

Probably the most important item in the vegetable food is corn, and by pulling up the newly sprouted seeds the bird renders himself extremely obnoxious. Observation and experiments with tame crows show that hard, dry corn is never eaten if anything else is to be had, and if fed to nestlings it is soon disgorged. The reason crows resort to newly planted fields is that the kernels of corn are softened by the moisture of the earth, and probably become more palatable in the process of germination, which changes the starch of the grain to sugar. The fact, however, remains that crows eat corn extensively only when it has been softened by germination or partial decay, or before it is ripe and still "in the milk." Experience has shown that they may be prevented from pulling up young corn by tarring the seed, which not only saves the corn but forces them to turn their attention to insects. If they persist in eating green corn it is not so easy to prevent the damage; but no details of extensive injury in this way have yet been presented, and it is probable that no great harm has been done.

Crows eat fruit to some extent, but confine themselves for the most part to wild species, such as dogwood, sour gum, and seeds of the different kinds of sumac. They have also a habit of sampling almost everything which appears eatable, especially when food is scarce. For example, they eat frozen apples found on the trees in winter, or pumpkins, turnips, and potatoes which have been overlooked or neglected; even mushrooms are sometimes taken, probably in default of something better.

In estimating the economic status of the crow, it must be acknowledged that he does some damage, but, on the other hand, he should receive much credit for the insects which he destroys. In the more thickly settled parts of the country the crow probably does more good than harm, at least when ordinary precautions are taken to protect young poultry and newly-planted corn against his depredations. If, however, corn is planted with no provision against possible marauders, if hens and turkeys are allowed to nest and to roam with their broods at a distance from farm buildings, losses must be expected.

THE BOBOLINK, OR RICEBIRD.

(Dolichonyx oryzivorus.)

The bobolink is a common summer resident of the United States, north of about latitude 40°, and from New England westward to the Great Plains, wintering beyond our southern border. In New England there are few birds, if any, around which so much romance has clustered; in the South none on whose head so many maledictions have been heaped. The bobolink, entering the United States from the South at a time when the rice fields are freshly sown, pulls up the young plants and feeds upon the seed. Its stay, however, is not long, and it soon hastens northward, where it is welcomed as a herald of summer. During its sojourn in the Northern States it feeds mainly upon insects and small seeds of useless plants; but while rearing its young, insects constitute its chief food, and almost the exclusive diet of its brood. After the young are able to fly, the whole family gathers into a small flock and begins to live almost entirely upon vegetable food. This consists for the most part of weed seeds, since in the North these birds do not appear to molest grain to any great extent. They eat a few oats, but their stomachs do not reveal a great quantity of this or any other grain. As the season advances they gather into larger flocks and move southward, until by the end of August nearly all have left their breeding grounds. On their way they frequent the reedy marshes about the mouths of rivers and on the inland waters of the coast region, subsisting largely upon wild rice. After leaving the Northern States they are commonly known as reed birds, and having become very fat are treated as game.

They begin to arrive on the rice fields in the latter part of August, and during the next month make havoc in the ripening crop. It is unfortunate that the rice districts lie exactly in the track of their fall migration, since the abundant supply of food thus offered has undoubtedly served to attract them more and more, until most of the bobolinks bred in the North are concentrated with disastrous effect on the South-east coast when the rice ripens in the fall. There was evidently a time when no such supply of food awaited the birds on their journey southward, and it seems probable that the introduction of rice culture in the South, combined with the clearing of the forests in the North, thus affording a larger available breeding area, has favored an increase in the numbers of this species. The food habits of the bobolink are not necessarily inimical to the interests of agriculture. It simply happens that the rice affords a supply of food more easily obtainable than did the wild plants which formerly occupied the same region. Were the rice fields at a distance from the line of migration, or north of the bobolinks' breeding ground, they would probably never be molested; but lying, as they do, directly in the path of migration, they form a recruiting ground, where the birds can rest and accumulate flesh and strength for the long sea flight which awaits them in their course to South America.

The annual loss to rice growers on account of bobolinks has been estimated at $2,000,000. In the face of such losses it is evident that no mere poetical sentiment should stand in the way of applying any remedy which can be devised. It would be unsafe to assume that the insects which the birds consume during their residence in the

EARTHQUAKE RECORDS.

McGILL COLLEGE, MONTREAL, MAY 27TH, 10H. 14.5M. P.M.

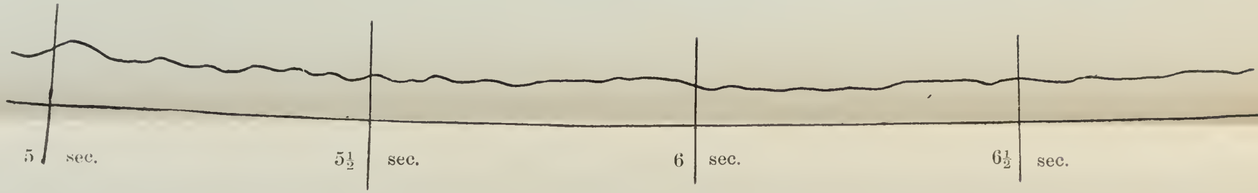
EARTH MOVEMENT.

Eastwards.

Westwards.

Scale 25 : 1.

E. and W. Horizontal trace.



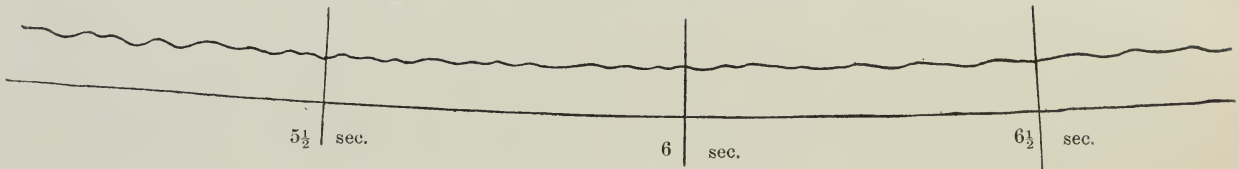
EARTH MOVEMENT.

Southwards.

Northwards.

Scale 24 : 1.

N. and S. Horizontal trace.



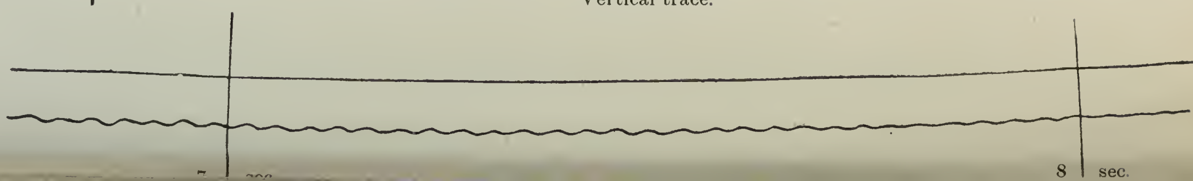
EARTH MOVEMENT.

Downwards.

Upwards.

Scale 10 : 1.

Vertical trace.



North can compensate for such destruction. If these figures are any approximation to the truth, the ordinary farmer will not believe that the bobolink benefits the Northern half of the country nearly as much as it damages the Southern half, and the thoughtful ornithologist will be inclined to agree with him. But even if the bird really does more harm than good, what is the remedy ? For years the rice planters have been employing men and boys to shoot the birds and drive them away from the fields, but in spite of the millions slain every year their numbers do not decrease. In fact, a large part of the loss sustained is not in the grain which the birds actually eat, but in the outlay necessary to prevent them from taking it all. At present there seems to be no effective remedy short of complete extermination of the species, and this is evidently impracticable even were it desirable.

Note on the Earthquake of May 27th, 1897.

The earthquake shock of May 27th, although not as severe as that of March 23rd, extended over a somewhat larger area. The district principally affected was, however, the same as on March 23rd and 26th, the centre of the disturbance being in each case the Island of Montreal. Reports of this shock were received from places covering a distance of approximately 350 miles along the St. Lawrence by a width of 250 miles.

The first rumbling was observed at 10h. 14m. 20s. p.m. (Eastern standard time), the main shock occurred at 10h. 14m. 30s., and the vibrations were appreciable to the senses until 10h. 15m. 25s. A subsequent earth tremor without distinct shock was also observed in Montreal, commencing at 10h. 45m. 20s. and continuing for 40 seconds.

The accompanying plates are greatly enlarged copies of portions of the traces obtained on the Seismograph at the

McDonald Physics Building. The greatest vertical movement there recorded amounted to $\frac{1}{400}$th of an inch, the greatest movement in a north and south direction was $\frac{1}{500}$th of an inch, and the greatest in the east and west direction $\frac{1}{280}$th of an inch.

The seconds marked on the traces indicate the time elapsed from the instant of starting the Seismograph. A certain amount of vibration is, of course, required to make the electrical contact which sets the machinery in motion.

C. M. AND H. C.

OUTLINE OF THE PRESIDENT'S RETIRING ADDRESS.

After thanking the members of the Society for the honour they had done him in electing him twice in succession to the highest office in their gift, and for the loyal support they had given him in the performance of his duties as President, he proceeded to review the work of the Society for the past two years.

1. He had to congratulate the Society upon the number of valuable papers which had been laid before it at the monthly meetings during the past two sessions. One of the special duties devolved upon the President was to secure original contributions on Natural History for those meetings. His endeavour had been to have all departments of Natural History represented in the communications made to the Society; and at least a measure of success in this aim had been secured. Important additions had been made to the volume of Canadian science by our members in the papers they submitted. But more might have been accomplished in this direction if all the members had charged themselves with co-operating according to their tastes, knowledge and opportunities. It ought not to be forgotten that the main object for which the Society exists was to foster a taste

for original research. It was a rallying centre for all persons in the community that were students of nature, and if members would lay themselves out to put the Society in possession, by written communications, of such observations as they had made on the departments of Natural History in which they were severally interested, it would at once be a stimulus to themselves to prosecute more eagerly their special line of study, and a great help to make the ordinary meetings of the Society attractive and useful. He could himself testify how the obligations under which he had lain to the Society had engaged him to lose no opportunity of providing matter in the department in which he worked as an amateur which might be serviceable to the Society. He knew that many more of the members who, like himself, were amateurs, and made the prosecution of some branch of science a holiday pastime, could produce papers that would be of value in widening the knowledge of science among the citizens; and he felt that the Natural History Society would not only strengthen itself, but would help to embellish the lives and adorn the homes of the mercantile and professional classes of Montreal, if it became the means of inducing many more of them to take up the study of some branch of Natural History.

2. Great improvements had been made in the Society's Museum. It was through the agency of the Museum—by the training which it gave, familiarizing those who frequented it with the acquisitions of Natural Science—that they expected to accomplish much of their work as a society, which aimed at encouraging the study of nature. They had been receiving from time to time additions to it in the way of donations from friends, and occasionally by exchanges, but in some departments it was far from being as complete as they could desire, if it was to exercise the educational influence they wished. It was, therefore, desirable that there should be a fund available

for the purchase of specimens. And, then, some expenditure was necessary towards cleaning and re-arranging the specimens they had. Much had been done with small means already in this direction by our zealous Honorary Curator, Mr. J. B. Williams, but much remained to be done, and in view of the prospective visit of so many distinguished men of science to Canada during the present summer, it would be well if a liberal grant could be at once made for this purpose. As to the Botanical specimens which he had himself collected for the Museum, and for which, through the kindness of the First Vice-President, Mr. J. S. Shearer, a cabinet had been provided, he hoped to have time this summer to have them duly arranged and deposited in the cabinet.

3. The Somerville Courses of Lectures of the two last seasons had been exceptionally able, popular and useful. The Course of 1896 had dealt with the natural products of the fields and forests of the Dominion, which are of economic value, and it was made specially interesting and valuable by being contributed to by the staff of the Government Experimental Farms. The lectures of the present year covered the field of human physiology, and they were most instructive and highly appreciated by the public, the attendance at them being unprecedentedly large. The Society was greatly indebted to the physicians of the city, who had so kindly placed their special scientific attainments at its disposal, for the enlightenment of the people, on the department of Natural Science which was of the greatest practical utility, and most nearly concerned the welfare of the race—the laws of human life. The last two Somerville Courses had done not a little to popularize science, and had thus promoted the aim of the founder.

4. The Record of Science still maintained its high character, and reflected the greatest credit on the Society. The issuing of this important publication, if nothing more

were accomplished, would justify the existence of the Natural History Society. To place within reach of the workers in Natural History a vehicle for communicating to the world the results reached was a very great service rendered to science. Such service the journal of this Society had long rendered, and no sacrifice the Society could make would be too great in continuing the publication, by which it extended its influence even far beyond the confines of the Dominion.

5. During the past two seasons the Society made a new departure which gives promise of the best results in instituting half hour Saturday afternoon lectures on Natural History, specially for the instruction of children. In this way good seed had been sown, and it was not too much to expect that the Society would in due time reap an abundant harvest from it, in finding added to its active membership not a few of those in whom a taste for the study of nature was first awakened at these Saturday lecturettes. For the initiation of this popular movement the credit was largely due to the Museum Committee, with the Honorary Curator at its head.

In leaving the chair, the President regretted one thing —that he had not been able, during his term of office, to endeavour raising a fund for enabling the Somerville foundation to pay the lecturers who honoured the Society by appearing on its platform. Many years ago he had been named convener of a committee having this aim in view. The subject had been talked of during the past year, but in view of the depressed financial situation it was deemed best not to make the attempt. It would be a great advantage to the Society to have a fund by which the services of distinguished lecturers could be secured. As Mr. Somerville's ecclesiastical successor, he naturally wished to see this important result reached; and if at any future time an effort in that direction were made, the Society might command any assistance he could render.

Field Day to Riviere Rouge.

Notwithstanding the fact that the official weather prophets had predicted that Saturday would be somewhat cold, with local showers, which is their modest way of describing a rainy, cheerless day, about a hundred and seventy-five persons boarded the special train at Windsor street station that had been engaged to convey the members of the Natural History Society to River Rouge for their annual field day. The number would have undoubtedly been greater had not the general opinion been that the weather would prove unfavorable for the occasion, but for those who participated in the excursion the decreased number was rather a benefit than otherwise. as there was no crowding on the cars, which rendered the run out and back all the more enjoyable.

The special train left the city about nine o'clock, and although the sky was at that time clouded over, Montreal island had scarcely been left behind before the clouds had all broken up and there appeared every prospect of a fine day. The run of sixty-two miles was made in two hours and a half, the comparatively long time being easily explained by the fact that it was a single-track road, which was pretty busy all day ; consequently rather long waits had to be made at some of the stations, although good time was made when actually running.

Prof. Frank D. Adams, the President of the Society, was unavoidably absent, so the party was, while on the train, in charge of Mr. John S. Shearer, the First Vice-President, the Secretary of the Excursion Committee, Mr. J. Stevenson Brown, assuming direction on arrival at River Rouge. River Rouge is a lumbering settlement belonging to the Hon. J. K. Ward, at the mouth of the river of that name, where it enters the Ottawa, just a couple of miles north-west of Calumet station. From the railway to the Ottawa river, about a quarter of a mile to one's left when going west, the ground is clear, and on it is built the lumbermen's shanties. On the right are hills that are thickly covered with forest of a virgin growth, having evidently been denuded of their timber in years gone past. The lumber is at the present time obtained some distance further up the River Rouge. Having arrived opposite the settlement, the party quickly disembarked, the cars returning to Calumet station, there to be side-tracked till the return.

At this point Mr. J. Stevenson Brown detailed to the party the programme arranged for the day; three parties would be formed of those willing to join for the purpose of hunting for geological, botanical and entomological specimens respectively. On behalf of the Hon. J. K. Ward, he also invited the party to a lunch of lumbermen's fare at the shanty, which was then ready. Acting upon the latter suggestion, most of the party adjourned to the shanty to partake of cold boiled pork, pea soup, boiled beans, bread and butter, all served up in lumbermen's ware, and green tea without milk or sugar, which was drunk out of tin pannikins. If the fare was plainer than that to which some of the guests were used, it was good and wholesome, and great inroads were made upon it by those whose appetites were sharp set. After lunch the exploring parties assembled and went off on their respective quests, the remainder of the guests taking walks through the woods or by the river side to watch the progress of the large logs that are brought down by the swift river current from above. The sun was found to be quite hot, hotter by far than on any previous day of this year, and the shade of the trees was much appreciated. The insects of the species that regarded the visitors in the light of so many edibles held a picnic on their own account, as the faces and hands of many of the guests soon bore witness. The mosquitoes especially must have enjoyed a course of city people after the hardskinned lumbermen that they have, as a rule, to put up with. But neither heat nor yet mosquitoes affected the ardor of the explorers. In and around the woods they went, keen on specimens, and were able to record good "bags" by the time their hunting was over. Some members of the party engaged in fishing, but whether the water at this point is too much disturbed by the floating logs or whether the fish were nervous, or what, the latter proved shy and refused to bite, leaving that work to the mosquitoes. Some of the more adventurous, especially the boys, clambered over the piles of logs that were collected at corners on the banks till they reached the outermost edge, to sit there within a foot or so of the swirling current that tossed the logs about on its seething surface as if they were so many splinters. Those who desired still more exercise scaled the rocky heights which fenced in the river till they reached a chute of noble appearance some three-quarters of a mile from the river mouth.

Everything, however, must come to an end, and from about four o'clock, in twos and threes, the members of the party commenced to assemble at the rendezvous agreed upon close by the railway track. The exploring parties were in the midst of comparing notes when, punctually to the minute, the special train again made its appearance and was at once boarded. After a few minutes' waiting and whistling for stragglers, the start was made for home. The halts made at the stations were longer than during the run out, trains coming in the opposite direction having to be waited for, but as the speed when running was about forty-five miles an hour and the cars cool and comfortable, the time passed quickly enough. Through the kindness of Sir William Van Horne, refreshments were served to the party on the train, and were much appreciated after the ramble through the woods. While *en route* for the city the names of the prize winners of the day in the various sections were announced.

In the geological section, under the leadership of Mr. Nevil N. Evans, no report was made. In the botanical party, which had been under the leadership of the Rev. G. Colborne Heine, Miss F. E. Currie, of 43 Lorne avenue, won the prize for the largest of named specimens, having twenty-three, Miss Urquhart, of 12 St. Famille street, winning that for unamed, having thirty-three specimens. In the entomological section, which was led by Mr. J. B. Williams, Mr. H. T. Pye, of 141 Stanley street, tied with Mr. G. A. Moore, of 24 Lorne avenue, each having caught nineteen different kinds of insects.

The party included, among others, Mr. and Mrs. John S. Shearer, Miss Shearer, the Hon. J. K. Ward, Mr. Albert Holden, Mr. F. W. Richards, Mr. N. N. Evans, the Rev. G. Colborne Heine, Mr. James Slessor, Mr. Stewart Munn and Miss Munn, the Misses Van Horne, Miss F. Campbell, Mr. James Baylis and Miss Baylis, Mr. and Mrs. A. R. Grafton, Mr. A. S. Ewing and Miss Ewing, Dr. Welsey Mills, Mr. J. B. Williams, Miss F. E. Currie, Miss Urquhart, Mr. H. T. Pye, Mr. G. A. Moore, Mr. and Mrs. T. H. Cripps and Miss Cripps, Mr. and Mrs. Robert Law, Mr. C. T. Williams and Miss Williams, Mr. Andrew Baile, Mr. H. McLaren, Mr. William Agnew, Mr. and Mrs. Charles Garth, Mrs. E. Bulmer (Detroit), Dr. and Mrs. Lovejoy, Mr., Mrs. and the Misses H. Cameron, Miss Paterson (Boston), Mrs, S. Patterson, (Port Hope), Mr. J. Stevenson Brown, Mr. C. S. J., Master and Miss Philips, Mr. and Miss Cayford, Mr. and Mrs. John Fair, Mrs. Kerr, Mr., Mrs. and Miss McCombe.

Montreal was reached at about half-past seven, after what every one admitted to have been a most successful day.

A hearty vote of thanks was accorded by the party to the Hon. J. K. Ward for his kindness in arranging for the guests at River Rouge, and three cheers were given for the C. P. R., who had so ably arranged for their comfort on the way out and home.

Report of Chairman of Council of the Natural History Society of Montreal, for the Year ending 27th May, 1896.

The Chairman of Council begs to report that the work of the Council has been regularly carried on during the past year. Nine meetings of Council have been held and eight meetings of the Society, all of which have been well attended, and showing increased interest in the work of the Society.

The Annual Field Day Excursion took place on the first Saturday in June of 1896, going to Ste. Jovite and proving a very attractive outing.

The Canadian Record of Science continues to be issued, due to the liberality of some of our members, as we are still without the Government grant for this purpose.

The Somerville Course of Lectures for the session 1897 proved a very enjoyable one, and was largely attended. The eight lectures were as follows, an extra being given by Dr. H. M. Ami on "Extinct Monsters" after the close of the regular Course :—

Thursday, Jan. 14th.—"Food and Digestion: What we Eat and what Becomes of it," by W. S. Morrow, M.D.

Thursday, Jan. 21st.—"The Blood and its Circulation and Distribution in the Body," by John W. Scane, M.D.

Thursday, Jan. 28th.—"Respiration: What, Why and How we Breathe," by A. Bruere, M.D.

Thursday, Feb. 4th.—"Waste and Repair : The Body as a Factory," by G. Gordon Campbell, M.D.

Thursday, Feb. 11th.—"The Nervous System: The Mechanism that Governs the Body and how it does it," by Neil D. Gunn, M.D.

Thursday, Feb. 18th.—"The Senses: How and what we Learn of the World about us," by A. Proudfoot, M.D.

Thursday, Feb. 25th.—"Voice and Speech: How we Sing and Speak," by H. S. Birkett, M.D.

Thursday, March 4th.—"Age and Function: The Body and its Work at Different Periods of Life," by D. J. Evans, M.D.

The Saturday Half Hour Lectures to Young People proved very popular and attracted large numbers of the young folk. Unfortunately Mr. Kearley was too ill to give his paper.

The attendance at the Museum has been large, showing an increase over last year. On Saturdays, being a free day, we have sometimes had as many as one hundred visitors.

Many interesting additions have been made to the Museum during the past year.

It is very desirable that some of our wealthy citizens should do something in the way of an endowment fund towards helping on the good work of the Society.

Natural History classes are now being held at the Protestant schools, which is a step in the right direction.

We have to mourn the loss through death during our past year of the Rev. Dr. Smyth, Messrs. E. D. Lacey, John Kerry, Geo. Kearley, Dr. Gentles and Mr. J. H. R. Molson, some of whom were very active members. We have added fifteen new names to our membership list.

The whole respectfully submitted.

GEO. SUMNER,
Chairman of Council.

MUSEUM REPORT FOR 1896–7.

The cleaning and re-arranging of the Foreign Birds has been completed this year, and, with the exception of the Humming Birds, they have all been named and labelled.

A large part of the "Ferrier" Collection of Egyptian Curiosities has also been cleaned, re-arranged and re-labelled.

A number of specimens were obtained by the Curator while in England last summer, in exchange for some of our duplicates, and at the same time an interesting series of British birds, nests and eggs were presented to the Museum by Mr. R. W. Chase, of Birmingham.

None of the live reptiles which were brought over by the Curator from the Zoological Gardens in London and from the Derby Museum, Liverpool, have survived the winter, *except three English frogs.*

The Crocodile and Puff Adder have, however, been mounted, and, in this form, will remain as permanent additions to the Museum.

Other additions might be made in exchange for some of our duplicates, as opportunities occur, and so gaps in our collections might be filled up.

Our Canadian series of Mustelidæ (the Weasel family) is complete, *with the exception* of the *Wolverene ;* and our birds are, at present, without any specimen of the *Vulture* family.

Two cases of Canadian Beetles, which have been stored away for some years, have been cleaned, re-arranged and placed on exhibition near the Insect Cabinet, and though not a complete series, they give a good general idea of the principal families of Coleoptera that are found in this country.

The Entomological Society propose to make considerable additions this year to the insect department.

Mr. Dunlop has named and arranged a number of birds' eggs, and I have placed movable covers over the egg cases to prevent injury from too much light.

Complete lists of additions and donations have been given at our monthly meetings, and need not, therefore, be repeated here in detail.

The Museum Committee arranged for the series of Saturday afternoon lectures to young people during the months of February and March on different objects in the Museum, the attendance at which was very good. Last year the numbers rather fell away towards the close of the Course, but this year the largest attendances were at the two or three closing lectures.

The number of visitors to the Museum has been considerably larger than last year. On Saturday—the free day—it has varied from 10 or 12 to about 100. On the other days, when only members are free, the number of visitors has been about 350, so that, including also the evenings of the Somerville Lectures, about 2,000 visitors must have been to the Museum during the year.

There is still much work needed to put the whole Museum into a good state of order. The collection of Fishes, and also that of Minerals, requires cleaning, re-arranging and labelling, and there are many objects stored away in drawers and cupboards, which would form interesting and valuable additions to the Museum if they were put into a proper state for exhibition.

J. B. Williams,
Curator.

Montreal, June 3rd, 1897.

NATURAL HISTORY SOCIETY OF MONTREAL,

IN ACCOUNT WITH

F. W. RICHARDS, *Hon. Treas.*

FROM MAY 28TH, 1896, TO JUNE 3RD, 1897.

Dr.

To balance cash on hand	$232 50
" Rents	900 00
" Members' Subscriptions	587 00
" Donations	213 00
" Entrance Fees to Museum	21 50
" Rebate of tax *re* widening Palace Street	18 20
" RECORD OF SCIENCE	15 08
" Cash from sale of old benches	9 00
" Surplus from Field Day and Conversazione	3 61
" Interest as per bank book	1 64
	$2001 53

Cr.

By Superintendent's Salary (13 months), $494.00 ; Commission, $50.85	$544 85
" Record of Science	288 02
" Repairs and Renovations	211 31
" Museum	206 27
" Lighting	139 68
" Fuel	137 85
" Sundry Expenses	128 41
" Fire Insurance	127 50
" Printing	95 08
" Lecture	49 45
" City Water Tax	33 95
" Cash on hand	39 16
	$2001 53

Audited and found correct,

A. Holden,

Montreal, June 3rd, 1897.

The receipts ($1769.03) for the past year shew a falling off of nearly one hundred dollars, due to the failure of our usual surplus from the Field Day, which, combined with a margin, netted only $3.61, as compared with $83.18 of the previous year, together with $35 less revenue from rents from the building. In 1896 the revenue included the sum of $223.18, proceeds of the sale of the dividing wall with the premises next door. The total amount of the different items in which there is a decrease is $126.19, added to the proceeds of the dividing wall, shew a total of $349.35. As an offset to this heavy handicap, on the past year's finances I am very glad to announce that economical and prudent management has enabled us to close the year with no outstanding accounts, and with a small balance in hand. There is a liability, however, in connection with the Record of Science, but the printers have not yet rendered their account, and I am unable to say what the exact amount is (probably $150). I am also pleased to be able to say that the following items of our income shew an increase :—

Membership Subscriptions	$587.00	against	$562.00	Increase,	$ 25.00
Donations	213.00	"	25.00	"	188.00
RECORD OF SCIENCE	15.08	"	3.80	"	11.28
Entrance Fees to Museum	21.50	"	12.90	"	8.60
Rebate of Tax	....	"	....	"	18.20
					$251.08

In our expenditure the following items shew a decrease:

Light Account	$139.68	against	$207.40	Decrease,	$67.72
Library and Museum	206.27	"	285.67	"	79.40
Sundry Expense Account	128.41	"	163.10	"	34.79
RECORD OF SCIENCE	288.02	"	360.86	"	72.84
					$254.75

The building and contents are insured against fire to the amount of $21,000. The premiums were paid last June, $127.50 for three years, so that for the next two years this item will not have to be provided for.

In connection with the reseating of the Hall, it may be interesting to note that we have received from the sale of old benches (one only remaining on hand), $32.50; the Plymouth Brethren paid towards the new chairs, $50.00; value of bench on hand, $1.00; total, $83.50.

This amount deducted from the cost of the new chairs, $175.00, shews a net cost to the Society of $92.50 for this much-needed improved seating for the Hall.

In conclusion, I would beg to urge all present to assist in making our Annual Field Day on Saturday the success which from the Treasurer's point of view is only calculated upon the amount handed to him when the accounts are adjusted, which has ranged all the way from $35 to $83 during the past seven years, excepting last year, when coupled with the conversazione, we only realized $3.61. Not since 1889, when $8.72 was the surplus, has such a poor showing resulted, and I earnestly hope that Mr. Shearer will have the pleasure of handing me at least one hundred dollars in order to, in a small measure, make up for what we ought to have had last year.

Report of the Library Committee.

I have to acknowledge the very useful and intelligent help I have received from Mr. Griffin, the Superintendent, which is always so readily and cheerfully given, and without which the work done could not have been accomplished.

There is little to report concerning the Library, as the whole time the Librarian has had for the work has been spent in receiving and acknowledging the exchanges and in completing the arrangement of the books in the cases, and making a list of the books as they stand on the shelves. A copy of this list has been placed in each of the cases. When these are arranged alphabetically an important step will have been taken in the preparation of the general catalogue. A large number of volumes are ready for the binder, but as the glass cases are full and the closets under them filled with works in Russian, Spanish, Italian and Swedish languages, there will be no room for the accumulating volumes. It will, therefore, be the work of the Committee for the ensuing year to provide additional shelving.

It is encouraging to find that the library has been more frequented by members than formerly.

I have to acknowledge the donation of a copy of the Geological Atlas of the United States from the United States Geological Survey, also a copy of Wental's History of Birds of Montreal from Mr. Drysdale, the publisher.

Fears were entertained that the tariff proposed by Mr. Laurier's Government would interfere with the receiving of the exchanges from foreign countries. The Council of the Society, therefore, petitioned the Finance Minister on the subject, and it is hoped that the changes made in the tariff will allow these books to come to us free of duty.

Respectfully submitted.

E. T. Chambers,
Hon. Librarian.

Report of the Editing and Exchange Committee.

Gentlemen,—During the past year the publication of the *Canadian Record of Science* has continued as usual. Three numbers have been issued already, and a fourth is now in press. It has, however, unfortunately, been found to be impossible to issue the several numbers on the dates when they were due, owing to the absence of the Editor from town during the summer months.

The rule of accepting only papers of merit and as far as possible only original papers for publication has been adhered to and a high standard has thus been maintained. One or two papers which appeared in German periodicals, and which were of especial importance to scientific workers in Canada, have also been translated and published.

As in past years, a large number of valuable exchanges have been received for the *Record* and placed in the library.

Respectfully submitted.

Frank D. Adams,
Chairman.

Book Notice.

Lawrence M. Lambe, F.G.S., F.G.S.A., of the Canadian Geological Survey, has published in the Transactions of the Royal Society, in successive years ('92, '93, '94) three monographs on the sponges of the Western coast of Canada and Behring Sea, also in '96 a monograph on the Atlantic coast sponges.

He has described and catalogued 56 species from the West coast, most of which are new and belong chiefly to the Monaxonida.

Those from the East coast number 30 modern and one fossil, *Craniella Logani.*

It is interesting to note that seven species and most of the genera are common to both coasts. It is rather unfortunate that the last publication is in the octavo form, as it precludes binding them together.

These publications bring this somewhat neglected part of Canadian Zoology well up to date, and forms a ready and valuable means of determining the sponges which are so abundant on our coasts. The illustrations and descriptions are well executed and complete, which greatly facilitates their determination. The collection from the West coast were made by a large number of men, those from the East coast chiefly by Sir William Dawson and Mr. Whiteaves. The following are lists of species, catalogued and described by him from the respective coasts :—

SPONGES FROM THE PACIFIC COAST.

Monaxonida.

Axenella rugosa
Chondrocladia Alaskensis
Chondrocladia pulchra
Clathria levigata
Clathria Loveni
Desmacella peunata
Esperella adhaerens
Esperella helios
Esperella hispida
Esperella lingua
Esperella modesta
Esperella occidentalis
Esperella serratohamala
Esperiopsis laxa
Esperiopsis Quatsinoensis
Esperiopsis rigida
Esperiopsis Vancouverensis
Eumastiu sitiens
Halichondria disparalis
Halichondria panicea
Iophon chelifer
Iotrochota magna
Myxilla Amakuakensis
Myxilla Barentsi
Myxilla Behringensis
Myxilla firma
Myxilla lacumsa
Myxilla parasitica
Myxilla rosacea
Petrosia hispida
Phakellia Dalli
Phakellia papyracea
Phakellia ventilabrum
Plocamia Manaarensis
Polymastia laganoides
Polymastia Pacifica
Reniera cinerea
Reniera mollis
Reniera rufescens
Suberites concinnus
Suberites latus
Suberites montalbidus
Suberites montiniger
Suberites simplex
Suberites subena
Tedania fragilis
Toxochalina borealis

Tetractinellidae.

Craniella spinosa
Craniella villosa
Cydonium Mülleri

Hexactinellidae.

Aphrocalliste Whiteavesianus
Bathydorus Dawsoni
Rhabdocalyptus Dowlingii

Calcarea.

Grantia Comoxensis
Lenconia pyriformis
Sycon compactum

SPONGES FROM THE ATLANTIC COAST.

Monaxonida.

Chalnia oculata
Cladorhiza abyssicola
Cladorhiza Nordenskiöldii
Clathria delicata
Cliona celata
Desmacidon (Homeodictya) palmata
Desmacella Peachübar Groenlandica
Esperella lingua
Esperella modesta
Eumastia sitiens
Gellius arcoferus
Gellius flagellifer
Halichondria panicea
Iophon chelifer
Myxilla incrustans
Phakellia ventilabrum
Polymastia mammilaris
Polymastia robusta
Reniera mollis
Reniera rufescens
Stylocordyla borealis
Suberites ficus
Suberites hispidus
Tentorium semisuberites
Trichostemma hemisphaericum

Tetractenellida.

Tethea muricata
Craniella Logani (fossil)

Calcarea.

Grantia Canadensis
Leneosolenia cancellata
Sycon asperum
Sycon protectum

ABSTRACT FOR THE MONTH OF JUNE, 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	51.45	60.1	46.0	14.1	29.8513	30.008	29.791	.217	.2393	61.8	39.0	N.W.	21.04	4.5	10	0	43	..*	....	....	1
2	53.35	61.2	41.5	19.7	30.0728	30.131	30.029	.102	.2147	52 0	36 0	W.	16.71	4.7	10	0	70	....	...	....	2
3	50.77	52.7	49.8	2.9	29.8150	29.991	29.733	.258	.3358	90 7	48 0	N.E.	10.32	10.0	10	10	0	0.36	....	0.36	3
4	58.73	69.4	49.0	20.4	29.7848	29.824	29.763	.061	.3933	80.3	51.5	W.	16.46	6.8	10	0	41	0.01	......	0.01	4
5	60.43	68.7	53.0	15.7	29.8928	29.932	29.873	.059	.3728	71.8	51.0	S.W.	8.68	6.2	10	0	48	....	....	....	5
SUNDAY........ 6	.....	75.0	53.0	22.0	......	.....	....	.....	......	....	....	S.W.	7.12	....	..	..	91	....	....	...	6..........SUNDAY
7	61.95	70.6	52.8	17 8	30.1538	30.187	30.116	.071	.4013	73.3	53.0	S. E.	12.37	5.3	10	0	39	....	....	....	7
8	57.38	61.8	51.0	10.8	30.1968	30.215	30.184	.031	.3370	71.5	48.2	S.E.	14.12	8.8	10	5	12	0.00	....	0.00	8
9	54.77	57.4	52.8	4.6	30.1475	30.207	30.068	.139	.3920	90 8	52 3	S E.	7.20	10 0	10	10	0	0.35	....	0.35	9
10	57.45	66.4	52.0	14.4	30.0120	30.048	29.980	.068	.4212	89.5	54.2	N E.	10.62	8 2	10	0	3	0.24	....	0.24	10
11	65.98	77.1	52.1	25.0	29.8477	29.989	29 736	.253	.4562	72.2	56.2	S.W.	12.21	4.0	10	0	71	....	....	....	11
12	63.18	73.0	57.3	15.7	29.6731	29.753	29.612	.141	.4413	77.7	55 3	S.W.	14.79	7.7	10	2	50	0.02	....	0.02	12
SUNDAY........13	.....	65.0	53.7	11.3	......	......	......	......	......	....	....	S.W.	14.04	...	..	..	22	0.21	....	0.21	13 ....SUNDAY
14	59 65	67.8	53.0	14.8	29.7880	29.848	29 754	.094	.4092	80.8	53.2	N.	7.33	6.5	10	0	31	0.00	....	0.00	14
15	67.00	77.8	52.9	24.9	29.7120	29 813	29.604	.209	.4720	72.0	57.3	N.W.	12.67	2.7	7	0	78	0.00	....	0.00	15
16	64.23	72.1	56.0	16.1	29 8190	29 870	20.776	.094	.3275	54.3	47.2	N W.	13.71	3.3	7	0	85	0.00	....	0.00	16
17	63.82	71.8	56.8	15.0	29.8468	29.908	29.775	.133	.3420	57.8	48.3	S.W.	7.07	4.0	8	0	59	....	....	....	17
18	66.45	77.1	57.0	20.1	29.8445	29.926	29.786	.140	.3448	53.8	48.8	N.W.	9.92	1.5	5	0	91	....	....	....	18
19	65.83	75.3	53 5	21.8	29.8848	30.004	29.685	.319	.3807	60.2	51.2	S.W.	6.30	5 7	10	0	47	...	....	....	19
SUNDAY. 20	.....	63.0	48.1	14.9	......	......	......	......	......	....	....	N.W.	16.25	....	..	..	56	0.03	....	0.03	20..........SUNDAY
21	53.28	59.3	44.6	14.7	29.7047	29.748	29.671	.077	.3032	74.3	45 2	S.W.	23.05	7.2	10	0	36	0.09	....	0.09	21
22	62.40	72.6	51.0	21.6	29.7627	29 784	29.741	.043	.3427	62.0	48.7	S.W.	25.42	3.3	10	0	69	0.00	....	0 00	22
23	69.35	81.6	54.0	27 6	29.8073	29 848	29.769	.079	.4568	64.3	56.2	S.W.	19.17	3.0	10	0	85	0 03	....	0.03	23
24	69.65	76.2	65.5	10.7	29.7958	29.844	29.716	.128	.6237	86.0	65.0	S.W.	11.46	8.0	10	5	18	1.61	....	1.61	24
25	69.10	77.2	62.1	15.1	20.7057	29.776	29.670	.106	.5070	71.3	59 0	S.W.	18.71	5.7	10	0	74	0.00	....	0.00	25
26	57.58	63.2	52.8	10.4	29.9357	30.013	29.857	.156	.2560	54.0	40.8	N.W.	19.12	4.3	9	0	54	....	....	....	26
SUNDAY........27	....	69 3	51.4	17.9	......	......	......	......	......	....	....	W.	18.42	...	..	..	82	0.00	...	0.00	27..........SUNDAY
28	63.43	72.2	55.5	16.7	30.0000	39 046	29.961	.085	.4092	70.0	53.2	S.W.	16.33	2.8	6	0	68	0.13	....	0.13	28
29	63.50	71.6	52.7	18.9	29.9972	30 107	29.828	.279	.3968	68.2	52.2	N.E.	8.92	6.2	10	0	49	0.05	....	0.05	29
30	60.77	66.1	58.0	8.1	29.7407	29.780	29 679	.101	.5017	94.2	59.2	W.	7.80	8.8	10	3	0	0.63	....	0 63	30
31	......	....	....	....	......	......	......	......	......	....	....	....	....	....	..	..	..	..	....	....	31
Means......	61.21	69.08	52.96	16.12	29.8766	29.9462	29.8137	.1325	.3877	71.38	51.20	S 77° W	13.60	5.39	9.3	1.3	49.3	3.76	....	3.76	..........Sums.
23 Years means for and including this month	64.41	73.61	56.31	17.29	29.9047	......	......	.150	.4341	69.8			S 13.17	5.6	..	.	¶ 53.5	3.52	....	3.52	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	304	709	155	889	128	3822	1469	2315	
Duration in hrs..	36	73	22	81	14	251	90	153	
Mean velocity....	8 45	9.71	7.05	10.98	9.14	15.22	16.32	15.13	

Greatest mileage in one hour was 30, on the 4th, 21st and 22nd.

Greatest velocity in gusts 36 miles per hour on the 4th and 22nd.

Resultant mileage, 4638.
Resultant direction, S. 77° W.
Total mileage, 9791.
Average mileage per hour, 13.60.

* 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 81°6 on the 23rd; the greatest cold was 41.°5 on the 2nd, giving a range of temperature of 40°1 degrees.

Warmest day was the 24th. Coldest day was the 3rd. Highest barometer reading was 30.215 on the 8th. Lowest barometer was 29.604 on the 15th giving a range of 0.611 inches. Maximum relative humidity was 99 on the 30th. Minimum relative humidity was 37 on the 18th.

Rain fell on 20 days.

Auroras were observed on 1 night, on the 15th.

Lunar halo on the 11th.

Fog on 3 days—4th, 11th and 30th.

Thunderstorms on 13th, 24th and 28th.

ABSTRACT FOR THE MONTH OF JULY, 1897.

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

DAY	THERMOMETER.				BAROMETER.				†Mean pressure of vapor.	Mean relative humidity.	Dew Point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	§Max.	§Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	66.77	78.3	54.5	23.8	29.7452	29.791	29.681	.110	.4757	75 2	57.5	W.	7.67	4.2	9	0	84	0.29	....	0.29	1
2	70.22	79.0	58.7	20.3	29.7518	29.816	29.725	.091	5075	69 5	59 3	S.W.	11.33	6.3	10	4	43	....	...	....	2
3	71.05	80.9	58.8	22.1	29 9677	30.013	29.879	.134	.6112	80 2	04 5	S.E.	6.42	3.3	10	0	92	....	....	....	3
SUNDAY........ 4	.....	87.5	65.3	22.2	......	.....		.....	......	....	..	S.	12.08	...	..	..	91	....	......	...	4..........SUNDAY
5	82.58	93.0	72.2	20.8	29.8972	29.955	29.810	.145	8678	78.0	74 7	S.W.	12.29	3.7	10	0	92	0.10	....	0 10	5
6	81.18	90.0	75.0	15.0	29 9573	30.015	29.893	122	.7556	71 0	70.5	N.W.	6.62	3.8	10	0	85	0.01	....	0.01	6
7	79.67	90.6	71.0	19 6	30 0862	30.125	30 061	.064	.5852	59 2	63.5	N.	6.50	0.5	2	0	99	...	....	....	7
8	82.13	92.0	71.0	21.0	29.9782	30.076	29.876	.200	.7017	65 0	68.7	S.W.	8.42	0.5	3	0	92	....	....	....	8
9	78.65	90.5	73.6	16.9	29 8455	29.913	29.771	.142	.6823	69.3	67 5	S.W.	18.62	6 8	10	4	69	....	....	....	9
10	72.10	81.5	61.3	20.2	29.9130	29 994	29.799	.195	.5137	65.8	59.7	N.E.	13.08	2 8	10	0	95	....	....	....	10
SUNDAY........11	.....	88.0	67.7	20.3	.....	......	......	......	......	....	....	S.	15.25	...	..	..	49	0.88	....	0.88	11 ....SUNDAY
12	63.53	68.3	59.5	8.8	29.6678	29 743	29 599	.144	.5232	89.5	60.5	N.E.	15.08	10.0	10	10	00	0 73	....	0.73	12
13	62.12	65.9	58.8	7.1	29.7180	29.755	29 702	.053	.5437	96 8	61 2	N.E.	11.92	10.0	10	10	00	0 63	..	0 63	13
14	67.78	77.2	60.5	16.7	29.7098	29.808	29 637	.171	.6062	89.3	64.3	S.W.	11.25	7.5	10	2	38	0.41	...	0.41	14
15	70 85	78.8	62.7	16.1	29.9400	30.007	29.864	.143	.5748	77 0	63.0	S.W.	17 37	3.2	10	0	89	0 01	....	0.01	15
16	74.02	83.3	64.8	18.5	30.0628	30 085	30 033	052	.6223	75 0	65.0	S W.	11.62	4.7	9	0	81	Trace	....	Trace	16
17	71.28	79.4	63.5	15.9	30.1707	30.212	30.122	090	.5633	74 0	62 2	N.E.	6.75	5.5	10	1	75	....	....	....	17
SUNDAY. 18	....	81.5	62.7	18.8	......	......	......	......	......	....	...	N.E.	5.75	....	..	..	83	....	....	....	18 ....SUNDAY
19	74.65	84.1	63.6	20.5	30.2667	30.343	30.199	.144	.6703	75.0	67 2	N E.	6.00	5.5	8	0	71	...	....	...	19
20	74.62	82.5	69 0	13.5	30.1048	30.197	30 022	.175	.6688	80 8	67.0	S.	8.21	7 5	10	0	13	0.02	....	0.02	20
21	75.42	82.8	66.1	16.7	29.9540	30.017	29.885	.132	.6910	79.5	68 0	S E.	6.25	3.2	10	0	74	Trace	....	Trace	21
22	73 17	82.7	69.1	13.6	29 8138	29 891	29.743	.148	.7257	89 3	69 5	S.E.	9.54	6.3	10	1	32	0.11	....	0 11	22
23	73.65	81.5	67.2	14 3	29.6680	29 745	29.616	.129	.6613	80.5	66.8	S.W.	7.87	6.8	10	3	56	0 02	....	0.02	23
24	67.03	74.1	63.3	10 8	29.6498	29.726	29 619	.107	.5977	90.2	64 2	N.	14.29	6.7	10	0	22	0.68	...	0.68	24
SUNDAY........25	....	74 0	61.5	12.5	......	......	......	......	......	....	....	N.E.	16.29	...	..	.	21	Trace	....	Trace	25...........SUNDAY
26	65.88	74.4	56.0	18.4	30.0353	30.062	30.011	.051	.4670	74.2	57 0	N.E.	11.92	1.7	4	0	90	....	....	....	26
27	65.45	74.6	56.5	18 1	30 0292	30.083	29 992	.091	.4097	66.8	53.5	S.E.	11.75	2.2	6	0	77		...	....	27
28	61.22	64.5	58.6	5.9	29.9633	29 979	29.946	.033	.4105	75 7	53 3	S.E	12.33	10.0	10	10	00	0.17	...	0.17	28
29	60.58	65.8	58.1	7.7	29.9163	29 940	29.897	.043	.4920	93.3	58.5	E	8.55	9.7	10	8	00	0 26	....	0.26	29
30	64.90	71.8	59.0	12.8	29.8950	29.944	29.830	.114	.5285	86.0	60.7	N.E.	8.04	6.0	10	0	29	Trace	....	Trace	30
31	65.40	69.5	61.0	8.5	27.7662	29.839	29.717	.122	.5597	89.3	62.2	S.W.	13 50	8.0	10	0	14	0.10	....	0 10	31
Means..........	70.96	79.61	63.57	16.04	29.9064	29.9657	29.8492	.1165	.5933	78.46	63.33	S 18¼° E	10.73	5.42	8.9	2.0	56.5	4.42	....	4.42	...............Sums.
23 Years means for and including this month	68.83	77.33	60.76	16 57	29.8948	......	......	.141	.5034	71.44			S 12.87	5.43	..	.	¶58.50	4.06	....	4.06	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	955	1957	371	955	768	2502	297	177	
Duration in hrs..	88	171	46	95	75	202	38	26	3
Mean velocity....	10.85	11.44	8.07	10.05	10.24	12.38	7.82	6.81	

Greatest mileage in one hour was 26, on the 9th.

Greatest velocity in gusts 36 miles per hour on the 9th.

Resultant mileage, 790.
Resultant direction, S. 18¼° E.
Total mileage, 7982.
Average velocity 10.73 m. p. h.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only. ∥ 11 years only.

The greatest heat was 93°0 on the 5th; the greatest cold was 54.°5 on the 1st, giving a range of temperature of 38°5 degrees.

Warmest day was the 5th. Coldest day was the 29th. Highest barometer reading was 30.343 on the 19th. Lowest barometer was 29.599 on the 12th giving a range of 0.744 inches. Maximum relative humidity was 99 on the 1st, 13th, 14th. Minimum relative humidity was 40 on the 7th.

Rain fell on 19 days.

Auroras were observed on 1 night

Fog on 1 day—on 23rd.

Thunderstorms on 4 days—on 1st, 5th, 11th and 23rd.

ABSTRACT FOR THE MONTH OF AUGUST, 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.
SUNDAY........ 1	....	73.3	61 0	12.3	......	......	......	....	......	....		N.E.	7.42		.	..	60	0.05	....	0.05	1..........SUNDAY
2	69.32	76.2	6 .6	14.6	29.9925	30.015	29.980	.035	.5880	81 8	63.8	N.E.	5.37	3 0	6	0	57	.	.	...	2
3	72.60	80 6	66 0	14.6	30.0047	30.037	29 980	.057	6293	79 0	65 7	S W	13.54	8 3	10	5	27	0.00	....	0.00	3
4	64.02	68.3	60.5	7.8	30 1342	30.165	30.067	.098	.4737	79 0	57 3	N E	9 50	8.5	10	5	11	0.11	......	0 11	4
5	67.33	75.7	58 0	17.7	30.1518	30 190	30.112	.078	4242	64 2	54.3	N.E	8.87	0.2	1	0	95	....	....	....	5
6	70..7	77.8	62.8	15.0	30 1005	30.134	30.050	.084	.4597	62.2	56.3	N.W.	11.17	2.2	6	0	76	....	....	....	6
7	71.00	81.5	57.4	24 1	30.0883	30.158	30.025	.133	.5127	66.8	59.2	S.W.	9.54	2.8	10	0	88	0.00	....	0.00	7
SUNDAY........ 8	.....	82.0	64.2	17.8	......	.....		.....	......	....	....	S.W.	14.33	...	..	..	95	...	....	...	8..........SUNDAY
9	70.45	80.6	63.6	17.0	29.9143	29.967	29.864	.103	.5172	69.8	60 0	S.W.	10.54	3.7	10	0	85	...	...	....	9
10	67.82	77.3	58.9	18.4	29.8085	29 875	29.744	.131	.5488	81.0	61.7	N.E.	8.08	7.8	10	0	45	0 09	....	0 09	10
11	65.17	75.4	62.3	13.1	29 5870	29.693	29.514	.179	.5630	90.5	62.2	S.E.	13.00	9.3	10	6	00	0.23	....	0.23	11
12	64 65	72.7	60.1	12.6	29 6768	29.824	29.547	.277	.4337	71.7	55 2	N.W.	17.92	7.0	10	2	75	0.00	....	0.00	12
13	61.25	64.6	54.0	10.6	29.9068	29 984	29.827	.157	.4238	78.2	54.2	S.W.	12.92	6 3	10	0	39	0.00	....	0.00	13
14	64.12	69.1	58.6	10.5	29.9645	30 022	29.905	.117	.4202	70.7	54.2	N.E.	9.21	4.3	9	0	57	....	....	....	14
SUNDAY........15	.....	80.5	59.5	21.0	.....	......	......	......	......	....	...	S.E.	12 33	....	..	..	47	0.25	....	0.25	15..........SUNDAY
16	70 40	79.0	64.5	14.5	29 6090	29.715	29 544	.171	.5887	80.0	63.5	S.W.	15 33	6.7	10	2	55	0.22	....	0.22	16
17	59.65	63.7	57.5	6.2	29 7115	29.849	29.577	.272	.4523	88 3	56 2	S.W.	17.67	8.0	10	2	00	0.24	....	0.24	17
18	62.02	69.0	53.4	15.6	29.9108	29.929	29.874	.055	.4193	76.5	54.2	S.	12.71	4.3	10	0	61	0 00	....	0.00	18
19	61.33	67.9	56.0	11.9	29.8747	29.891	29.865	.026	.4710	86 5	57.2	S.W.	13 25	7 2	10	0	05	0.10	....	0.10	19
20	57.95	63.0	53 3	9.7	29.9402	30.020	29.846	.174	.3663	77.0	50 3	S W.	16.58	2.2	6	0	89	0.00	....	0.00	20
21	62.00	72.0	50.1	21.9	29 9750	30.044	29.901	.143	.3857	69 8	51.8	S.W.	19 50	0.3	4	0	97	....	....	....	21
SUNDAY........22	... .	64.6	46.3	18.3	......	......	......	......	......	....	....	S.W.	12.62	...	..	..	25	0 03	....	0.03	22..........SUNDAY
23	53 38	60.7	44.9	15.8	30.0583	30.136	29.991	.145	.2873	70.3	43 8	N.E.	7.91	3 0	7	0	76	....	....	....	23
24	54.52	59.7	48.8	10 9	29.8638	29 932	29 807	.125	.3943	91.9	52.0	N.	7.91	10.0	10	10	00	0.02	....	0.02	24
25	60.72	68 7	52.1	16.6	29.7448	29.850	29.664	.186	.5035	94.3	59.2	S W.	10.96	8.8	10	6	11	0.54	....	0.54	25
26	60.83	67.3	55.0	12.3	29.9558	29.982	29 909	.073	.4123	77.7	53.7	S.W.	11.25	3.5	8	0	90	0.00	....	0 00	26
27	64.00	72.7	53.0	19 7	29.8165	29 962	29.715	.247	.4762	69 5	57 5	S E.	14.17	3.7	10	0	49	0.02	...	0 02	27
28	64.63	72.1	61.3	10.8	29.8793	29 969	29.780	.183	.5140	84.2	59 5	S.W.	14.79	5.2	10	0	22	0.00	....	0.00	28
SUNDAY....... 29	.....	77.7	57.2	20.5	......	.....	......	.....	......	....	....	S.W.	17.62	.	..	..	91	....	....	....	29 ....SUNDAY
30	62.87	70.4	58.1	12.3	29 9132	29.926	29 896	.030	.4160	73.0	54 0	S W.	16.58	1.2	5	0	95	0.05	....	0.05	30
31	60.18	67.5	52.3	15.2	29.9650	29.987	29.936	.051	.3643	70.5	50.2	S W.	16.25	1.0	5	0	56	....	....	...	31
Means..........	63.94	71.99	57.17	14.82	29.9057	29.9714	29.8433	.1281	.4633	77.09	56.42	S. 47° ½ W.	12 54	4 94	8.26	1.46	55.45	1.95	....	1.95	..............Sums.
23 Years means for and including this month	66.59	75.17	58.61	16 30	29.9399	......	......	.134	.4800	73.18			S 12.50	5.31		.	¶58.51	3.60	....	3 60	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	388	885	107	1107	664	4698	815	679	
Duration in hrs..	44	110	11	88	51	318	63	59	
Mean velocity....	8.82	8.05	9 73	12.58	13.02	14.77	12.94	11.51	

Greatest mileage in one hour was 27, on the 30th.

Greatest velocity in gusts 36 miles per hour on the 30th.

Resultant mileage, 4570.
Resultant direction, S. 47° ½ W.
Total mileage, 9343.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only. s 11 years only.

The greatest heat was 82°0 on the 8th; the greatest cold was 44.°9 on the 23rd, giving a range of temperature of 37°1 degrees.

Warmest day was the 3rd. Coldest day was the 23rd. Highest barometer reading was 30.190 on the 5th. Lowest barometer was 29.514 on the 11th giving a range of 0.676 inches. Maximum relative humidity was 99 on the 25th. Minimum relative humidity was 49 on the 14th.

Rain fell on 21 days.

Auroras were observed on 2 nights on 20th and and 23rd.

Lunar halo on 1 night on 7th.

Lunar Corona on 3 nights on 12th, 15th and 19th.

Thunderstorms on 5 days—on 10th, 15th, 16th, 25th and 27th.

ABSTRACT FOR THE MONTH OF SEPTEMBER, 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.
1	63.72	72.7	54.7	18.0	30.0132	30.050	29.992	.058
2	60.32	t8.9	54.4	14.5	30 1350	30.254	30 022	.232
3	55.53	63 4	48.5	14.9	30.3523	30.376	30.296	.080
4	56 08	64.7	47.8	16.9	30 3265	30 404	30.227	.177
SUNDAY........ 5	.....	76.8	52.4	24 4	......	......	.....	.....
6	69.13	80.2	59 5	20.7	30 1672	30.300	30.061	.239
7	57.33	64.6	50.0	14.6	30.3283	30 421	30.225	.196
8	68.07	78.6	55.8	22.8	30 0603	30.187	29 965	.222
9	74 43	83:2	65 6	17.6	29.9685	30 005	29.931	.074
10	77.72	86.8	69.9	16.9	29 9618	29 995	29 921	.074
11	62.33	74.5	52.5	22.0	30.1637	30.283	30.063	.220
SUNDAY........12	....	65.0	44.8	20.2	......	......	......	....
13	64.63	74 8	56 6	18.2	29.8470	29.980	29.742	.238
14	56.45	62.2	52.5	0.7	30.1855	30 295	30.053	.242
15	55 82	63.8	47.2	16.6	30.2430	30.345	30.127	.218
16	60 97	63.3	49.7	18.6	29 8970	30 099	29.729	.370
17	56.90	64.7	45.6	19 1	29.9040	30 020	29.756	.264
18	48.75	56.1	41.3	14.8	29 8803	30.015	29.729	.286
SUNDAY. 19	.....	65.1	50.4	14.7	......	......	......	......
20	46.10	49.3	42.6	6.7	30 0723	30 091	30 036	.055
21	46.32	51.8	40.3	11.5	30.1378	30.205	30 077	.128
22	51.40	59.5	42.7	16.8	30.2672	30 287	30 239	.048
23	54.73	63.5	45.0	18.5	30.2077	30.291	30.110	.181
24	56.30	62.5	50.5	12.0	29.9678	30.047	29.905	.142
25	61.77	70.9	51.5	19.4	29 9723	30 020	29.918	.102
SUNDAY........26	.....	66.9	46.0	20 9	......	......	......	......
27	42.98	47.7	39.4	8.3	30.0958	30.195	29.981	.214
28	46.17	56.0	35.5	20.9	30.2287	30.290	30 166	.124
29	50.10	55 2	43.8	11.4	30.2760	30 317	30.242	.075
30	58.68	69.4	44.2	25.2	30.1225	30 237	29.992	.245
31	.....	....	....	....	......	......	......	......
Means..........	57.80	66.24	49.36	16.88	30.1072	30.1924	30.0193	.1731
23 Years means for and including this month	58.49	66.56	50.70	15.87	30.0144	......	......	.180

DAY	†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	.4277	72.3	54.5	S.W.	16.88	2.2	8	0	94	....	....	....	1
2	.3453	66.8	48.8	N.W.	12.63	2 8	7	0	81	....	...	....	2
3	3060	70 2	45.5	N. W.	9.29	2.2	8	0	79	...	....	....	3
4	.3813	85 3	51.3	S.W.	9 04	3.7	10	0	33	0.00	......	0.00	4
5	......	....	....	S.W.	23.67	...	..	..	96	....	....	...	5..........SUNDAY
6	.4917	68 5	58.0	W.	16.08	0.5	2	0	85	....	....	....	6
7	.3513	74.3	49.2	N.	9.71	4.7	10	0	34	0.02	....	0.02	7
8	.5745	82.5	62.5	S.W.	14.75	3.2	10	0	55	0.01	....	0.01	8
9	.6473	75.8	66.3	S.W.	22 63	0 2	1	0	89	....	...	....	9
10	.6838	71.5	68.0	S.W.	21.25	3.3	8	0	79	0.02	....	0.02	10
11	.3795	58.0	47.2	N.	13.00	5.0	10	0	47	0.00	....	0.00	11
12	......	....	....	N.E.	9.96	....	..	..	82	0.03	....	0.03	12..........SUNDAY
13	.4775	77.2	57 2	S.W.	17.42	6.5	10	1	38	0.26	....	0.26	13
14	.3315	72.8	47.7	W.	11.71	4.3	10	0	78	0.00	....	0.00	14
15	.3417	76.3	48.3	N	6.92	1.0	6	0	98	...	....	....	15
16	.4462	83.0	55 5	E.	10.13	5.3	10	0	29	0 03	....	0 03	16
17	.3428	72 0	47.3	N.W.	15.08	3.8	10	0	86	0.02	....	0.02	17
18	.2392	68.8	39.0	S.	11.54	6 5	10	0	17	0.00	....	0.00	18
19	......	....	....	S.	14.63	....	..	..	25	0.13	....	0.13	19..........SUNDAY
20	.2608	84.2	41.7	N.	12.75	9.7	10	4	0	0.38	....	0.38	20
21	.2105	67.2	35.7	S.W.	17.38	1.5	8	0	96	....	....	....	21
22	.2845	75.2	43.7	N.	10 67	5.8	10	0	28	0.00	....	0.00	22
23	.3235	76 2	47.0	N.	7.17	4.5	10	0	76	....	....	....	23
24	.3782	83.7	51.2	N.	9.92	6.3	10	0	0	0.00	....	0.00	24
25	.4187	76.0	53.8	S W.	22.46	0.0	0	0	93	....	....	....	25
26	......	....	....	S W.	19.46	...	..	..	4	0.24	....	0.24	26..........SUNDAY
27	.1913	68.8	33.7	S.W.	22.87	4.8	10	0	36	0.01	...	0 01	27
28	.1813	59.5	32.0	S W.	19.92	0 0	0	0	97	....	....	....	28
29	.2485	68.2	39.8	S.W.	11.08	7 8	10	5	24	0.00	....	0.00	29
30	.3707	74.2	50.2	S.W.	18.21	0.8	4	0	86	....	....	....	30
31	......	....	....	......	......	....	..	..	..	....	....	....	31
Means	.3687	73.40	49.04	S. 63½° W.	14 61	3.71	7.8	0.4	59.23	1.15	....	1.15	..............Sums.
23 Years means	.3744	75.5			S 12.64	5.41	.	.	¶54.32	3.05	....	....	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	1217	94	202	311	966	5469	699	1558	
Duration in hrs..	132	16	21	30	66	298	47	110	
Mean velocity....	9.22	5.88	9.62	10.37	14.64	18.35	14.87	14.16	

Greatest mileage in one hour was 33, on the 5th.

Greatest velocity in gusts 36 miles per hour on the 5th, 27th and 30th.

Resultant mileage, 5838.
Resultant direction, S. 63° ½ W.
Total mileage, 10,516.
Average velocity, 14.61 m. p. h.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only. δ 11 years only.

The greatest heat was 86°8 on the 10th; the greatest cold was 35°.5 on the 28th, giving a range of temperature of 51.3 degrees.

Warmest day was the 10th. Coldest day was the 27th. Highest barometer reading was 30.421 on the 7th. Lowest barometer was 29.640 on the 26th giving a range of .781 inches. Maximum relative humidity was 98 on the 13th. Minimum relative humidity was 40 on the 28th.

Rain fell on 18 days.

Lunar Coronas on 8 nights.

Thunder storms on 10th, 13th and 26th.

NOTICES.

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AND REPLACING

THE CANADIAN NATURALIST.

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THE

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

POSTSCRIPT TO A "DESCRIPTION OF A NEW GENUS AND SPECIES OF CYSTIDEANS FROM THE TRENTON LIMESTONE AT OTTAWA."

By J. F. WHITEAVES.

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

OTTAWA. Sept. 14th, 1897.

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

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

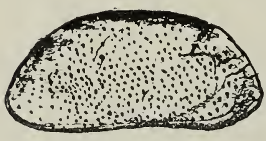

FIG. 10.
C. Rankiniana.

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

J. WM. DAWSON.

Sept. 30th, 1897.

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

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

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

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

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

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

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

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

E

Address

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

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

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

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

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

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

On our last visit to Canada, in 1884, our place of assembly was Montreal, a city which is justly proud of her McGill University; to-day we meet within the buildings of another of the Universities of this vast Dominion—and in a city, the absolute fitness of which for such a purpose must have been foreseen by the native Indian tribes when they gave to a small aggregation of huts upon this spot the name of Toronto—" the place of meetings."

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

The domain of science is no doubt one in which the various nations of the civilized world meet upon equal terms, and for which no other passport is required than some evidence of having striven towards the advancement of natural knowledge. Here, on the frontier between the two great English-speaking nations of the world, who is there that does not inwardly feel that anything which conduces to an intimacy between the representatives of two countries, both of them actively engaged in the pursuit of science, may also, through such an intimacy, react on the affairs of daily life, and aid in preserving those cordial relations that have now for so many years existed between the great American Republic and the British Islands, with which her early foundations are indissolubly connected? The present year has witnessed an interchange of courtesies which has excited the warmest feelings of approbation on both sides of the Atlantic. I mean the return to its proper custodians of one of the most interesting of the relics of the Pilgrim Fathers, the Log of the May Flower. May this return, trifling in itself, be of happy augury as testifying to the feelings of mutual regard and esteem which animate the hearts both of the donors and of the recipients!

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

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

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

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

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

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

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

A familiarity with all the details of Greek and Roman mythology and culture must be regarded as a literary rather than a scientific qualification; and yet when among the records of classical times we come upon traces of manners and customs which have survived for generations, and which seem to throw some rays of light upon the dim past, when history and writing were unknown, we are, I think, approaching the boundaries of scientific Archæology.

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

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

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

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

When we come to the consideration of the relics of the Early Iron and Bronze Ages, the aid of Chemistry has of necessity to be invoked. By its means we are able to determine whether the iron of a tool or weapon is of meteoritic or volcanic origin, or has been reduced from iron-ore, in which case considerable knowledge of metallurgy would be involved on the part of those who made it. With bronze antiquities the nature and extent of the alloys combined with the copper may throw light not only on their chronological position, but on the sources whence the copper, tin, and other metals of which they consist were originally derived. I am not aware of there being sufficient differences in the analysis of the native copper from different localities in the region in which we are assembled, for Canadian Archæologists to fix the sources from which the metal was obtained which was used in the manufacture of the ancient tools and weapons of copper that are occasionally discovered in this part of the globe.

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

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

The changes in the surface configuration and in the extent of the land, especially in a country like Britain, as well as the modifications of the fauna and flora since those days, have been such that the Archæologist pure and simple is incompetent to deal with them, and he must either himself undertake the study of these other sciences or call experts in them to his assistance. The evidence that man had already appeared upon the earth is afforded by stone implements wrought by his hands, and it falls strictly within the province of the Archæologist to judge whether given specimens were so wrought or not; it rests with the geologist to determine their stratigraphical or chronological position, while the Palæontologist can pronounce upon the age and character of the associated fauna and flora.

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

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

Some among us may be able to call to mind the excitement, not only among men of science, but among the general public, when, in 1859, the discoveries of M. Boucher de Perthes and Dr. Rigollot in the gravels of the valley of the Somme, at Abbeville and Amiens, were confirmed by the investigations of the late Sir Joseph Prestwich, myself, and others, and the co-existence of man with the extinct animals of the Quaternary fauna, such as the mammoth and woolly-haired rhinoceros, was first virtually established. It was at the same time pointed out that these relics belonged to a far earlier date than the ordinary stone weapons found upon the surface, which usually showed signs of grinding or polishing, and that in fact there were two Stone Ages in Britain. To these the terms Neolithic and Palæolithic were subsequently applied by Sir John Lubbock.

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

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

It is at the same time instructive and amusing to look back on the discussions of those days. While one class of objectors accounted for the configuration of the flint implements from the gravels by some unknown chemical agency, by the violent and continued gyratory action of water, by fracture resulting from pressure, by rapid cooling when hot or by rapid heating when cold, or even regarded them as aberrant forms of fossil fishes, there were others who, when compelled to acknowledge that the implements were the work of men's hands, attempted to impugn and set aside the evidence as to the circumstances under which they had been discovered. In doing this they adopted the view that the worked flints had either been introduced into the containing beds at a comparatively recent date, or if they actually formed constituent parts of the gravel, then that this was a mere modern alluvium resulting from floods at no very remote period.

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

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

"When speculations on the long series of events which occurred in the glacial and post-glacial periods are indulged in, the imagination is apt to take alarm at the immensity of the time required to interpret the monuments of these ages, all referable to the era of existing species. In order to abridge the number of centuries which would otherwise be indispensable, a disposition is shown by many to magnify the rate of change in prehistoric times by investing the causes which have modified the animate and inanimate world with extraordinary and excessive energy. It is related of a great Irish orator of our day that when he was about to contribute somewhat parsimoniously towards a public charity, he was persuaded by a friend to make a more liberal donation. In doing so he apologised for his first apparent want of generosity by saying that his early life had been a constant struggle with scanty means, and that 'they who are born to affluence cannot easily imagine how long a time it takes to get the chill of poverty out of one's bones.' In like manner we of the living generation when called upon to make grants of thousands of centuries in order to explain the events of what is called the modern period, shrink naturally at first from making what seems so lavish an expenditure of past time. Throughout our early education we have been accustomed to such strict economy in all that relates to the chronology of the earth and its inhabitants in remote ages, so fettered have we been by old traditional beliefs, that even when our reason is convinced, and we are persuaded that we ought to make more liberal grants of time to the geologist, we feel how hard it is to get the chill of poverty out of our bones."

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

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

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

Flint implements of ordinary Palæolithic type have, for instance, been recorded as found in the Eastern Counties of England, in beds beneath the Chalky Boulder Clay; but on careful examination the geological evidence has not to my mind proved satisfactory, nor has it, I believe, been generally accepted. Moreover, the archaeological difficulty that man, at two such remote epochs as the pre-Glacial and the post-Glacial, even if the term Glacial be limited to the Chalky Boulder Clay, should have manufactured implements so identical in character that they cannot be distinguished apart, seems to have been entirely ignored.

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

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

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

In the case of a more recent discovery in Upper Burma in beds at first pronounced to be Upper Miocene, but subsequently "definitely ascertained to be Pliocene," some of the flints are of purely natural and not artificial origin, so that two questions arise: First, Were the fossil remains associated with the worked flints or with those of natural forms ? and second, Were they actually found in the bed to which they have been assigned or did they merely lie together on the surface ?

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

When we return to Palæolithic man, it is satisfactory to feel that we are treading on comparatively secure ground, and that the discoveries of the last forty years in Britain alone enable us to a great extent to reconstitute his history. We may not know the exact geological period when first he settled in the British area, but we have good evidence that he occupied it at a time when the configuration of the surface was entirely different from what it is at present: when the river valleys had not been cut down to anything like their existing depth, when the fauna of the country was of a totally different character from that of the present day, when the extension of the southern part of the island seaward was in places such that the land was continuous with that of the continent, and when in all probability a far more rainy climate prevailed. We have proofs of the occupation of the country by man during the long lapse of time that was necessary for the excavation of the river valleys. We have found the old floors on which his habitations were fixed, we have been able to trace him at work on the manufacture of flint instruments, and by building up the one upon the other the flakes struck off by the primæval workman in those remote times we have been able to reconstruct the blocks of flint which served as his material, That the duration of the Palæolithic Period must have extended over an almost incredible length of time is sufficiently proved by the fact that valleys, some miles in width and of a depth of from 100 to 150 feet, have been eroded since the deposit of the earliest implement-bearing beds. Nor is the apparent duration of this period diminished by the consideration that the floods which hollowed out the valleys were not in all probability of such frequent occurrence as to teach Palæolithic man by experience the danger of settling too near to the streams, for had he kept to the higher slopes of the valley there would have been but little chance of his implements having so constantly formed constituent parts of the gravels deposited by the floods.

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

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

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

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

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

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

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

And yet, remote as the date of the first known occupation of Britain by man may be, it belongs to what, geologically speaking, must be regarded as a quite recent period, for we are now in a position to fix with some degree of accuracy its place on the geological scale. Thanks to investigations ably carried out at Hoxne in Suffolk, and at Hitchin in Hertfordshire, by Mr. Clement Reid, under the auspices of this Association and of the Royal Society, we know that the implement-bearing beds at those places undoubtedly belong to a time subsequent to the deposit of the Great Chalky Boulder Clay of the Eastern Counties of England. It is, of course, self-evident that this vast deposit, in whatever manner it may have been formed, could not for centuries after its deposition was complete have presented a surface inhabitable by man. Moreover, at a distance but little farther north, beds exist which also, though at a somewhat later date, were apparently formed under glacial conditions. At Hoxne the interval between the deposit of the Boulder Clay and of the implement-bearing beds is distinctly proved to have witnessed at least two noteworthy changes in climate. The beds immediately reposing on the clay are characterized by the presence of alder in abundance, of hazel, and yew, as well as by that of numerous flowering plants indicative of a temperate climate very different from that under which the Boulder Clay itself was formed. Above these beds characterized by temperate plants comes a thick and more recent series of strata, in which leaves of the dwarf Arctic willow and birch abound, and which were in all probability deposited under conditions like those of the cold regions of Siberia and North America.

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

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

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

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

In the valley of the Euphrates implements of the same kind have also been found, and again farther east in the lateritic deposits of Southern India they have been obtained in considerable numbers. It is not a little remarkable, and is at the same time highly suggestive, that a form of implement almost peculiar to Madras reappears among implements from the very ancient gravels of the Manzanares at Madrid. In the case of the African discoveries we have as yet no definite Palæontological evidence by which to fix their antiquity, but in the Narbadà Valley of Western India Palæolithic implements of quartzite seem to be associated with a local fauna of Pleistocene age, comprising, like that of Europe, the elephant, hippopotamus, ox, and other mammals of species now extinct. A correlation of the two faunas with a view of ascertaining their chronological relations is beset with many difficulties, but there seems reason for accepting this Indian Pleistocene fauna as in some degree more ancient than the European.

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

How long a term of years may be involved in such a migration it is impossible to say, but that such a migration took place the phenomena seems to justify us in believing. It can hardly be supposed that the process that I have shadowed forth was reversed, and that man, having originated in North-Western Europe, in a cold climate where clothing was necessary and food scarce, subsequently migrated eastward to India and southward to the Cape of Good Hope! As yet, our records of discoveries in India and Eastern Asia are but scanty; but it is there that the traces of the cradle of the human race are, in my opinion, to be sought, and possibly future discoveries may place upon a more solid foundation the visionary structure that I have ventured to erect.

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

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

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

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

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

It has been said that "what song the Syrens sang, or what name Achilles assumed when he hid himself among women, though puzzling questions, are not beyond all conjecture"; and though the questions now proposed may come under the same category, and must await the discovery of many more essential facts before they receive definite and satisfactory answers, we may, I think, throw some light upon them if we venture to take a few steps upon the seductive if insecure paths of conjecture. So far as I know we have as yet no trustworthy evidence of any transition from the one age to the other, and the gulf between them remains practically unbridged. We can, indeed, hardly name the part of the world in which to seek for the cradle of Neolithic civilisation, though we know that traces of what appear to have been a stone-using people have been discovered in Egypt, and that what must be among the latest of the relics of their industry have been assigned to a date some 3,500 to 4,000 years before our era. The men of that time had attained to the highest degree of skill in working flint that has ever been reached. Their beautifully made knives and spear-heads seem indicative of a culminating point reached after long ages of experience; but whence these artists in flints came or who they were is at present absolutely unknown, and their handiworks afford no clue to help us in tracing their origin.

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

The occupation of some of the caves in the south of France seems to have been carried on after the erosion of the neighboring river valleys had ceased, and so far as our knowledge goes these caves offer evidence of being the latest in time of those occupied by man during the Palæolithic Period. It seems barely possible that, though in the north of Europe there are no distinct signs of such late occupation, yet that, in the south, man may have lived on, though in diminished numbers; and that in some of the caves, such, for instance, as those in the neighborhood of Mentone, there may be traces of his existence during the transitional period that connects the Palæolithic and Neolithic Ages. If this were really the case we might expect to find some traces of a dissemination of Neolithic culture from a North Italian centre, but I much doubt whether any such traces actually exist.

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

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

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

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

It is, however, lamentable to notice how little is being or has been officially done towards preserving a full record of the habits, beliefs, arts, myths, languages and physical characteristics of the countless other tribes and nations more or less uncivilised which are comprised within the limits of the British Empire. At the meeting of this Association held last year at Liverpool it was resolved by the General Committee "that it is of urgent importance to press upon the Government the necessity of establishing a Bureau of Ethnology for Greater Britain, which by collecting information with regard to the native races within and on the borders of the Empire will prove of immense value to science and to the Government itself." It has been suggested that such a bureau might with the greatest advantage and with the least outlay and permanent expense be connected either with the British Museum or with the Imperial Institute, and the project has already been submitted for the consideration of the trustees of the former establishment.

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

Wherever such an institution is to be established, the question of its existence must of necessity rest with Her Majesty's Government and Treasury, inasmuch as without funds, however moderate, the undertaking cannot be carried on. I trust that in considering the question it will always be borne in mind that in the relations between civilised and uncivilised nations and races it is of the first importance that the prejudices and especially the religious or semi-religious and caste prejudices of the latter should be thoroughly well known to the former. If but a single "little war" could be avoided in consequence of the knowledge acquired and stored up by the Bureau of Ethnology preventing such a misunderstanding as might culminate in warfare, the cost of such an institution would quickly be saved.

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

It must, however, be borne in mind that most, if not indeed all, of these topics will be discussed by more competent authorities in the various Sections of the Association by means of the Presidential addresses or otherwise. Nor must it be forgotten that I occupy this position as a representative of Archæology, and am therefore justified in bringing before you a subject in which every member of every race of mankind ought to be interested—the antiquity of the human family and the scenes of its infancy.

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

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

Report of Explorations in the Labrador Peninsula Along the East Main, Koksoak, Hamilton, Manicuagan and Portions of other Rivers in 1892–93–94–95. By A. P. Low, B. Ap. Sc.[2]

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

[1] Preface to Robert Recorde's "Castle of Knowledge," 1556.
[2] Annual Report of Progress, Geological Survey of Canada. Vol. VIII., p. 385.

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

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

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

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

One of the most remarkable physical features of the country are the deep canons or fjords, followed by all the rivers draining the interior where they cut through the margin of the peninsula and run out to sea. These have rock walls from 1,000 to 4,000 feet in height, while the river channels are from 10 to 100 fathoms deep. They appear to be valleys of denudation and are of very ancient origin, antedating the Cambrian ; undisturbed, horizontal beds of Cambrian age being found deposited upon their lower levels. The gorges of the Hamilton, Sandwich and Kaipokok might be cited as examples as well as those of the Moisie and Saguenay discharging into the Gulf of St. Lawrence.

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

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

The Cambrian strata, which rest unconformably upon the Laurentian and Huronian, consist of bedded sandstones, argillites, shales and limestones along with bedded traps and other volcanic rocks and enormous deposits of excellent iron ore, whose mode of occurrence is closely analogous to that of the iron ores of Michigan and Wisconsin.

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

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

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

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

Frank D. Adams.

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

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

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

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

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

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

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

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

ASIA.

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

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

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

THE FORBIDDEN CITY.

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

But besides these great unexplored regions there are many blanks to be filled up in other parts of Asia, and regions which, though known in a general way, would well repay careful examination. There is the mountain track between the Zarafshan river and the middle course of the Sarkhab, tributary of the Oxus, and the country lying between that and the Oxus. There is the great Takla-Makan desert in Chinese or Eastern Turkistan, part of which has recently been explored by Russian expeditions and by that young and indefatigable Swedish traveller, Dr. Sven Hedin. It is now one of the most forbidding deserts to be found anywhere, but it deserves careful examination, as there are evidences of its once having been inhabited, and that at no very remote period. It is almost surrounded by the Tarim, and on its eastern edge lies Lob-nor, the remarkable changes in which have been the subject of recent investigation. As readers of Dr. Nansen's Voyage of the "Fram" will remember, the Siberian coast is most imperfectly mapped. Of course it is a difficult task, but it is one to which the Russian government ought to be equal. China has on paper the appearance of being fairly well mapped: but as a matter of fact our knowledge of its mountain ranges and of its great river courses is to a large extent extremely vague. All this awaits careful survey. In north-eastern Manchuria and in many parts of Mongolia there are still blanks to be filled up and mountain and river systems to be surveyed. In the Malay peninsula and in the great array of islands in the east and south-east of Asia—Sumatra, Borneo, the Philippines—much work still remains to be done. Thus for the coming century there will be abundance of work for explorers in Asia and plenty of material to occupy the attention of our geographical societies.

DARKEST AFRICA.

Coming to the map of Africa, we find the most marvellous transformation during the last sixty years, and mainly during the last forty years, dating from Livingstone's memorable journey across the continent. Though the north of Africa was the home of one of the oldest civilizations, and though on the shores of the Mediterranean Phœnicians, Carthaginians, Greeks and Romans were at work for centuries, it has only been within the memory of many of us that the centre of the continent, from the Sahara to the confines of Cape Colony, has ceased to be an unexplored blank. This blank has been filled up with bewildering rapidity. Great rivers and lakes and mountains have been laid down in their main features, and the whole continent, with a few unimportant exceptions, has been parcelled out among the powers of Europe; but much still remains to be done ere we can form an adequate conception of what is in some respects the most interesting and the most intractable of the continents. Many curious problems still remain to be solved. The pioneer work of exploration has to a large extent been accomplished; lines have been run in all directions: the main features have been blocked out; but between these lines the broad meshes remain to be filled in, and to do this will require many years of careful exploration. However, there still remain one or two regions that afford scope for the adventurous pioneer.

To the south of Abyssinia and to the west and north-west of Lake Rudolf, on to the Upper Nile, is a region of considerable extent, which is still practically unknown. Again, in the western Sahara there is an extensive area, inhabited mainly by the intractable Tuaregs, into which no one has been able to penetrate, and of which our knowledge is extremely scanty. Even in the central Sahara there are great areas which have not been traversed, while in the Libyan desert much remains to be done. These regions are of interest almost solely from the geographical and geological standpoints; but they deserve careful investigation, not only that we may ascertain their actual present condition, but in order, also, that we may try to discover some clues to the past history of this interesting continent. Still, it must be said that the great features of the continent have been so fully mapped during the last half century that what is required now is mainly the filling-in of the details. This is a process that requires many hands and special qualifications. All over the continent there are regions which will repay special investigation. Quite recently an English traveller, Mr. Cowper, found not far from the Tripoli coast miles of magnificent ruins and much to correct on our maps. If only the obstructiveness of the Turkish officials could be overcome, there is a rich harvest for any one who will go to work with patience and intelligence. Even the interior of Morocco, and especially the Atlas mountains, are but little known. The French, in both Tunis and Algeria, are extending our knowledge southward.

EFFECTS OF THE POWERS.

All the powers who have taken part in the scramble for Africa are doing much to acquire a knowledge of their territories. Germany especially deserves praise for the persistent zeal with which she has carried out the exploration of her immense territories in East and West Africa. The men she sends out are unusually well qualified for the work, capable not simply of making a running survey as they proceed and taking notes on country and people, but of rendering a substantial account of the geology, the fauna, the flora, and the economic conditions. Both in the French and British spheres good work is also being done, and the map of Africa is being gradually filled up. But what we especially want now are men of the type of Dr. J. W. Gregory, whose book on the Great Rift valley is one of the most valuable contributions to African geography ever made. If men of this stamp would settle down in regions like that of Mount Ruwenzori or Lake Rudolf or the region about lakes Bangweolo and Tanganyika, or in the Atlas or in many other regions that could be named, the gains to scientific geography, as well as to the economic interests of Africa, would be great. An example of work of this kind is seen in the discoveries made by a young biologist trained in geographical observation, Mr. Moore, on Lake Tanganyika. There he found a fauna which seems to afford a key to the past history of the centre of the continent, a fauna which, Mr. Moore maintains, is essentially of a salt-water type. Mr. Moore, I believe, is inclined to maintain that the ancient connection of this part of Africa with the ocean was not by the west, as Joseph Thomson surmised, but by the north, through the Great Rift valley of Dr. Gregory, and he strongly advocates the careful examination of Lake Rudolf as the crucial test of his theory. It is to be hoped that he or some one equally competent will have an opportunity of carrying out an investigation likely to provide results of the highest importance.

CLIMATE OF THE COUNTRY.

But there are other special problems connected with this, the most backward and the most repellent of continents, which demand serious investigation—problems essentially geographical. One of the most important of these, from the point of view of the development of Africa, is the problem of acclimatization. The matter is of such prime importance that a committee of the Association has been at work for some years collecting data as to the climate of tropical Africa. In a general way we know that that climate is hot and the rainfall scanty; indeed, even the geographers of the ancient world believed that Central Africa was uninhabitable on account of its heat; but science requires more than generalities, and therefore we look forward to the exact results which are being collected by the committee referred to with much hope. We can only go to work experimentally until we know precisely what we have to deal with. It will help us greatly to solve the problem of acclimatization when we have the exact factors that go to constitute the climate of tropical Africa. At present there is no doubt that the weight of competent opinion—that is, opinion of those who have had actual experience of African climate and of those who have made a special study of the effects of that climate on the human constitution—is that, though white men, if they take due precautions, may live and do certain kinds of work in tropical Africa, it will never be possible to colonize that part of the world with people from the temperate zone. This is the lesson taught by generations of experience of Europeans in India.

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

HIDDEN ENEMIES.

An able young Italian physician, Dr. Sambon, has recently faced this important problem, and has not hesitated to come to conclusions quite opposed to those generally accepted. His position is that it has taken us centuries in Europe to discover our hidden enemies, the microbes of the various diseases to which northern humanity is a prey, and to meet them and conquer them. In Africa we have a totally different set of enemies to meet, from lions and snakes down to the invisible organisms that produce those forms of malaria, anæmia, and other diseases characteristic of tropical countries. He admits that these are more or less due to heat, to the nature of the soil, and other tropical conditions, but that if once we knew their precise nature and modes of working we should be in a position to meet them and conquer them. It may be so, but this is a result that could only be reached after generations of experience and investigation, and even Dr. Sambon admits that the ultimate product of European acclimatization in Africa would be something quite different from the European progenitors. What is wanted is a series of carefully conducted experiments.

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

NORTH AMERICA.

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

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

But it is not so long since that Dr. Dawson, in reviewing what remains to be done in the Dominion in the way of even pioneer exploration, pointed out that something like a million square miles remained to be mapped. Apart from the uninhabitable regions in the north, there are, as Dr. Dawson pointed out, considerable areas which might be turned to profitable agricultural and mining account of which we know little, such areas as these which have been recently mapped out on the south of Hudson bay by Dr. Bell and beyond the Ottawa by Mr. O'Sullivan. Although the eastern and western provinces have been very fully surveyed, there is a considerable area between the two lying between Lake Superior and Hudson bay which seems to have been so far almost untouched. A very great deal has been done for the survey of the rivers and lakes of Canada. I need hardly say that in Canada, as elsewhere in America, there is ample scope for the study of many problems in physical geography—past and present glaciation and the work of glaciers, the origin and régime of lake basins, the erosion of river beds, the oscillation of coast lines. Happily, both in Canada and the United States there are many men competent and eager to work out problems of this class, and in the reports of the various surveys, in the transactions of American learned societies, in scientific periodicals, and in separate publications, a wealth of data has already been accumulated of immense value to the geographer.

UNITED STATES.

Every geologist and geographer knows the important work which has been accomplished by the various surveys of the United States, as well as by the various State surveys. The United States Coast Survey has been at work for more than half a century, mapping not only the coast but all the navigable rivers. The Lake Survey has been doing a similar service for the shores of the Great Lakes of North America. But it is the work of the Geological Survey which is best known to geographers—a survey which is really topographical as well as geological, and which, under such men as Hayden, King and Powell, has produced a series of magnificent maps, diagrams and memoirs of the highest scientific value and interest. Recently this survey has been placed on a more systematic basis, so that now a scheme for the topographical survey of the whole of the territory of the United States is being carried out. Extensive areas in various parts of the States have been already surveyed on different scales. It is to be hoped that in the future, as in the past, the able men who are employed on this survey work will have opportunities of working out the physiography of particular districts, the past and present geography of which is of advancing scientific interest. Of the complete exploration and mapping of the North American continent we need have no apprehension; it is only a question of time, and it is to be hoped that neither of the governments responsible will allow political exigencies to interfere with what is really a work of national importance.

CENTRAL AND SOUTH AMERICA.

It is when we come to Central and South America that we find ample room for the unofficial explorer. In Mexico and the Central American States there are considerable areas of which we have little or only the vaguest knowledge. In South America there is really more room now for the pioneer explorer than there is in Central Africa. In recent years the Argentine Republic has shown laudable zeal in exploring and mapping its immense territories, while a certain amount of good work has also been done by Brazil and Chili. Most of our knowledge of South America is due to the enterprise of Europeans and of North American explorers. Along the great river courses our knowledge is fairly satisfactory, but the immense areas, often densely clad with forests, lying between the rivers are almost unknown. In Patagonia, though a good deal has recently been done by the Argentine government, still in the country between Punta Arenas and the Rio Negro we have much to learn, while on the West Coast range, with its innumerable fjord-like inlets, its islands and peninsulas. there is a fine field for the geologist and physical geographer. Indeed, throughout the whole range of the Andes systematic exploration is wanted, exploration of the character of the excellent work accomplished by Whymper in the region around Chimborazo.

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

In short, in South America there is a wider and richer field for exploration than in any other continent. But no mere rush through these little-known regions will suffice. The explorer must be able not only to use his sextant and his theodolite, his compass, and his chronometer. Any expeditions entering these regions ought to be able to bring back satisfactory information on the geology of the country traversed, and of its fauna and flora, past and present. Already the revelations which have been made of the past geography of South America and of the life that flourished there in former epochs are of the highest interest. Moreover, we have here the remains of extinct civilizations to deal with, and although much has been done in this direction, much remains to be done, and in the extensive region already referred to the physique, the traditions, and the customs of the natives will repay careful investigation.

AUSTRALIA.

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

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

POLAR EXPLORATION.

The marvellous success which has attended Dr. Nansen's daring adventure into the Arctic seas has revived a widespread interest in polar exploration. Nansen may be said to have almost solved the North Pole problem—so far, at least, as the Old World side of the Pole is concerned. That some one will reach the Pole at no distant date is certain; Nansen has shown the way, and the legitimate curiosity of humanity will not rest satisfied till the goal be reached. But Arctic exploration does not end with the attainment of the Pole. Europe has done her share on her own side of the Pole; what about the side which forms the hinterland of North America, and especially of Canada? To the north of Europe and Asia we have the scattered groups of islands, Spitsbergen, Franz Josef Land, Nova Zembla, and the New Siberian islands. To the north of America we have an immense archipelago, the actual extent of which is unknown. Nansen and other Arctic authorities maintain that the next thing to be done is to complete exploration on the American side—to attempt to do for that half of the North Pole region what Nansen has done for the other half. It may be that the islands which fringe the northern shores of the new world are continued far to the north; if so, they would form convenient stages for the work of a well-equipped expedition. It may be that they do not go much farther than we find them on our maps. Whatever be the case, it is important, in the interests of science, that this section of the polar area be examined; that as high a latitude as possible be attained; that soundings be made to discover whether the deep ocean extends all round the Pole.

It is stated that the gallant Lieutenant Peary has organized a scheme of exploring this area which would take several years to accomplish. Let us hope that he will be able to carry out his scheme. Meantime, should Canada look on with indifference? She has attained the standing of a great and prosperous nation. She has shown the most commendable zeal in the exploration of her own immense territory. She has her educational, scientific and literary institutions which will compare favorably with those of other countries; her press is of a high order, and she has made the beginnings of a literature and an art of her own. In these respects she is walking in the steps of the mother country. But has Canada not reached a stage when she is in a position to follow the maternal example still further? What has more contributed to render the name of Great Britain illustrious than those enterprises which for centuries she has sent out from her own shores, not a few of them solely in the interests of science? Such enterprises elevate a nation and form its glory and its pride. Surely Canada has ambitions beyond mere material prosperity; and what better beginning could be made than the equipment of an expedition for the exploration of the seas that lie between her and the Pole? I venture to throw out these suggestions for the consideration of those who have at heart the honor and glory of the great Canadian Dominion.

THE ANTARCTIC REGIONS.

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

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

OCEANOGRAPHY.

But our science has to deal not only with the lands of the globe; its sphere is the whole of the surface of the earth and all that is thereon, so far at least as distribution is concerned. The department of oceanography is a comparatively new creation ; indeed, it may be said to have come definitely into being with the famous voyage of the "Challenger." There had been expeditions for ocean investigation before that, but on a very limited scale. It has been through the results obtained by the "Challenger," supplemented by those of expeditions that have examined more limited areas, that we have been able to obtain an approximate conception of the conditions which prevail throughout the various ocean depths—conditions of movement, of temperature, of salinity, of life. We have only a general idea of the contours of the ocean bed, and of the composition of the sediment which covers that bed. The extent of the knowledge thus acquired may be gauged from the fact that it occupies a considerable space in the fifty quarto volume—the "Challenger" publications—which it took Dr. John Murray twenty years to bring out.

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

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

Book Notices.

THE MINERAL WEALTH OF CANADA: A GUIDE FOR STUDENTS OF ECONOMIC GEOLOGY.—By Arthur B. Willmott, M.A., B.Sc. Toronto: William Briggs, 1897.

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

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

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

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

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

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

The volume is well printed and of convenient size.

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

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

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

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

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

F. D. A.

Report of the Geology of a Portion of the Laurentian Area, lying North of the Island of Montreal.

The last Annual Report of the Geological Survey of Canada (Vol. VIII.) contains a report and map of a portion of the Laurentian area, lying north of Montreal. It is of especial scientific interest, inasmuch as it is the first publication which describes in a complete form all the different rock structures which are found in a typical area of the Canadian Archæan, with the purpose of ascertaining their true origin. The report is written by Dr. F. D. Adams, of McGill University. The first appendix contains a list of the different publications referring to the Canadian anorthosites, while the second is an abridgement of a paper by Mr. A. J. Rossi, of New York, on the smelting of Titaniferous Iron Ores. The latter is very important, as the areas occupied by the anorthosites contain enormous masses of iron ore of this character.

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

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

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

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

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

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

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

Three railways traverse this district, so that, considering the extreme ruggedness of the country, the travelling facilities are very good. The Canadian Pacific Railway, branching from the main line at St. Martin's Junction, runs over the Palæozoic almost to St. Jerome, then across the Laurentian to Piedmont; from thence it crosses the Morin anorthosite to Morisson's Station, and then unto the Laurentian again. Its western terminus is beyond the limits of the map. The altitude of each station is printed underneath the name, and may be taken as approximate for the immediate surrounding country.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The gneisses of aqueous origin form the next class—are so determined chiefly from the fact that they have a chemical composition identical with shales or other sediments, but quite different from that of any igneous rock. These gneisses, in addition to the essential constituents of the igneous class, contain garnet, sillimanite and graphite. They are divided according to their mode of weathering—one variety crumbling to a rusty sand, caused by the iron pyrites it contains, and the other variety, being free from that mineral, not doing so.

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

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

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

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

The third class of gneisses, or those of doubtful origin, are numerous and occur in many parts of this area. The varieties include quartz orthoclase biotite gneiss, with and without garnet, garnetiferous hornblende gneiss, granulite, and pyroxene and amphibolite granulites. These, as in the case of the former classes, have been submitted to intense pressure. In this class, however, as in many other classes of rocks, the work of the investigator is by no means ended, and the future will no doubt settle the problems concerning their origin, which are to-day unsolved.

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

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

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

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

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

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

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

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

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

Considerable attention has been given to the economic geology, with the result that the following minerals have been found, some of which are of importance: Magnetite, ilmenite, bog ore, ochre, graphite, apatite, mica, garnet rock, crystalline limestone and anorthosite. The latter makes a good paving stone, and has been used for that purpose in Montreal. No traces of gold or silver were discovered, though numerous specimens were taken from localities where these precious metals were supposed to exist, but careful assays gave a negative result.

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

O. E. LeRoy.

ABSTRACT FOR THE MONTH OF OCTOBER, 1897.

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

DAY	THERMOMETER.				BAROMETER.				†Mean pressure of vapor.	‡Mean relative humidity.	Dew Point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	§Max.	Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	59.21	65.8	48.7	17.1	30.1635	30.411	29.982	.429	3088	60.3	45.3	N.	21.04	1.7	10	0	77	....	....	...	1
2	47.17	54.8	39.1	15.7	30 5890	30.621	30.529	.092	.2002	62.2	34.5	N	14.46	0.0	0	0	97	....	...	....	2
SUNDAY........ 3	.....	62.0	35.0	27.0	......	.....	. ..	.....	......	....	....	S.W.	12 63	...	..	..	87	....	....	....	3..........SUNDAY
4	54 43	66.3	41.8	24.5	30.3168	30.441	30.193	.248	.2717	64.2	42.2	S.W.	18.96	0.3	2	0	92	....	......	...	4
5	56.30	69.4	43.3	26.1	29.9418	30.130	29.756	374	.2750	60.3	42.2	S.W.	15.33	1 5	3	0	93	....	....	....	5
6	52 63	64.6	46.3	18.3	29.7345	29.876	29.631	.245	.3182	79.5	46.2	S W.	17 67	7.0	10	0	16	0.05	....	0.05	6
7	42.67	47.2	38.3	8.9	30 0025	30.120	29.891	.229	.2010	73.2	34.7	N.W.	8.58	8 8	10	5	0	0.00	....	0.00	7
8	42.83	48.0	35.0	13.0	29.9932	30.143	29.763	.380	.2047	73.0	34.8	S.W.	8.83	8.2	10	5	36	0.02	....	0.02	8
9	41.87	53.3	31.5	21.8	30.0400	30.273	29.705	.568	.1777	64.2	30.5	W.	21.17	2.2	10	0	94	0.00	....	0.00	9
SUNDAY........10	.....	39.8	26.0	13.8	......	......	......	....	.....	....	...	N. W.	7.21	....	..	..	63	....	....	...	10 ....SUNDAY
11	52.22	64.7	30.4	34.3	29 9177	30 069	29.764	.305	.3260	75.8	44.7	S.W.	15 79	9.0	10	8	19	....	...	...	11
12	61.33	67.0	52.3	14.7	29.7600	29.993	29.642	.351	.4678	84.3	56.8	S W.	24.75	7 0	10	0	0	0.26	...	0.26	12
13	51.12	58.7	43.9	14.8	30.3292	30.454	30 116	.338	.2545	68 5	40.8	S.W.	15.17	0.2	1	0	97	....	... .	....	13
14	53.73	62.2	42.4	19.8	30.3072	30 500	30.106	.394	.2962	71 7	44.7	S.	13 75	4.8	10	0	52	...	...	..	14
15	68.58	77.8	44.0	33.8	29.9938	30.071	29.927	.144	.5185	73 8	59.7	S W	18.04	3.5	10	0	63	....	....	....	15
16	62.75	71.8	45.8	26.0	29 7802	29 897	29.632	.265	.4847	80.8	56.7	S. W.	25 25	7.0	10	3	15	0.13	....	0.13	16
SUNDAY........17	... .	44.5	37.4	7.1	......	......	......	......	......	....	....	N.W	20 67	. ..	..	..	82	0.00	....	0.00	17..........SUNDAY
18	44.83	54 2	35.0	19.2	30.2990	30.442	30.191	.251	.1853	63.2	32.2	S	22.88	5.5	10	0	41	...	....	....	18
19	49.27	55.2	42.8	12.4	30.1112	30.160	30.053	.107	.2468	65.0	39.5	S.W.	14.79	4.8	10	0	58	....	....	....	19
20	42.15	52.2	33.5	18.7	30.1223	30.203	30.063	.140	.1783	66.5	31.7	N.	17.79	0.8	3	0	94	....	....	....	20
21	44.00	53.8	35.5	18.3	30 0555	30.086	30 011	.074	.1877	64 2	32.5	N.	13.75	6.8	10	0	26	....	....	....	21
22	43.38	51.4	36.0	15.4	30.1872	30 270	30.100	.170	.1982	70 2	34.2	N.	8.33	4.3	10	0	37	....	....	....	22
23	44.83	54.8	34.0	20.8	30.3277	30.383	30.287	.096	.2335	78.5	38.0	S.	8.33	1.7	10	0	71	....	....	....	23
SUNDAY........24	....	56.2	40.0	16.2	......	.....	......	......	......	....	....	S.W.	12.63	...		..	68	....	...	....	24.......... SUNDAY
25	49 75	58.4	41.3	17.1	30.0968	30.133	30.060	.073	.3235	89.5	46.7	N.	11.58	0 8	5	0	86	....	...	....	25
26	48.95	58.4	41.0	17.4	30.1400	30.171	30.110	.061	.2740	79.3	42.7	N.	6.67	0.0	0	0	88	....	....	....	26
27	49 92	61.2	39.7	21.5	30 0998	30.187	29.972	.215	.2378	80.3	44.0	S.	10.33	1.3	8	0	68	....	.	....	27
28	50.62	60.5	44.4	16.1	29.6975	29.924	29.525	.399	.2883	76.8	43 5	S.E	16.29	5.3	10	0	38	0.16	....	0.16	28
29	35.70	44.5	31.0	13.5	29.7215	29.847	29 612	.235	.1593	67.3	28.5	N W.	16.58	2.5	8	0	90	0 03	....	0.03	29
30	30.92	34.8	26.6	8.2	30.0050	30.134	29.884	.250	.1270	73 3	23.5	S W.	8.04	4.5	10	0	0	....	....	....	30
SUNDAY........31	.....	42.7	29.6	13.1	......	......	......	......	......	....	...	E.	8.71	...	..	..	6	....	..	....	31..........SUNDAY
Means...........	49.39	56.65	38.44	18.21	30.0666	30 1899	29.9425	.2474	.2690	71.77	40.42	S. 54¾° W	14 71	3.83	7.7	0.8	57.3	0.65	....	0.65	..............Sums.
23 Years means for and including this month	45.43	52.45	38.55	13.93	29.9985	......	......	.215	.2438	76.4			s 13.55	6.33	.	:	¶41.34	2.96	....	3.08	23 Years means for and including this month.

ANALYSIS OF WIND RECORD.

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

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

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

Resultant mileage, 4495.

Resultant direction, S. 54° ¾ W.

Total mileage, 10,944.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only. *s* 11 years only.

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

Warmest day was the 15th. Coldest day was the 30th. Highest barometer reading was 30.644 on the 3rd. Lowest barometer was 29.525 on the 28th giving a range of 1.119 inches. Maximum relative humidity was 98 on the 16th. Minimum relative humidity was 39 on the 18th.

Rain fell on 9 days.

Aurora was observed on one night.

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

Fog on 5 days.

ABSTRACT FOR THE MONTH OF NOVEMBER, 1897.

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

DAY	THERMOMETER. Mean.	Max.	Min.	Range.	BAROMETER. Mean.	§Max.	Min.	Range.	†Mean pressure of vapor.	‡Mean relative humidity.	Dew Point.	WIND. General direction.	Mean velocity in miles per hour	SKY CLOUDED IN TENTHS. Mean.	Max.	Min.	Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	40.25	47.0	35.6	11.4	30.0282	30.087	29.996	.091	.2392	94.7	38.8	S.E	11.67	10 0	10	10	00	0.35	....	0.35	1
2	35.20	37.8	31.7	6.1	29.8080	29.937	29.610	.327	.1885	91.7	32.8	N.	27.75	10.0	10	10	00	0.64	...	0.64	2
3	38.47	42.7	32.5	10.2	29.8098	30.053	29.597	.456	.2123	90.5	35.8	N	14.92	6.7	10	0	00	0.11	....	0.11	3
4	43.70	51.2	37.3	13.9	30.1597	30.190	30.129	.061	.2498	86.7	39.8	S.	13.13	3.0	7	0	00	....	......	....	4
5	39.93	48.8	34.0	14.8	30.0005	30.168	29.832	.336	.2163	87.2	36.5	N.	13.67	6.8	10	0	27	0.00	....	0.00	5
6	46.22	51.4	37.7	13.7	29.7273	29.805	29.675	.130	.2520	79.0	40.0	S.W.	21.96	8.2	10	3	35	0.27	....	0.27	6
SUNDAY........ 7	.....	37.2	34.5	2.7	......	......		.....	......	....	....	S.W.	22.13	...	..	..	00	0.00	0.0	0.00	7 ....SUNDAY
8	33.83	37.5	29.4	8.1	29.8860	30.002	29.763	.239	.1642	84.0	29.7	S.	6.83	7.2	10	0	00	....	....	....	8
9	33.92	35.6	32.2	3.4	29.3813	29.699	29.100	.599	.1783	91.5	31.7	N.	21.38	10.0	10	10	00	....	8.7	1.10	9
10	31.38	35.6	27.7	7.9	29.7913	29.951	29.560	.391	.1525	86.2	27.7	S.W.	20.63	6.3	10	0	56	...	....	....	10
11	30.95	35.2	25.7	9.5	29.8068	29.963	29.596	.367	.1577	90.7	28.5	E.	12.08	7.5	10	0	00	....	3.2	0.41	11
12	32.40	33.6	30.2	3.4	29.5697	29.614	29.518	.096	.1730	94.0	30.7	N.	14.46	10.0	10	10	00	....	3.5	0.45	12
13	32.18	35.2	29.3	5.9	29.8018	29.973	29.665	.308	.1530	83.5	27.8	S.W.	25.08	9.7	10	8	9	....	....	....	13
SUNDAY........14	.....	31.7	24.6	7.1	......	......	......	....	......	....	....	S.W.	21.33	....	..	..	93	....	....	....	14..........SUNDAY
15	29.03	36.3	20.5	15.8	30.1947	30.291	30.066	.225	.1420	87.0	26.0	E.	10.21	8.0	10	0	37	....	....	...	15
16	38.38	46.6	31.2	15.4	29.9063	30.129	29.715	.414	.2195	91.8	36.2	S.W.	21.13	9.7	10	8	00	0.51	....	0.51	16
17	25.95	28.8	23.0	5.8	30.3247	30.398	30.252	.146	.0967	68.5	17.5	S.W.	14.21	4.5	10	0	98	....	0.0	0.00	17
18	21.52	24.3	17.6	6.7	30.4150	30.439	30.395	.044	.0865	74.8	15.2	W.	9.46	10.0	10	10	6	....	0.0	0.00	18
19	15.32	18.2	11.6	6.6	30.3440	30.419	30.272	.147	.0653	74.5	8.8	N.	9.63	2.0	8	0	89	....		....	19
20	22.07	35.8	11.0	24.8	30.1418	30.268	29.930	.338	.1082	86.3	18.7	N.	13.71	7.8	10	0	00	0.02	0.0	0.02	20
SUNDAY.......21	....	43.6	35.5	8.1	......	......	......	......	......	....	....	E.	23.83	....	..	..	5	....	....	....	21..........SUNDAY
22	21.07	26.3	16.9	9.4	30.0837	30.182	29.946	.236	.0772	67.8	12.5	S.W.	16.96	1.7	10	0	95	....	....	...	22
23	14.58	23.2	9.0	14.2	30.0470	30.225	29.913	.312	.0612	72.3	7.5	W	13.15	2.7	10	0	80	....	....	....	23
24	24.72	34.2	8.5	25.7	30.2225	30.257	30.166	.091	.1043	75.5	18.3	S.	17.96	7.0	10	3	12	....	0.0	0.00	24
25	32.58	35.3	26.2	9.1	30.1663	30.226	30.081	.145	.1637	87.8	29.5	S.W.	18.17	10.0	10	10	00	0.06	0.9	0.20	25
26	45.30	53.2	33.2	20.0	29.7553	30.019	29.575	.444	.2955	95.2	44.0	S.E.	23.17	10.0	10	10	00	0.49		0.49	26
27	24.55	54.2	16.2	38.0	30.2080	30.537	29.711	.826	.1113	78.5	19.0	W	20.33	5.0	10	0	67	0.21	0.0	0.21	27
SUNDAY........28	.....	30.3	14.5	15.8	......	......	......	......	......	....	....	S.E.	12.29	...		..	58	....	....	....	28..........SUNDAY
29	29.47	35.2	24.0	11.2	30.0608	30.316	29.941	.375	.1310	78.8	24.2	S.E.	24.21	5.3	10	0	00	....	2.3	0.27	29
30	13.13	19.3	8.8	10.5	30.1728	30.223	30.118	.105	.0612	77.0	7.5	S.W.	12.21	1.0	6	0	70	....	....	....	30
31																					
Means......	30.62	36.84	25.00	11.84	29.9928	30.1297	29.8509	.2788	.1562	83.68	26.33	S. 35½° W.	16.92	6.93	9.7	3.5	27.9	2.66	18.6	5.03	....Sums.
23 Years means for and including this month	32.45	38.90	26.50	12.41	30.0160	......	......	.267	.1602	79.9			s 16.07	7.36	..	..	¶23.59	2.41	12.75	3.71	23 Years means for and including this month.

ANALYSIS OF WIND RECORD.

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

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

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

Resultant mileage, 3315.
Resultant direction, S. 35°½ W.
Total mileage, 12,183.
Average velocity 16.92 m. p. h.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only. s 11 years only.

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

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

Rain fell on 11 days.

Snow fell on 11 days.

Rain or snow fell on 18 days.

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

Hoar Frost on two days.

Fog on 5 days.

NOTICES.

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AND REPLACING

THE CANADIAN NATURALIST.

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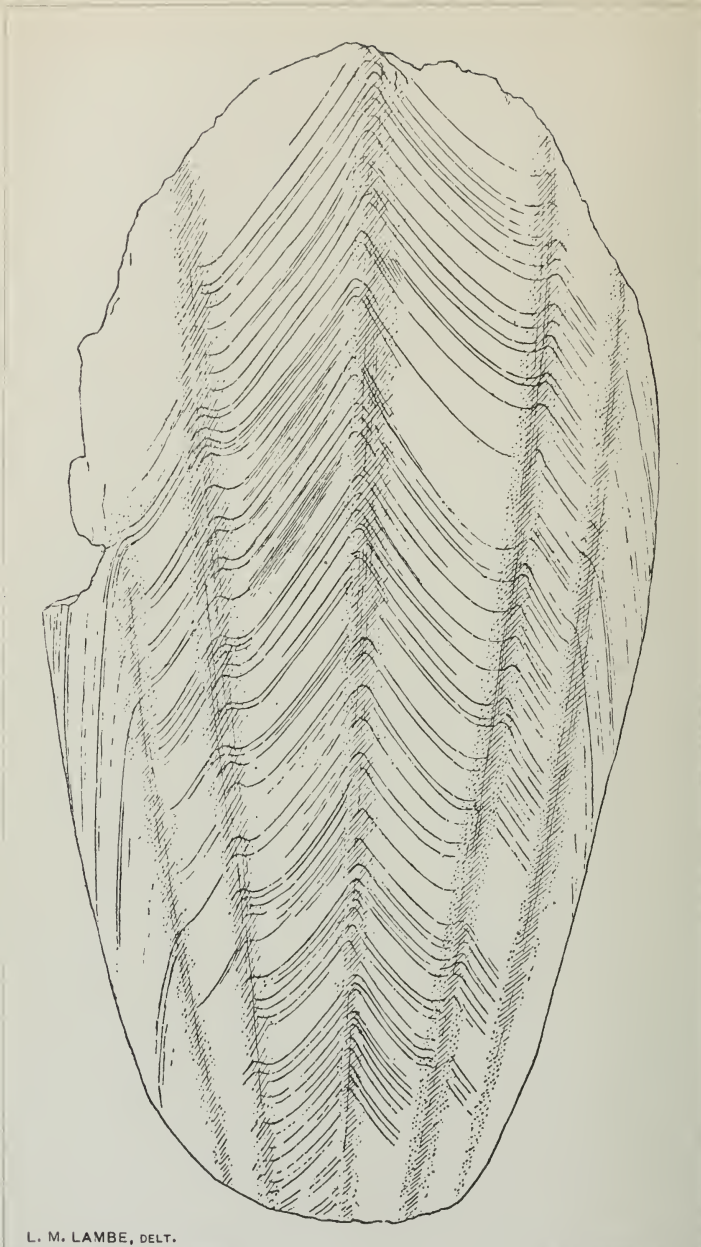

ACTINOSEPIA CANADENSIS.

THE

CANADIAN RECORD

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On some remains of a Sepia-like Cuttle-fish from the Cretaceous rocks of the South Saskatchewan.

By J. F. Whiteaves.

In 1889, four rather remarkable fossils, which probably represent the dorsal side of the internal shell or sepiostaire of a new species of an apparently new genus closely allied to *Sepia*, were collected by Mr. T. C. Weston, of the Geological Survey of Canada, from the Montana or Pierre-Fox Hills formation of the Later North American Cretaceous, at the South Saskatchewan, opposite the mouth of Swift Current Creek.

Each of these fossils is imperfect posteriorly, and not a trace of the mucro is preserved in any of them. The most perfect of the four (which is represented, of the natural size, in the accompanying plate), is about six inches and a quarter in length by about three inches and a quarter in its maximum breadth. It is elliptical or elliptic-ovate in outline, slightly convex, but marked with five narrow, acute, but not very prominent longitudinal ridges, with rather distant, faint depressions or shallow grooves between them. One of these ridges is median, but the two lateral ones on each side are slightly divergent, and a bilateral symmetry is very obvious.

A considerable portion of the surface of each of these fossils is obscured by a blackish and apparently bituminous substance, so that it is difficult to trace any of the lines of growth continuously, though they are remarkably well preserved in patches. Near the lateral margins the incremental striae are simply concentric, but in the median region (where they are fine, extremely numerous and much more densely crowded than it is possible to represent them in the figure, by this mode of reproduction), each one is produced anteriorly into an angular and acutely pointed lobe, with its apex upon the summit of the median ridge. From this fact it may be inferred that the anterior margin of the dorsal side of the shell was pointed in the middle when perfect.

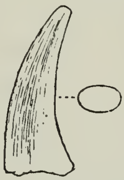
So far as the writer has been able to ascertain, there is no known genus of Sepiidae, fossil or recent, to which these fossils can be satisfactorily referred. They bear, no doubt, a certain general resemblance to the internal shells of *Sepia* itself, but, in the sepiostaires of all the recent species of that genus which the writer has been able to examine, the radii of the dorsal surface are broad, flattened and almost obsolete. As already suggested, they seem to indicate a new genus and species of Sepiidae, for which the name *Actinosepia Canadensis* may not be inappropriate. In any case these fossils are the first well marked remains of sepiostaires that have been found in a fossil state in Canada.

(This paper was read, and the specimens upon which it was based were exhibited, on the 23rd of August, 1897, in Section D (Zoology), at the Toronto meeting of the

British Association for the Advancement of Science. In the discussion which followed, Professors L. C. Miall, the President of the Section, and W. E. Hoyle, its Recording Secretary, expressed their opinion that the interpretation of the specimens suggested in the paper was probably the correct one.)

Note on a Fish Tooth from the Upper Arisaig series of Nova Scotia.[1]

By J. F. Whiteaves.



Dendrodus Arisaigensis.
Side view of the only specimen known to the writer.
Twice the natural size.

The only indication of the existence of vertebrate animals in the Silurian rocks of Canada that has yet been recorded is a single specimen of a Pteraspidian fish discovered by Dr. G. F. Matthew in the Nerepis hills of southern New Brunswick in 1886. This specimen, which consists of the rostrum, the lateral cornua, the dorsal and ventral scutes, and some other plates of the anterior armature of the fish, was subsequently described by its discoverer as the type of a new genus, under the name *Diplaspis Acadica,* though Mr. A. Smith Woodward claims that it should be referred to Lankester's genus *Cyathaspis.*

[1] Read Aug. 21, 1897, in Section C (Geology) at the Toronto meeting of the British Association.

However this may be, in the Museum of the Geological Survey at Ottawa there is a well preserved fish tooth from the Upper Arisaig series at McDonald's Brook, near Arisaig, N.S., collected by Mr. T. C. Weston in 1869. On the evidence of large numbers of other kinds of fossils, the upper portion of the "Arisaig series" is still held to be of about the same age as the Lower Helderberg group of the State of New York and the Ludlow group of England, but no Devonian rocks are known to exist at McDonald's Brook.

The tooth itself, which is not quite perfect at either end, is about eleven millimetres in height by about five in breadth at the base. It is conical, slightly curved and somewhat compressed, the outline of a transverse section a little below the mid-height being elliptical, and its surface is covered with a thin coat of a finely and longitudinally striated enamel. The figure is a line drawing of the tooth, as viewed laterally, with an outline of the transverse section, both of twice the natural size.

Judging by its external characters, this specimen seems to be what is usually called a dendrodont tooth, and therefore probably that of a crossopterygian, perhaps allied to *Holoptychius*, though its fore and aft edges are not trenchant. Only one specimen of it has been obtained, so that no thin sections of it have been made, to show its microscopical structure. As it does not seem referable to any known species, it may be convenient to call it provisionally *Dendrodus Arisaigensis.*

If the limestones from which this tooth was collected are, as there is every reason to believe that they are, of Silurian age, a second species can be added to the vertebrate fauna of that system in Canada; but if not, the tooth is still of interest as indicating the possible existence of Devonian rocks at a locality where such rocks have not previously been recognized.

Contributions to Canadian Botany.

By James M. Macoun.

XI.

Nesodraba megalocarpa, Greene, Pittonia, Vol. III., p. 253.

Central tuft of three leaves 3 inches high or more; leaves oblong-spatulate, obtuse, with a few coarse teeth near the summit; stout ascending peduncles 6 inches high, clothed below the raceme with oval sessile leaves ¾ inch long; pods linear-oblong, ½ to ¾ inch long, two or three lines wide, acutish, and tipped with an acute style.

Seal Rocks, Dawson Harbour, Skidegate Inlet, Queen Charlotte Islands, B.C., 1897. Herb. No. 16,928. (*Dr. C. F. Newcombe.*)

Dr. Greene's new genus, *Nesodraba*, includes three species, one of which, *N. grandis*, has long been a puzzle to botanists, having been by the earlier botanists referred to *Cochlearia* and by the later, with less reason, to *Draba*. *N. megalocarpa* is known only from Dr. Newcombe's specimens. *N. grandis* is common in herbaria as *Draba hyperborea.*

Polygala Senega, L., var. latifolia, T. & G.

Dry bank, Valley Inn near Hamilton, Ont., 1896, (*J. M. Dickson.*) Only other known Canadian station. Georgian Bay.

Cerastium arvense, L., var. villosum, Holl. & Britt.

In sod and along old paths near the cemetery at Hamilton, Ont., 1897. (*J. M. Dickson.*) New to Canada.

Sagina procumbens, L.

Growing in Mr. R. Cameron's yard at Niagara, Ont.

Probably indigenous, though not before recorded from Ontario.

TRIFOLIUM DIANTHUM, Greene, Pittonia, Vol. III., p. 217.

Very dwarf perennial, the rather stoutish stems, scarcely an inch long, surpassed by the upper petioles and peduncles; herbage deep green and very glabrous; leaflets obcordate or obovate, about $\frac{1}{4}$ inch long, rather sharply and mucronately dentate; peduncles shorter than the leaves, bearing an involucrate pair of purple flowers; involucre large for the plant, lacerately cleft; calyx with 10-nerved tube shorter than the teeth, these with oblong-lanceolate body tapering to a stoutish aristiform apex; corolla twice the length of the calyx, the petals purple, tipped with white.

Species founded on specimens collected at Esquimault near Victoria, Vancouver Island, by Prof. Macoun, May 13th, 1893. Herb. No. 97, and distributed as *T. pauciflorum.* Specimens collected at the same place by Prof. Macoun in 1875, and labelled *T. pauciflorum* var. (Herb. No. 18,015), are this species.

TRIFOLIUM AGRARIUM, L.

New Westminster, B.C. (*A. J. Hill.*) Not recorded west of Ontario.

PRUNUS MAHALEB, L.

Mountain side at Hamilton, Ont., May 15th, 1895. (*J. M. Dickson.*) Well naturalized. Not before recorded from Canada.

ASTER ANGUSTUS, T. & G.

Growing in railway round-house at Montrose, Ont. (*R. Cameron.*) Introduced from the west along railway.

ERIGERON MACOUNII, Greene, Pittonia, Vol. III., p. 162.

Low perennial, with a stout branching caudex bearing many spatulate, linear, acute, entire leaves, and stoutish ascending, sparsely leafy monocephalous peduncles; the younger foliage canescently strigose, the older glabrate; heads large, hemispherical; bracts of the somewhat hoary-tomentose involucre subequal, in two series; rays about 50, rather broad, purple.

Summit of Sheep Mountain, Waterton Lake, Rocky Mountains, alt., 7,500 ft., July 31st, 1895. Herb. No. 10,858. (*John Macoun.*) Distributed as *Erigeron ochroleucus.*

ERIGERON KINDBERGI, Greene, Pittonia, Vol. III., p. 165.

Stems several, erect, from a perennial root, 6 inches high, pilose-pubescent, apparently flaccid and not conspicuously angled; lowest leaves oblanceolate, entire, acute, wholly glabrous and, in no degree, ciliate; the cauline narrowly linear, elongated, sessile by an abruptly dilated base; heads mostly solitary, small, the involucre barely three lines high; bracts very unequal, all narrowly linear and rather abruptly acute, glabrous and glandless, except at the pilose-pubescent base; rays very numerous, narrow and short; pappus scanty for the *E. acris* group, and not at all accrescent, dull-white, unchanged in age.

Meadows on the plateau east of Stump Lake, B.C., July 14th, 1891. Herb. No. 7,793. (*Jas. McEvoy.*) Named for Dr. Nils Conrad Kindberg, by whom some of the characters were indicated in 1892.

ERIGERON JUCUNDUS, Greene, Pittonia, Vol. III., p. 165.

E. acris, Macoun, Cat. Can. Plants, Vol. I., p. 547 in part.

E. acris, var. *Drœbachensis*, Macoun, Cat. Can. Plants, Vol. I., p. 547 in part.

E. alpinus, Macoun, Cat. Can. Plants, Vol. I., p. 234 in part.

Perennial, 2 to 10 inches high, the several stems monocephalous, or in larger plants with several and corymboseracemose rather large heads; herbage, light-green and flaccid, more or less pilose-pubescent, and at least the upper parts of the plant glandular-viscid; lowest leaves spatulate-ovate and oblanceolate, obtuse, mucronulate, entire, or with one or two pairs of crenate and mucronulate teeth below the apex, both faces sparsely pubescent and the petioles as sparsely ciliate; the cauline oblong-lanceolate, entire; heads three or four lines high, but involucral bracts notably shorter than the flowers, unequal, nearly linear, the inner acuminate, the tips of all more or less spreading, the whole involucre as well as the peduncles viscid-glandular, the basal parts hirsute-pubescent; rays apparently 60 to 80, not extremely narrow; pappus, copious and accrescent, dull white, little darker in age.

Distributed freely from the Herbarium of the Geological Survey of Canada as *E. acris*, *E. acris*, var. *Drœbachensis* and *E. alpinus*, to which species it was at various times referred by Dr. Gray and Dr. Watson. Easily distinguished from *E. Drœbachensis* by its very different habit, pubescence and inflorescence; and the pappus of the latter, at least in the American plant, becomes of a rich and beautiful brown-red in age. The peduncles in the present species, though slender, are abruptly and conspicuously enlarged at summit under the involucre.

Summit of Sheep Mountain, Waterton Lake, Rocky Mountains, alt., 7,000 ft. Herb. No. 10,841; Lake Louise, Rocky Mts., alt., 6,500 ft. Herb. No. 7,794; Kicking Horse Lake, Rocky Mts., alt., 7,000 ft. Herb. No, 18,010; Roger's Pass, Selkirk Mountains, alt., 5,000 ft. Herb. No. 11,005; Revelstoke, B.C. Herb. No. 18,011. (*John Macoun.*) Western summit of North Kootanie Pass, Rocky Mountains. Herb. No. 18,012. (*Dr. G. M. Dawson.*) Mount Queest, Shuswap Lake, B.C., alt., 6,000 ft. Herb. No. 11,009. (*Jas. M. Macoun.*) Dr. Kindberg was of the opinion that the Lake Louise plant agreed very nearly with *E. politus* Fr., but *E. politus* is not only glabrous, but it has none of the viscid-glandulosity which is so characteristic of *E. jucundus.*

E IGERON ELATUS, Greene, Pittonia, Vol. III., p. 164.

E. alpinus, var. *elatus*, Hook. ; Macoun, Cat. Can. Plants in part.

Collected by Drummond in the Rocky Mountains, Lat. 54°–56°, re-discovered by Prof. Macoun in 1890. Kicking Horse Lake, Rocky Mountains. Herb. No. 18,014 ; Cave Avenue, Banff, Rocky Mountains. Herb. No. 11,018. (*John Macoun.*)

ERIGERON ALPINUS, L.

The specimens, collected by Dr. Dawson and referred here by Prof. Macoun in Cat. Can. Plants, Vol. I., p. 234, are *E. jucundus.* Our only specimens of *E. alpinus* were collected by Prof. Macoun at Kicking Horse Lake, Rocky Mountains, in 1885, when they were referred to *E. acris.*

ERIGERON PEREGRINUS (Pursh), Greene, var. DAWSONI, Greene, Pittonia, Vol. III., p. 166.

Differs from the type in having its leaves gradually reduced from the middle of the stem upward almost as much as in *E. salsuginosus ;* and more notably different in having twice as many and much more slender involucral bracts, and about 50 rather narrow rays. In damp, grassy thickets, Queen Charlotte Islands, B.C. Herb. No. 11,205. (*Dr. G. M. Dawson.*) Referred provisionally to *E. salsuginosus*, var. *Unalaschkensis*, Less, by Prof. Macoun in Cat. Can. Plants, Vol. I., p. 233, where some of its distinguishing characters were indicated.

IVA XANTHIFOLIA, Nutt.

Along Grand Trunk Railway near Clifton, Ont. (*R. Cameron.*) Waste ground, St. Catherines, Ont. (*W. C. McCalla.*) Introduced from the west along railway.

SENECIO MACOUNII, Greene, Pittonia, Vol. III., p. 169.

Tufted and apparently somewhat stoloniferous perennial, the slender, nearly naked stems about a foot high, simple, subcorymbose at summit, leafy below, floccose-tomentose throughout; leaves chiefly at and near the base of the stem, hoary-tomentose beneath, more deciduously so above, 3 to 6 lines long, including the slender petiole, this much longer than the obovate or oblong-lanceolate or oblanceolate blade, which is 3-nerved and with variously crenate, or dentate or repand-denticulate margin; heads small (as in *S. Fendleri*), in a rather compact cymose corymb; bracts of the involucre about 12 or 15, lanceolate, thinnish; rays as many, yellow; achenes light colored, 5-angled, with 5 intervening striæ; pappus fine and soft.

Goldstream, (Herb. No. 554), and Mount Benson. (Herb. No. 555), Vancouver Island. (*John Macoun.*) Distributed as *S. lugens*, var. *exaltatus*, Gray.

SENECIO COLUMBIANUS, Greene, Pittonia, Vol. III., p. 169.

Taller and stouter than *S. lugens*, often 3 feet high, the stems solitary, not clustered, and without a root stock, but proceeding from a not at all deep-seated fascicle of fibrous roots; leaves scattered up and down the lower half of the stem (not clustered at base of a nearly naked stem); pubescence scanty, curled-hairy rather than fine and lanate or tomentose; heads three or four times as large as in *S. lugens*, more than twice as numerous, and the corymb compound; bracts of the involucre more thick and fleshy, scarcely black-tipped; mature achenes light-colored, scarcely angled or even striate.

Hillsides, Farewell Creek, Assiniboia. Herb. No. 11,637; grassy slopes, Guichon Creek, B.C. Herb. No. 16,586. Typical. (*Dr. G. M. Dawson.*) Confounded with *S. lugens* and figured as that species in Hooker's *Flora Boreali-Americana*, probably from specimens collected in British Columbia by Douglas, while Richardson's description in the same volume was from sub-arctic specimens of his own collecting. *S. lugens* is well represented in our herbarium, and seems to be an exclusively sub-arctic and Rocky Mountain species. Specimens from Old Man's River, about 30 miles north of the International Boundary, answer to Richardson's description even better than specimens in our herbarium of his own collecting.

SENECIO NEWCOMBEI, Greene, Pittonia, Vol. III., p. 249.

Slender and weak, simple stemmed and monocephalous perennial, with thin membranaceous foliage; leaves few and remote, long-petioled, reniform-palmate, *i.e*, of reniform outline, but distinctly and evenly 7-lobed, the lobes not deep, from broadly triangular to broadly oval, mucronulate, the whole hardly an inch wide, all the lower on elongated petioles dilated and clasping at the base; the uppermost cuneate or spatulate and sessile; the whole plant with a little loose and probably deciduous lanate pubescence; involucre short and broad, almost campanulate; bracts broad, thin, almost biserial; calyculate bracts, none; rays, 10 or 12, $\frac{1}{2}$ to $\frac{3}{4}$ inch long; ovaries glabrous; pappus rather coarse, almost barbellulate.

Seal Rocks, Dawson Harbour, Skidegate Inlet, Queen Charlotte Islands, 1897. Herb. No. 16,929. (*Dr. C. F. Newcombe.*) As pointed out by Dr. Greene, this plant resembles superficially a debilitated and monocephalous *Chrysanthemum segetum*, and in its pappus, as well as broad involucre, it seems to approach *Arnica*. But if not a *Senecio*, it represents a new genus.

PHACELIA FRANKLINII, Gray; Macoun, Cat. Can. Plants, Vol. I., p. 333.

Additional stations for this species are burnt hillsides north of Prince Albert, Saskatchewan, Herb. No. 12,220. (*John Macoun.*) East of Lake Athabasca, 1893. (*J. W.*

Tyrrell.) Miles Canon, Lat. 62°, north of British Columbia, 1887. (*Dr. G. M. Dawson. Wm. Ogilvie.*)

PHACELIA SERICEA, Gray; Macoun, Cat. Can. Plants, Vol. I., pp. 333 and 567.

P. sericea, Gray, var. *Lyallii*, Gray; Macoun, Cat. Can. Plants, Vol. I., p. 333 in part and p. 567.

Common in the Rocky Mountains from Lat. 52° south to the International Boundary, Roger's Pass, Selkirk Mountains, alt. 4,500 ft.; Mount Arrowsmith, Vancouver Island, alt. 5,500 ft. (*John Macoun.*)

PHACELIA SERICEA, Gray, var. LYALLII, Gray.

Our only Canadian specimens of this species were collected in 1895 by Prof. Macoun on the high slopes of Sheep Mountain, Waterton Lake, Rocky Mountains.

AMSINCKIA ECHINATA, Lehm.

Near an old mining camp at Revelstoke, B.C., July 21st, 1890. Introduced from the United States. (*John Macoun.*) New to Canada.

AMSI CKIA LYCOPSOIDES, Lehm.

A. lycopsoides, Lehm. var. *bracteosa*, Macoun, Cat. Can. Plants, Vol. I., p. 568.

Mary Island, Gulf of Georgia, B.C., 1885. (*Dr. G. M. Dawson.*) Our only Canadian specimens. The type was collected by Scouler on an island or along the shores of the Straits of Juan de Fuca.

AMSINCKIA LYCOPSOIDES, Lehm, var. BRACTEOSA, Gr.; Macoun, Cat. Can. Plants, Vol. I., p. 338.

Common on Vancouver Island, B.C.

MYOSOTIS COLLINA, Hoffen.

Low fields, Edmonton, Ont., 1890. (*Jas. White.*) New to Canada. Introduced.

MYOSOTIS VERNA, Nutt, var. MACROSPERMA, Chapm.

New stations for this species are Agassiz, B.C., and Deer Park, Lower Arrow Lake, B.C. (*John Macoun.*) Eastern limit in Canada. Not a very well defined variety and probably only a western form of *M. verna*, which has not been collected in Canada west of Ontario.

SYMPHYTUM ASPERRIMUM, Sims.

Waste places at Spence's Bridge, B.C., 1889. (*John Macoun.*) Escaped from cultivation, and naturalized. Not before recorded from Canada.

ONOSMODIUM CAROLINIANUM, DC., var. MOLLE, Gray.

New stations for this plant are Souris, Man. (*Thos. L. Walker.*) Brandon, Man. Herb. No. 12,258 and Stand-Off, Belly River, Alta. Herb. No. 11,841. (*John Macoun.*)

IPOMÆA QUAMOCLIT, L.

Climbing over weeds near the upper Suspension Bridge at Niagara Falls, Ont. (*R. Cameron.*) Probably a garden escape, but not before recorded as being naturalized.

SOLANUM TRIFLORUM, Nutt.

Along the C. P. Railway at Port Arthur, Ont. (*Dr. and Mrs. N. L. Britton* and *Miss Timmerman.*) Introduced from the west.

ANTIRRHINIUM ORONTIUM, L.

Niagara Falls, Ont. (*R. Cameron.*) Only record for Eastern Canada.

LINARIA VULGARIS, Mill.

Waste places, Beacon Hill, Vancouver Island, B.C. (*John Macoun.*) Not recorded west of Ontario.

MIMULUS ALATUS, Ait.

Wet places in a ditch which crosses the 2nd concession line, township of Harwich, and runs into the foot of Rondeau Harbour, Elgin Co., Ont., Aug. 18th, 1897. (*Dr. A. J. Stevenson and J. Dearness.*) New to Canada.

MIMULUS ALSINOIDES, Benth. ; Macoun, Cat. Can. Plants, Vol. I., p. 358 in part.

Abundant on Vancouver Island. North Arm, Burrard Inlet, B.C. (*J. M. Macoun.*) Yale, B.C., and Agassiz, B.C. (*John Macoun.*) This species seems to be confined in Canada to the vicinity of the Pacific coast.

MIMULUS FLORIBUNDUS, Dougl.

Botanie Creek, north of Lytton, B.C. (*Jas. McEvoy.*) Damp places at Sproat, Columbia River, B.C. (*John Macoun.*) Elk River, Kootanie River, B.C. (*Dr. G. M. Dawson.*) Not before recorded from Canada. The specimens referred to this species in Macoun's Catalogue of Canadian Plants, Vol. I., p. 571, prove to be small plants of *M. moschatus*, Dougl.

MIMULUS MOSCHATUS, Dougl. ; Macoun, Cat. Can. Plants, Vol. I., p. 358.

M. floribundus, Macoun, Cat. Can. Plants, Vol. I., p. 571.

Beaver Creek, Selkirk Mts., B.C. ; Revelstoke, B.C. ; Kootanie River, near its junction with the Columbia River, B.C. ; Burrard Inlet, B.C. ; common on Vancouver Island. (*John Macoun.*) Quesnell Lake, B.C. (*A. Bowman.*) Anstey Creek, Shuswap Lake, B.C. (*J. M. Macoun.*) The var. *sessilifolius*, Gray, is much commoner than the type on Vancouver Island, but has not been found elsewhere in Canada.

MIMULUS NASUTUS, Greene ; Macoun, Cat. Can. Plants, Vol. I., p. 571.

Lower Arrow Lake and Sproat, Columbia River, B.C. ; common on Vancouver Island. (*John Macoun.*) Among the specimens from Sproat are some which are very canescent and vary somewhat from the type as to foliage, but they do not appear to be separable from *M. nasutus.*

MIMULUS LUTEUS, L.

There are some thirty or forty sheets of *Mimulus*, labelled *M. luteus*, in our herbarium. These include many forms and varieties, and we believe several species, but we find it impossible even with Dr. Greene's "*Mimulus luteus* and some of its allies" in hand to satisfactorily separate and determine our specimens. They cover a wide range—from the Cypress Hills, Alberta, through the Rocky Mountains and British Columbia north to the Aleutian Islands, including Unalaska, the locality from which seeds of *M. Langsdorffii* were taken to Europe, but the various forms so intergrade that our present knowledge does not enable us to definitely and finally separate them.

ORTHOCARPUS PALLESCENS, Gray.

Lower Arrow Lake, Columbia River, B.C. (*Dr. G. M. Dawson. John Macoun.*) First collected by Dr. Dawson in 1889 and referred to *Castilleia pallida.* New to Canada.

PEDICULARIS CONTORTA, Benth.

New stations for this rare plant are Mt. Aylmer, Devil's Lake, Rocky Mountains, alt. 6,000 ft. (*John Macoun.*) Toad Mountain, Kootanie Lake, B.C., alt. 6,000 ft. (*Jas. M. Macoun.*)

PEDICULARIS RACEMOSA, Dougl.; Macoun, Cat. Can. Plants, Vol. I., pp. 368 and 572.

Common on sub-alpine slopes throughout British Columbia. Near the road to Union Mines, Comox, Vancouver Island; Mount Mark, V.I., alt. 3,000 ft. (*John Macoun.*) Not before recorded from Vancouver Island.

PENSTEMON CONFERTUS, Dougl.; Macoun, Cat. Can. Plants, Vol. I., pp. 354 and 570.

Prairies near Sage Creek, Milk River, Assa. Herb. No. 11,859. (*John Macoun.*) Eastern limit in Canada.

PENSTEMON DIFFUSUS, Dougl.; Macoun, Cat. Can. Plants, Vol. I., p. 357.

New stations for this species are Botanie, north of Lytton, B.C.; Griffin Lake, B.C. (*Jas. M. Macoun.*) Agassiz, B.C.; Cowichan River, Vancouver Island. (*John Macoun.*)

PINGUICULA VILLOSA, L.; Macoun, Cat. Can. Plants, Vol. I. p. 376 and Vol. II., p. 349.

Bogs, Lat. 60° 30′, Long. 104°. (*J. W. Tyrrell.*) The Lake Mistassini, reference, (Pursh), is, as Prof. Macoun suggests in his catalogue, to *P. vulgaris*, which is very common about that lake.

VERBENA HASTATA, L.; Macoun, Cat. Can. Plants, Vol. I., p. 379.

Sicamous, B.C.; near Victoria and at Sumas River, Vancouver Island. (*John Macoun.*) Not before recorded west of Gold Range, B.C.

LAMIUM AMPLEXICAULE, L.

A weed in gardens at Comox, Vancouver Island. (*John Macoun.*) Not recorded from west of Ontario.

LYCOPUS LUCIDUS, Turcz., var. AMERICANUS, Gray; Macoun, Cat. Can. Plants, Vol. I., p. 382.

Kamloops, B.C. (*John Macoun.*) Bonaparte River, B.C. (*Jas. McEvoy.*) Not recorded west of

MONARDA FISTULOSA, L., var. RUBRA, Gray.

In thickets at Wingham, Ont. (*J. A. Morton.*) New to Canada.

NEPETA GLECHOMA, Benth.

Waste places, Battle Harbour, Labrador. (*Rev. A. Waghorne.*) Not before recorded from Labrador.

PLANTAGO BOREALIS, Lange.

P. maritima, Macoun, Cat. Can. Plants, Vol. I., pp. 393 and 575 in part.

Commonly referred to *P. maritima*, but a good species. Our specimens are from Battle Harbour, Labrador, Herb. No. 16,890. (*Rev. A. Waghorne.*) Fort Chimo, Labrador, Herb. No. 15,955. (*A. P. Low.*) Nachvak, Labrador, Herb. No. 16,891; Nottingham Island, Hudson Strait, Herb. No. 16,892. Fort Churchill, Hudson Bay. Herb. No. 16,889. (*Dr. R. Bell.*) *P. pauciflora*, Pursh, is a very different plant, and has nothing to do with this species.

ASARUM CANADENSE, L.

Mr. E. P. Bicknell, in the Bulletin of the Torrey Botanical Club for November, 1897, has described a new species of *Asarum*—*A. reflexum*—hitherto confounded with *A. Canadense.* We have in the herbarium of the Geological Survey typical specimens of both species from the United States, *A. Canadense* from the New England States, *A. reflexum* from Ohio. Our Canadian species are all from Ontario. Those collected at Ottawa in the eastern part of the province very nearly approach *A. Canadense*, as described and figured by Mr. Bicknell; those from the western part of the province are referable to *A. reflexum* rather than to *A. Canadense*, but none of our specimens are typical representatives of either species, the series apparently connecting the two species. Canadian collectors should study this genus in the field with Mr. Bicknell's descriptions in hand.

Since writing the above Mr. J. M. Dickson, of Hamilton, has sent me drawings of two specimens of *Asarum*, one of which represents *A. Canadense*, the other *A. reflexum*, probably the variety *ambignum*, as Mr. Dickson writes that the calyx is tomentose and the lobes very long-pointed.

TRILLIUM GRANDIFLORUM, Salisb.

Monstrosities of this species are not uncommon in South Western Ontario, a fine series in our herbarium having been received from Mr. J. Dearness, London, Ont.; Mr. R. Cameron, Niagara, Ont.; Mr. J. M. Dickson, Hamilton, Ont., and Mr. Wm. Scott, Toronto, Ont. Mr. Dickson, after studying in the field the different forms found in the vicinity of Hamilton, sent me the following notes :—

"A few years ago several green flowered Trilliums were observed growing in a flat piece of woods on the banks of the Waterdown Creek, near this city. To see if they were persistent and not merely sports of a season, I visited the locality during the latter part of May, 1897, and, upon a close inspection, found several remarkable forms not previously noted. Some of these may be described as below :—

"1st. Several with white edgings and markings on sepals. The most remarkable of these had one sepal green, one half green and half white and the third pure white, while both sepals and petals were inserted in a distinct spiral on the axis; the leaves were normal.

"2nd. Leaves and sepals normal. Petals marked with green lines or bands toward the base.

"3rd. Leaves and sepals normal. Petals green, with a narrow white margin.

"4th. Leaves distinctly petiolate. Petioles one to three inches long; sepals white, with a green stripe down the midrib. Petals narrowed, lanceolate, white, with broad green band in centre, running from base, and terminating near the apex.

"5th. Leaves as in No. 4. Sepals normal. Petals obovate. Apiculate long clawed, with broad green centres and white margins.

"6th. Leaves ovate, long acuminate, petioled. Petioles ascending, widely spreading, seven inches long, inserted about two inches above the root stock and six or seven inches below the flower. Sepals normal. Petals green, with white margins.

"All the flowers seemed to be perfect, some having a sterile filament, which might be due to accident."

No. 6 was potted and photographed by Mr. Dickson. When photographed the stem was 10 inches high, the peduncle being 8 inches in length. The petioles were 8½ inches long; leaves 2½ inches long, 1½ inches broad, long-acuminate.

A remarkable form, sent from Niagara by Mr. Cameron, has the petals changed into petioled leaves (petioles more than an inch long.) Mr. Cameron has also sent me a photograph of a very large flowered plant with 21 pure white petals. It was found on Navy Island, Niagara River, by Mr. Cameron in 1896. He transplanted it, and last summer two flowers were produced, each with 21 petals. Mr. Cameron also reports a double yellow-flowered dwarf specimen from Niagara Falls, but this is probably some other species.

Crystallised Pyrrhotite from Frontenac County.

By Professor Wm. Nicol.

Among other minerals sent to the School of Mining for identification, was a reddish-colored, coarsely-crystalline marble containing small but well-formed crystals of pyrrhotite or magnetic iron pyrites, closely associated with crystals of apatite and masses of iron pyrites. The crystals were from one to three millimetres in diameter and in general tabular in form. Some of them, however, were pyramidal in habit. The crystals were secured by treating the mass for several days with acetic acid. The faces of some of the crystals were plane and glancing, and hence gave fairly good reflections for measuring the angles on the reflecting goniometer. The measurements were made with the "two-circle" goniometer in the laboratory of Professor Dr. Victor Goldschmidt in Heidelberg. The reflections were single, though faint in some cases, but by using the magnifying apparatus in connection with the instrument the faces, were determined beyond doubt. The following forms were observed :—

c = 0	$\{0001\}$	r = 10	$\{10\bar{1}1\}$
m = ∞0	$\{10\bar{1}0\}$	s = 20	$\{20\bar{2}1\}$
		v = 40	$\{40\bar{4}1\}$

The basal plane is usually large and sometimes in combination with the prism m alone. In other crystals the basis c occurs in combination with the prism m and pyramid s. Fig. 1 shows an ideal top view of the crystal, and Fig. 2 shows the actual form of the distorted basal plane and pyramids. Fig. 3 shows the crystal in perspective. Owing to distortion the crystal has a somewhat rhombic appearance, but the measurements show that it belongs rather to the hexagonal system.

Laboratory, School of Mining,
Kingston, Ont.

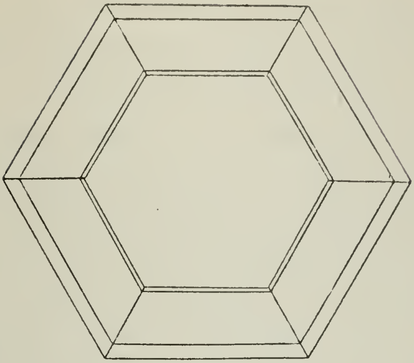


Fig. 1.

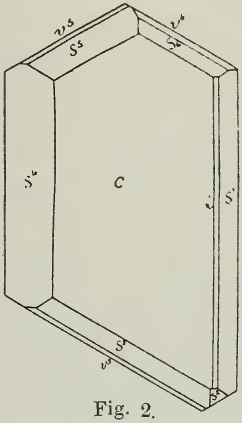


Fig. 2.

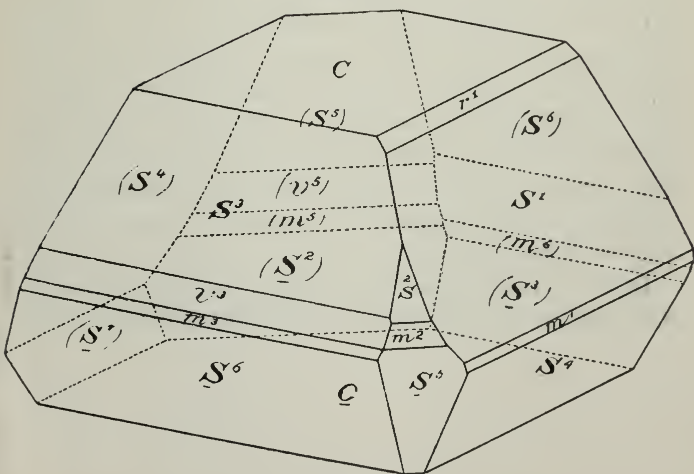


Fig. 3.

Problems in Quebec Geology.

Read at the meeting of the British Association, Toronto, August, 1897.

By R. W. Ells, LL.D., F.R.S.C.

Probably no questions in Canadian geology are of greater interest, or have been more widely discussed, than those connected with the complicated structure of some of the rock formations, found in the Province of Quebec, which are located on both sides of the St. Lawrence river. That on the north of the river relates to the vexed question of the origin and structure of the oldest crystallines or the rocks of the Laurentian system; while to the east of the St. Lawrence the relations of the several divisions of the fossiliferous sediments to each other, and to the crystalline schists of the Sutton Mountain range, as well as the structure of the latter group, have long been a subject for study to those interested in the interpretation of one of the most puzzling problems with which the Canadian Survey has had to deal.

The history of the attempt to work out the structure of the Archæan or Laurentian rocks north of the St. Lawrence dates back nearly fifty years. After several seasons devoted, in part, to the general examination of the rock masses along the course of the St. Lawrence, Sir William Logan, in 1853, began the detailed study of an area north of the River Ottawa, in the county of Argenteuil, which might be taken as the foundation of all subsequent work on these oldest rocks in Canada. The complicated arrangement of the various gneisses, limestones and quartzites, with granite, greenstone and other igneous masses, which is there presented has furnished, for half a century, a problem of undiminished interest to the geologist.

In the earliest days of their study a working hypothesis was adopted which held that the greater portions of the strata or rock masses there found were originally sedimentary deposits; and that by subsequent metamorphism these passed into the condition of crystalline rocks such as gneiss, limestone and quartzite as we now find them displayed. In this category were also included the great masses of anorthosite rocks which have a very considerable development to the north of the city of Montreal; and these were supposed, from their presumed relations to the crystalline limestones, to represent the upper member of the Laurentian system. The Laurentian was, therefore, practically divisible into three parts, viz., a lower fundamental gneiss, a middle gneiss and limestone series, and an upper or anorthosite division, all of which were held to be originally of sedimentary origin. These were, however, usually described under two heads, a lower and an upper, and the whole of the rocks pertaining to the system beneath the anorthosite was placed in the lower division of the Laurentian. The syenites of Grenville and certain dykes of trappean or diabase rock were regarded as of igneous origin.

As early as 1877–78 the study of the anorthosites by Vennor led to the expression of the opinion on his part that these, in part at least, were intrusive in the crystalline limestones, and this view was shortly after supported by Dr. Selwyn. Subsequent study of the granitic and anorthosite masses by McConnell and Adams showed that this new view was the correct one, and that all these rocks should be removed from the position they had long held as the upper portion of the Laurentian, as an altered sedimentary series, and that they were clearly intrusive and newer than the limestones and quartzites with which they were associated. The series of limestones and grey gneisses became, therefore, the upper member of the Laurentian. The sedimentary origin of these has also been called in question by some geologists, but the recent study of these rocks, by the aid of the microscope, has established their clastic character.

As regards the sedimentary nature of the underlying or Fundamental Gneiss, it has also been clearly shown that the early view as to its origin cannot now be maintained, but that these oldest of the Laurentian rocks are igneous in their character and represent metamorphosed portions of the original cooled crust of the earth. It would appear, therefore, that in the Laurentian system there are two distinctly separable series of rocks, viz., an altered igneous or basal portion and an altered sedimentary or upper portion (Logan's Grenville series in part), while the original upper member of the system is relegated to a different class entirely.

The grey gneiss, limestone and quartzite of the Grenville series represent, therefore, presumably, the oldest series of clastic or sedimentary rocks on the American continent. The term Grenville, like many others which have appeared in Canadian geology, is useful for purposes of comparison, though great portions of the rock masses which were originally included in this series have in recent years been removed from their original place in the scale. In the present use of the term "Grenville series" it is proposed to include only those rocks concerning whose origin there is no doubt and to confine the use of the term to the clastic members of the series as far as this is possible. These have a wide distribution throughout the Ottawa basin, and are apparently continuous to the west with the series described by Vennor in Ontario, nearly thirty years ago, as the "Hastings series." In character, however, many of the rocks of the latter differ from those of the original Grenville series. Thus, in the Hastings series, there is a large preponderance of schists of various kinds, along with dolomites and slaty limestones, which present a much less altered aspect than is found in the limestones of the

Grenville division. There are also undoubted conglomerates and slaty beds and the clastic nature of many of the rocks is easily seen. There is also seen a large development of hornblendic and granitic rocks, the former being rarely found in the Grenville series north of the Ottawa, while in the character of certain of the gneisses and crystalline limestones there is a marked resemblance. It would appear, therefore, that these rocks of the Hastings series are not easily separable from those of the Grenville series. They appear on stratigraphical grounds to represent an upper portion of the Grenville series, though for purposes of discussion the two series may be considered as one and the same, in so far at least as our investigations in this direction have extended. As for their position in the geological scale, it may be said that they rest upon the Fundamental Gneiss as a distinct clastic series, but whether they should be styled an upper division of the Laurentian or the lowest member of the Huronian is not of much moment, so long as their relations to the underlying rocks and to each other are clearly established. In character, lithologically, they are very like the schists and limestones, which in New Brunswick and the eastern townships of Quebec have been styled pre-Cambrian and probably Huronian.

On the east side of the St. Lawrence, throughout the area extending from the Vermont boundary on the south, to the city of Quebec, and thence eastward along the south side of the St. Lawrence to the extremity of the Gaspé peninsula, a peculiar development of slates, limestones, sandstones and conglomerates extends, distinct in character from most of the horizontal formations found in the more immediate vicinity of the St. Lawrence basin, where the characteristic strata of the Cambro-Silurian system have a wide development and an extended range from the Potsdam sandstone to the summit of the Hudson River or Lorraine formation. In the eastern portion of the area a great development of crystalline rocks, comprising schists of various kinds, limestone, altered slates, diorites, diabases, serpentines, etc., are found, which constitute the rocks of the Sutton Mountain chain, the extension northward of the Green Mountain range of the state of Vermont, and these, in Canada, with some interruptions, continue for many miles in the area south of the St. Lawrence, reappearing again in the northern part of the Gaspé peninsula.

All the sedimentary formations throughout this area are well defined by the characteristic fossils peculiar to each, and can be readily recognized. These have been divided into groups of strata and named according to the system of nomenclature adopted by the Geological Survey of the state of New York many years ago. The delimitation of the several divisions of the Cambro-Silurian rocks in this area presents but few difficulties, other than those which are due to the fact that, over large portions of the country, great deposits of clays are found by which the underlying sediments are frequently concealed. To the east of these flat-lying sediments, however, and separated from them by a series of faults, some of which are of considerable extent, is the group of strata first alluded to; the series as a whole being highly inclined, folded and sometimes overturned, and presenting at many points features quite distinct from the ordinary Cambro-Silurian formations, so that for many years great difficulty was experienced in reconciling these with well established horizons, or in finding a secure geological basis for their proper disposition in the general scheme of classification.

This, it is hoped, has at length been achieved through the careful work, both from the stratigraphical and palæontological standpoints, of the last ten to twelve years, and it is thought desirable that a brief resumé of the results arrived at in this work should here be presented; embodying the views that have been stated in the latest scientific publications on this subject, by the Canadian Geological Survey, in order that the true aspect of the question may be clearly seen,

The area over which these rocks are distributed is not confined to the province of Quebec. They are also recognized in the province of Newfoundland along the western portion of the island as well as in the states of New York and Vermont to the south. The literature on the subject is abundant and extends from the first quarter of the century to the present day.

The study of these rocks, which presented so many points of difference from the established formations, was greatly complicated by the presence of certain bands of conglomerate associated with the limestones and slates, in which fossils were found, both in the paste and the pebbles, of quite different horizons; in the arrangement of which it was not always found practicable to separate the fossils of the two series, owing to the great similarity of the matrix in the two cases. The elucidation of the structure was also hindered by the presence of numerous faults which occur throughout the area, and, through the agency of which, strata widely different in age have been brought into close proximity; so that in some cases the older series now rests upon the newer, both conforming in strike and dip, and in the absence of fossils their true relations are sometimes difficult to determine. Further complications also arose from the attempt to reconcile the crystalline schists and associated rocks of the mountain area, which present features strongly resembling certain portions of the Archæan, with the slates, sandstones and limestones of the sedimentary series which they were supposed to represent.

In the earlier days of their study all these various groups of strata were considered as belonging to a generally ascending series, so that a great part of the crystalline members of the whole series of formations was regarded as more recent than much of the fossiliferous portion. About the year 1870, however, Dr. T. S. Hunt, then on the staff of the Canadian Survey, advanced the theory that these crystalline rocks were older than the fossiliferous strata and that they were probably referable to the Huronian system. This view was gradually adopted, and has since been proved to be correct, since these rocks undoubtedly underlie the lowest Cambrian. The use of the term "Quebec Group," therefore, which was adopted to include all these divisions, under the supposition that they all represented fossiliferous sediments, is now misleading, and if employed should be confined to the peculiar series of fossiliferous limestones, slates, conglomerates, etc., which are well recognized. As, however, all these have now been studied and assigned to their proper position in the geological scale, the use of the term, except in the way of reference, may now be discontinued.

The first paper in which these rocks are discussed in their development about the city of Quebec is found in the Transactions of the Geological Society of London, December, 1827, by Dr. J. Bigsby; who in the earlier years of the century did a very considerable amount of geological exploration in various parts of the Canadian field, both on the fossiliferous and the crystalline rocks. The slate, conglomerate and limestone series about Quebec city was described and the presence of the contained fossils recognized; but from the existence of small deposits of carbonaceous matter, which are found in some of the strata around Lévis and in the vicinity, in the slaty rocks, and which apparently belong to the variety of coaly matter now called Anthraxolite, Bigsby considered that the rocks of this series might represent or be the equivalents of the Carboniferous limestone of the English geologists.

In 1845, Capt. Bayfield, in a paper published in the *Geological Journal*, claimed that the Trenton limestone, which appears on the north side of the St. Lawrence, above Quebec city, must, from its stratigraphical position beneath the greywacke and slate series, be an older formation ; and this view was held to be supported by the presence of fossils in certain bands of conglomerate which appeared to be an integral portion of this latter series. These fossils were in pebbles, supposed to be derived from beds of the Trenton limestone, which rests upon the Laurentian gneiss in the area to the north of Quebec city ; so that on this evidence, if correctly interpreted, the slate and conglomerate portion would be more recent than the Trenton. In the report for 1843, Sir W. E. Logan stated that the rocks of the Point Lévis series came out from beneath the limestone of the St. Lawrence and belonged to an apparently older horizon, but in a footnote to this report, it is also stated that the bulk of the evidence points to their superior position, which would make them the equivalents of the Hudson River and Lorraine formations.

In the report for 1844, while discussing the general character of the slates, limestone and conglomerates along the south side of the St. Lawrence to the east of Cape Chat and towards the extremity of Gaspé, Logan expressed the opinion that, from the run of the strata along this part of the coast, it is not improbable that certain portions of the strata, to the west of that point, may belong to a lower formation ; since along this part of the river below Quebec they come to the shore in an oblique direction from the mainland, and may therefore represent older horizons. As for those beds which contain the coaly matter, it is also stated that the rock containing it is supposed to be the equivalent of the Hudson River group of the New York geologists.

In the report for 1847–48, it is stated that the red slates and sandstones (now regarded as Sillery), which are developed in portions of the Eastern Townships in association with Trenton limestones, are the equivalents of certain dolomitic bands, as well as of the chloritic and quartzose rocks of the Green Mountain range; and that the whole of these Green Mountain rocks, including the auriferous quartz veins, belong to the Hudson River group, with the possible addition of the Shawangunk conglomerates. As for their extension, it is also said that these Hudson River strata have a continuous run from Lake Champlain along the south bank of the St. Lawrence to Cape Rozier.

This view as to the Hudson River age of these deposits along the east side of the river was maintained for some years; and as regards the various widely different rocks which make up the crystalline series of the mountain range in their extension through the province of Quebec, it was held that these represented the same series of strata, the marked difference in their appearance and composition being entirely due to metamorphism, so that shales became slates and sandstones were altered into quartzites and talcose strata, while the red slates and green sandstones became converted into chloritic, epidotic and ferriferous slates and less schistose forms of rock. The whole were held to belong to the Lower Silurian series of deposits, followed upward by others which were of Upper Silurian age and contained fossils of that division.

The red and green slates seen along the north side of the St. Lawrence above Quebec city were also supposed to represent the Oneida division of the New York series, and to rest upon the supposed Trenton rocks of the city and of the Ste. Foye road.

In 1855 Hunt, in discussing the structure and age of these rocks, claimed that the red and green slates and sandstones of the Sillery division, which had been so named by Logan, were the equivalents of the Shawangunk or Oneida conglomerates of the New York geologists, and lay between the Richelieu shales and Medina sandstone. He also regarded the peculiar rocks of the mountain region as the equivalents of these, their metamorphic and crystalline character being the result of chemical action, so that the fossils could no longer be recognized. The rocks thus metamorphosed were also stated to belong to the Hudson River group and to the Sillery division, and he added that the changes which these sedimentary beds had undergone were often remarkable, some of them passing into chloritic, micaceous and talcose schists, while others took the form of felspathic, hornblendic and epidotic rocks.

In 1855 Prof. James Hall presented his report on the graptolites of Point Lévis, and in this the age of the strata in which these fossils were found was held to be that of the Hudson River formation. Up to 1857, in which year this report was published, there was therefore a great unanimity of opinion as to the comparatively recent age of the several divisions of these strata, though of necessity there were many complex explanations in order to account satisfactorily for the marked differences in character between the various groups, more especially as regarded the crystalline division. The first change of opinion as to their age is due to the researches of E. Billings, who, from an examination of certain fossils collected from the Lévis rocks in 1856–57, found among these certain forms, characteristic of the Calciferous and Chazy formations as developed in the Ottawa valley, where these strata are undisturbed. In consequence of this discovery Billings came to the conclusion that a great portion of these strata were referable to the base rather than to the summit of the Lower Silurian, as had so long been supposed, and that the Lévis and Sillery rocks were in reality older than the Trenton limestone.

These views were first published in the *Canadian Naturalist* for December, 1860, and in the *American Journal of Science* for March, 1861, where the opinion was expressed that "this series of rocks, to which the term 'Quebec Group' was now first applied, represents a great development of strata about the horizon of the Chazy and Calciferous, brought to the surface by an overturn anticlinal fold, with a crack and dislocation running along the summit, by which the Quebec Group was brought to overlap the Hudson River formation."

In this connection it may be mentioned that the new views thus expressed by the Canadian Survey were confirmatory of those advanced by Emmons years before, who had maintained that the strata of the group were beneath the Birds-eye limestone.

The discovery of these fossils and their satisfactory determination as Calciferous by Billings, led naturally to renewed explorations among the rocks of this area. The presence of several great faults was recognized and their relations to the various groups were determined. The series of slates and sandstones, limestones and conglomerates of the Quebec and Lévis area was divided into two principal groups, of which the supposed lower portion included the limestone, greyish slates and conglomerates, which was styled the Lévis division, while the great bulk of the red and green slates with the sandstone was placed at the top of the series and styled Sillery. These were all held to be newer than the Potsdam formation.

Exception was taken to these views of Logan by Prof. Jules Marcou, who, after an examination of the rocks in this locality, as well as of certain strata in the vicinity of Phillipsburgh, which were also regarded by Billings as about the same horizon, came to the conclusion that the strata of the 'Quebec Group' of Logan were of the age of the middle portion of the Taconic and far below the Potsdam sandstone.

Marcou regarded the presence of the Calciferous types of fossils as illustrations of the "Theory of Colonies" (Barrande's), and held that these forms received their full development at a later period. These peculiar colonies of fossils were supposed to occur in lenticular masses of limestone, enclosed in the slate. Their presence was recognized by Marcou both at Lévis and Phillipsburgh, and the associated slates, limestones and conglomerates were by him considered to be a little higher in the series than the Georgia slates, which were supposed to represent the lowest part of the Taconic.

The controversy between Logan and Marcou at length drew from Billings a statement, after carefully working out all the facts connected with the fossil contents of the different divisions, to the effect that the fossiliferous Quebec Group was apparently on the same horizon as the Llandeilo of England and Australia, and the equivalent of the Calciferous and Chazy of the American scale of formations; and he also showed from the evidence that their position was in reality at the base of the Lower Silurian, instead of at the summit, where they had so long been placed by some; and not, on the other hand, beneath the Potsdam, as was maintained by Marcou. He regarded the strata of the group as a peculiar development, the upper limit of which could scarcely be newer than the Black River formation or older than the middle of the Calciferous.

The views of the structure of this group, as given in the Geology of Canada, 1863, may be briefly summed up as follows: The Quebec Group was divided into two portions stratigraphically, viz., the Lévis and the Sillery, of which the latter was regarded as the upper member; and into two divisions lithologically, viz., a fossiliferous sedimentary and a crystalline metamorphic, the latter of which was held to represent the former in a different condition, the Sutton Mountain rocks being supposed to represent, in part at least, the Sillery formation.

In Newfoundland similar rocks to those seen at Phillipsburgh and Lévis are recognized, and the sequence of strata in that province is supposed to be nearly the same as in Quebec. The red sand-rock division, or the Georgia group, was styled the Potsdam formation, and this, along the Strait of Belle-isle, was established as the base of the whole series. These rocks were overlain by the Calciferous, which was represented by rocks regarded as the equivalents of the Phillipsburgh limestones, and these in turn were supposed to be succeeded by the slates and sandstone of the Sillery, which was still regarded as constituting the upper member of the group.

In 1866 the Quebec Group was divided into three parts, a new term, the Lauzon, being added, which comprised the greater portion of the red, green and purple slates in which fossils were rarely found, and which was held to be intermediate between the Lévis and Sillery. This arrangement was, however, soon discarded and the rocks of the group were included under the two original heads.

In 1866–69, Richardson, after a study of the red and green slates, sandstones and conglomerates of the country to the south of the St. Lawrence, and between that river and the mountain chain of crystalline rocks, assumed that the division styled the Sillery was separable into three portions and should be referred to the Potsdam formation as representing its upper part. In 1870, however, Hunt, after a study of the crystalline rocks of New Brunswick and of their relations to the overlying Cambrian, and by a comparison of these with the rocks of the mountain area in the province of Quebec, became convinced that the latter should be separated from the fossiliferous formations and assigned to a much lower position, being in fact the equivalent of the Huronian. This change of view on the part of Hunt naturally met with much dissent from those who had been so long at work in this field. It, however, gradually acquired weight, and after a careful study of the problem for some years by Dr. Selwyn, then the Director of the Canadian Survey, this opinion was adopted and was officially announced in the publications of the department for 1877–78, where the whole series was divided into three parts, viz. : 1st, Lower Silurian ; 2nd, a volcanic group, probably lower Cambrian ; and 3rd, the crystalline schist group, probably Huronian, embracing the rocks of the Sutton Mountain anticlinal, etc.

This change of view placed the study of these complicated rocks on an entirely new basis. The careful separation of the fossils found in the pebbles of the limestone conglomerates from those which occur in the paste of the rock, served to simplify the difficulty arising from the mixing of widely separated types, since in the earlier days of their study this discrimination was not always attended to, and hence arose the difficulty of reconciling fossils of widely different horizons, said to be obtained from the same layer.

The study of the entire series was taken up in detail by the writer in 1885, and since that date the structure of the entire area east of the St. Lawrence and extending to the American boundary, has been mapped, so that several of the most difficult geological problems have now been satisfactorily solved.

The conclusions arrived at after so many years of constant work in this field may be briefly stated. The results of these investigations involve not only the stratigraphical relations of the several fossiliferous divisions of the Quebec Group, and the definite placing of the schists and associated rocks at their base, but the determination also of the age and relations of the great intrusive masses which are so conspicuous throughout the area east of the St. Lawrence, and which are found both to the east and west of the anticlinal axis of the crystalline schists which compose the greater part of the Sutton Mountain range.

1st. As regards the crystalline schists, formerly regarded as Upper Silurian and then as a metamorphic portion of the Sillery division of the Lower Silurian, included in the Quebec Group, it has been very conclusively shown on stratigraphical grounds that these are directly overlain by the lowest beds of the Cambrian, which in their extension to the south of the province into the state of Vermont, have been found to contain primordial fossils. These were obtained from certain of the quartzite beds several years ago by Prof. C. D. Walcott, now Director of the United States Geological Survey. But little attempt has as yet been made to ascertain the presence of these fossils in the similar beds in their extension through Quebec.

On the eastern side of the anticlinal lower Cambrian strata are also found, but this area is affected by heavy faults, so that the thickness of the Cambrian formations is greatly reduced, while the fossiliferous strata are quite well developed. These rocks in the old scheme were placed in the Upper Silurian system.

2nd. The complicated series of the stratified fossiliferous sediments of the Quebec Group proper has been resolved into several well defined divisions. The lowest of these include the red and green slates, with certain bands of coarse conglomerate and hard sandstone, which appear at intervals along the south shore of the St. Lawrence, between Quebec and Gaspé, and, though the greater part of these is poor in organic remains, portions are found which contain forms which place them on the horizon of the upper Cambrian, while certain other portions, from their stratigraphically lower position, apparently represent the lower part of the Newfoundland section and may be the equivalents of the Georgia slates, which there underlie the Sillery and Lévis formations.

Portions of the Sillery are conspicuous for the great development of a coarse conglomerate, holding pebbles of slate, limestone and quartzite, often of large size. In the limestone pebbles an abundant fauna of trilobites has been found, which indicates that these have been derived from the beds of the Georgia series, though their source does not readily appear. As the whole series has, however, been so faulted and overturned, it is presumable that the lower members have been thrust upward and removed by denudation. The gap in the sequence of formations along the lower St. Lawrence may thus be explained, though it is possible that a more careful search among some of the oldest or lowest beds will yet result in the discovery of strata holding a true lower Cambrian fauna from which these pebbles have been derived. Certain beds below the upper Sillery have already yielded very ancient types of graptolites, as well as Cambrian forms of trilobites.

3rd. The Sillery has been conclusively shown by the examination of a number of sections, both near the St. Lawrence River, as well as at points inland, to represent the lower part of the group, and there is a marked break between these beds of red and green shale and sandstone, which are the extension downward of the Lévis beds and the lower series of hard slates and quartzose strata. It is at the base of the former portion that the coarse conglomerates, in the limestone pebbles of which the primordial fossils are found, occur, so that these lower beds must represent a lower or older portion of the Cambrian.

As a result of the recent work in this area, therefore, the Sillery formation is now transferred from its supposed position above the Lévis to the lower part of the series; and there appears to be a gradual upward passage from the slates and conglomerates of this portion to the slates and limestones of the Lévis, the fossils in which are of a more recent aspect and quite distinct as a whole in character from those found in the lower division.

The study of the Lévis beds, and a careful discrimination of the fossils found in the pebbles of the associated conglomerates from those found in the associated slates and limestones, shew that these are of the horizon of the Calciferous formation of the Ottawa district, and that the upper part of the Sillery would therefore be the equivalent of the Potsdam sandstone, which in that area has been conclusively proved to be the lower part of the Calciferous formation. The Lévis graduates upward into the Chazy, as certain beds near the top of the series contain fossils which bear a close resemblance to those obtained from the true Chazy beds elsewhere.

The peculiar development of strata which compose the hill on which the city of Quebec is built, has also been a fruitful source of controversy. They were for many years supposed to be a portion of the Lévis division, though differing in many respects from the typical strata of that formation as developed on the south side of the river, both in physical characters and in the nature of the contained fossils. They were subsequently regarded by some observers as the equivalents of the Utica and Hudson River formations. A careful study of the fauna of the city rocks has, however, very conclusively disproved both of these views, in so far at least as the greater portion of the strata are concerned. The fossils, of which large collections have been made, show that these are more closely related to the base of the Trenton formation, and that they represent a peculiar development about the horizon on the Black River or near the top of the Chazy. They are separated from the Utica and Lorraine on the north by a fault which skirts the north flank of the city along the valley of the St. Charles River, and from the Sillery formation by another fault which passes to the south of the city, in front of the Citadel, and which comes to the north shore of the St. Lawrence about two miles above the city.

The strata in the city itself are, however, thrown into a series of folds ; and from the presence of certain fossils at a few points it would appear that, along the crests of some of these the underlying Lévis beds are disclosed. The areas of such underlying strata must, however, be comparatively small.

A development of black shales and limestones is seen along the upper part of the north side of the Island of Orleans. These are separated from the slates of the Lévis by a fault, which appears to be the continuation of that seen along the north side of the city of Quebec. The strata of the Lévis division here appear to rest conformably upon the rocks of this series, but there is a difference in the physical aspect of the two series as well as in the character of the contained fossils in the two divisions. The northern, and apparently underlying portion, is undoubtedly the same as that seen in the city of Quebec, the age of which has been stated to be that of the lower Trenton. This group of rocks appears at a number of places along the south side of the lower St. Lawrence in such close relations to the overlying Sillery as to have led to the conclusion on the part of some observers that it really occupied a lower stratigraphical position. The presence of several faults between the strata of the two series is plain, and the fossils obtained from the apparently underlying beds show conclusively that the underlying member is really the higher in the geological scale. These beds also apparently belong to the lower part of the Trenton.

To the north of the St. Lawrence, below the city of Quebec, these peculiar developments of strata do not appear. The Trenton along the south flank of the hill range of the Laurentian rests directly upon the crystalline rocks of that system. The lower beds of the Trenton here consist of a thin development of arkose strata resembling very closely a quartzite, but the upper portion of this has been found to contain the characteristic fossils of the formation. These quartzose beds appear in the bed of the Ste. Anne River, above the Montmorency Fall, as well as in patches on the face of the gneiss at the fall itself.

The Trenton, at the foot of the Falls, is overlain by the Utica shales, and these pass upward into the Lorraine, which extends out into the north channel of the St. Lawrence. All these formations are clearly defined by their characteristic fossils.

On apparently the same horizon with the Quebec city rocks are certain other areas, which for many years have been in dispute as to their true horizon. Among these may be mentioned the areas of black slate and limestone near Farnham, which on presumed stratigraphical grounds were, in the Geology of Canada, 1863, regarded as beneath the Potsdam. An examination of the fossil contents by Billings, however, showed that they were higher in the scale; and subsequent investigations in this direction have proved them to be the equivalents of the Quebec city series. Along the east side of the Sutton Mountain anticlinal also are other areas of slates with limestones, which for a long time yielded no organic remains, and these were, from their supposed relations to Upper Silurian rocks in their vicinity, regarded as of that age. These also, on the evidence of fossils, principally graptolites, are now assigned to their proper place at the base of the Trenton.

The areas of these rocks are very considerable, both on the east and west side of the main anticlinal. Interesting developments of this group of black slates and limestones are also found in close association with the crystalline schists near Melbourne and Danville, where, through a peculiar series of folds and overturns, these rocks, which have recently been found to contain lower Trenton fossils, are apparently beneath the crystalline series. Like the Farnham rocks, these were also formerly regarded as older than the Potsdam and supposed to be in their true place beneath the crystalline rocks of the Sutton Mountain anticlinal axis, at that time regarded as the metamorphic development of the Sillery. The series of foldings to which these mountain rocks have been subjected has resulted in enclosing not only certain areas of the Sillery strata but also of the Trenton as well.

The rocks of Phillipsburg, about which there has long been much dispute, have recently been carefully studied by the aid of their contained fossils as well as from their stratigraphical relations, and satisfactory conclusions as to their structure and true position have been reached. They have been paralleled with the Lévis formation, both on the evidence of their contained fossils as well as their general features. Along the shores of the Mississquoi Bay they are separated by a fault from the beds of the lower Trenton, the conditions of the two series being apparently similar to those seen on the north side of the island of Orleans. The lowest beds of the Phillipsburg series are apparently the transition beds between the Calciferous and the Potsdam sandstone formations. There is then a gradually ascending series through somewhat crystalline strata into the fossiliferous beds of the Calciferous till the overlying shales of the Chazy are reached, a short distance west of the railway at St. Armand station. These Chazy shales are associated with limestone beds which hold fossils ; and occupy a synclinal which extends north-easterly to Bedford and on to Stanbridge. While these are separated on the west from the Trenton strata by a fault, they, on the east, pass upward gradually into the Farnham beds of the lower Trenton, the whole series in this direction lying in a broad synclinal basin. The succession, therefore, from the base of the Phillipsburg series appears to be quite regular, though the fossils are not exactly identical with those found in the typical Calciferous and Chazy which they are held to represent. They are evidently distinct from the Georgia sandrock of the vicinity and have a considerably higher position in the geological scale.

The term Potsdam formation in the discussion of these rocks must be carefully distinguished from the Potsdam sandstone since the indiscriminate use of the terms has led to a certain amount of confusion in the interpretation of these geological problems.

In the earlier reports of the Geological Survey the term Potsdam was held to include all between the Calciferous and the Huronian as then understood, the sandstone forming the upper member. Since that time, however, the intervening or Cambrian system has been studied, and the formations which compose it have been clearly recognized between the sandstone and the Huronian, and these have yielded a great variety of fossils of Primordial types. These include the rocks of the Georgia formation, which extends into Quebec near St. Armand station from the state of Vermont, but these rocks of the Georgia division are distinct from the Potsdam sandstone formation which has been clearly shown to be simply an extension downward of the Calciferous, and has, therefore, now been included in the Cambro-Silurian system as its lowest member. The Cambrian rocks are developed along the flanks of the Sutton anticlinal, and these underlie the Sillery proper or upper portion of that division, which on the understanding that the Lévis formation is the equivalent of the Calciferous naturally falls into the place of the Potsdam sandstone as a peculiar local development.

There is yet another portion of the old Quebec Group which calls for a word of explanation, viz., the series of diorites, diabases and serpentines, which occur along the east side of the Sutton mountain range ; and which, under the old hypothesis, were regarded as, in large part, the altered equivalents of the sandy portions of the Sillery formation. A careful study of these masses over a large area has clearly shown that in their original form the greater part of these are igneous rocks and that in point of time they are among the newest of our rock formations. Thus while they are often found closely associated with strata that extend downward as low as the pre-Cambrian, they are also seen in connection with Silurian and Devonian strata and have altered these to a very considerable extent. They may, in part, therefore, be considered as newer than Upper Silurian, or in fact than the lower part of the Devonian, since the fossiliferous strata of these formations have been altered by their action.

The recent age of these rock masses will probably apply to the greater portion of the igneous rocks lying to the east side of the Sutton Mountain anticlinal which extends from the Vermont boundary for at least 150 miles to the north-east. It also applies presumably to a number of isolated mountains which rise from the generally level country of the St. Lawrence plain.

There are, however, quite extensive areas of altered igneous rocks in connection with the crystalline schists of the mountain range. Some of these undoubtedly underlie the lowest Cambrian strata of quartzites and slates, and must, therefore, be older than these. The serpentines are, however, closely associated with the diabase mountains east of the anticlinal, and, therefore, belong to the newer period of igneous action. They are apparently altered diabase or olivine rocks. These diabase mountains sometimes form areas of considerable extent and are always conspicuous features in the landscape.

The igneous rocks of the Gaspé peninsula are of two kinds. Some of the masses are undoubtedly comparatively new, while others, as in the case of the Shick-Shock range, consist of hornblende, epidote, chlorite and serpentine, portions of which are apparently older than the slates of the Cambrian system, which occur along their northern flank.

In the case of the granite masses which are found at a number of points throughout the Eastern Townships, the same association of these with strata of widely different horizons is seen; since in some places the granites are surrounded by pre-Cambrian rocks, while in other cases the slates of the Cambrian and of the Cambro-Silurian are in contact. Near the line of junction these slates are frequently converted into schists and contain crystals of staurolite and chiastolite. That there was a period of great disturbance subsequent to the Silurian time is evident from the fact that at several points in this area the Silurian and Devonian strata are folded up, overturned and altered; so that these newer sediments are now beneath those of Cambro-Silurian age, while the corals which are found in the Devonian slates are drawn out into flat masses, and the slates themselves are sometimes altered to schists, which in hand specimens can with difficulty be distinguished from those of the pre-Cambrian areas.

Some Common Birds in their Relation to Agriculture.[1]

By F. E. L. Beal, B.S.

Continued from No. 6, page 309.

THE REDWINGED BLACKBIRD.

(Agelaius phœniceus.)

The redwinged, or swamp, blackbird is found all over the United States and the region immediately to the north. While common in most of its range, its distribution is more or less local, mainly on account of its partiality for swamps. Its nest is built near standing

[1] Reprinted from Farmers' Bulletin No. 54, U.S. Department of Agriculture, 1897.

water, in tall grass, rushes, or bushes. Owing to this peculiarity the bird may be absent from large tracts of country which afford no swamps or marshes suitable for nesting, It usually breeds in large colonies, though single families consisting of a male with several wives, may sometimes be found in a small slough, where each of the females builds her nest and rears her own little brood, while her liege lord displays his brilliant colors and struts in the sunshine. In the Upper Mississippi Valley it finds the conditions most favorable, for the countless prairie sloughs and the margins of the numerous shallow lakes form nesting sites for thousands of red-wings; and there are bred the immense flocks which sometimes do so much damage to the grain fields of the West. After the breeding season is over, the birds collect in flocks to migrate, and remain thus associated throughout the winter.

Many complaints have been made against the redwing, and several States have at times placed a bounty upon its head. It is said to cause great damage to grain in the West, especially in the Upper Mississippi Valley; and the rice growers of the South say that it eats rice. No complaints have been received from the north-eastern portion of the country, where the bird is much less abundant than in the West and South.

An examination of 725 stomachs showed that vegetable matter forms 74 per cent. of the food, while the animal matter, mainly insects, forms but 26 per cent. A little more than 10 per cent. consists of beetles, mostly harmful species. Weevils, or snout beetles, amount to 4 per cent. of the year's food, but in June reach 25 per cent. As weevils are among the most harmful insects known, their destruction should condone for at least some of the sins of which the bird has been accused. Grasshoppers constitute nearly 5 per cent. of the food, while the rest of the animal matter is made up of various insects, a few snails, and crustaceans. Several dragon flies were found, but these were probably picked up dead, for they are too active to be taken alive, unless by one of the flycatchers. So far as the insect food as a whole is concerned, the redwing may be considered entirely beneficial.

The interest in the vegetable food of this bird centres around the grain. Only three kinds, corn, wheat and oats were found in appreciable quantities in the stomachs, and they aggregate but little more than 13 per cent. of the whole food, oats forming nearly half of this amount. In view of the many complaints that the redwing eats grain, this record is surprisingly small. The crow blackbird has been found to eat more than three times as much. In the case of the crow, corn forms one-fifth of the food, so that the redwinged blackbird, whose diet is made up of only a trifle more than one-eighth of grain, is really one of the least destructive species; but the most important item of this bird's food is weed seed, which forms practically the whole food in winter and about 57 per cent. of the whole year's fare. The principal weed seeds eaten are those of ragweed, barn grass, smartweed, and about a dozen others. That these seeds are preferred is shown by the fact that the birds begin to eat them in August, when grain is still readily accessible, and continue feeding on them even after insects become plentiful in April. The redwing eats very little fruit and does practically no harm in the garden or orchard.

While it is impossible to dispute the mass of testimony which has accumulated concerning its grain-eating propensity, the stomach examinations show that the habit must be local rather than general. As the area of cultivation increases and the breeding grounds are curtailed, the species is likely to become reduced in numbers and consequently less harmful. Nearly seven-eighths of the redwing's food is made up of weed seed or of insects injurious to agriculture, indicating unmistakably that the bird should be protected. except, perhaps, in a few places where it is too abundant.

THE MEADOW LARK, OR OLD FIELD LARK.

(Sturnella magna.)

The meadow lark is a common and well-known bird occurring from the Atlantic Coast to the Great Plains, where it gives way to a closely related subspecies, which extends thence westward to the Pacific. It winters from our southern border as far north as the District of Columbia, Southern Illinois, and occasionally Iowa. Although it is a bird of the plains, finding its most congenial haunts in the prairies of the West, it does not disdain the meadows and mowing lands of New England. It nests on the ground and is so terrestrial in its habits that it seldom perches on trees, preferring a fence rail or a telegraph pole. When undisturbed, it may be seen walking about with a peculiar dainty step, stopping every few moments to look about and give its tail a nervous flirt or to sound a note or two of its clear whistle.

The meadow lark is almost wholly beneficial, although a few complaints have been made that it pulls sprouting grain, and one farmer claims that it eats clover seed. As a rule, however, it is looked upon with favor and is not disturbed.

In the 238 stomachs examined, animal food (practically all insects) constituted 73 per cent. of the contents and vegetable matter 27 per cent. As would naturally be supposed, the insects were ground species, such as beetles, bugs, grasshoppers, and caterpillars, with a few flies, wasps and spiders. A number of the stomachs were taken from birds that had been killed when the ground was covered with snow, but still they contained a large percentage of insects, showing the bird's skill in finding proper food under adverse circumstances.

Of the various insects eaten, crickets and grasshoppers are the most important, constituting 29 per cent. of the entire year's food and 69 per cent. of the food in August. It is scarcely necessary to enlarge upon this point, but it can readily be seen what an effect a number of these birds must have on a field of grass in the height of the grasshopper season. Of the 238 stomachs collected at all seasons of the year, 178, or more than two-thirds, contained remains of grasshoppers, and one was filled with fragments of 37 of these insects. This seems to show conclusively that grasshoppers are preferred and are eaten whenever they can be procured. The great number taken in August is especially noticeable. This is essentially the grasshopper month, *i.e.*, the month when grasshoppers reach their maximum abundance; and the stomach examination has shown that a large number of birds resort to this diet in August, no matter what may be the food during the rest of the year.

Next to grasshoppers, beetles make up the most important item of the meadow lark's food, amounting to nearly 21 per cent., of which about one-third are predaceous ground beetles. The others are all harmful species, and when it is considered that the bird feeds exclusively on the ground, it seems remarkable that so few useful ground beetles are eaten. Many of them have a disgusting odor, and possibly this may occasionally save them from destruction by birds, especially when other food is abundant. Caterpillars, too, form a very constant element, and in May constitute over 28 per cent. of the whole food. May is the month when the dreaded cutworm begins its deadly career, and then the bird does some of its best work. Most of these caterpillars are ground feeders, and are overlooked by birds which habitually frequent trees; but the meadow lark finds them and devours them by thousands. The remainder of the insect food is made up of a few ants, wasps, and spiders, with a few bugs, including some chinch bugs.

The vegetable food consists of grain, weed, and other hard seeds. Grain in general amounts to 14, and weed and other seeds to 12 per cent. The grain, principally corn, is mostly eaten in winter and early spring, and must be therefore simply waste kernels; only a trifle is consumed in summer and autumn, when it is most plentiful. No trace of sprouting grain was discovered. Clover seed was found in only six stomachs, and but little in each. Seeds of weeds, principally ragweed, barn grass, and smartweed, are eaten from November to April, inclusive, but during the rest of the year are replaced by insects.

Briefly stated, more than half of the meadow lark's food consists of harmful insects; its vegetable food is composed either of noxious weeds or waste grain, and the remainder is made up of useful beetles or neutral insects and spiders. A strong point in the bird's favor is that, although naturally an insect eater, it is able to subsist on vegetable food, and consequently is not forced to migrate in cold weather any farther than is necessary to find ground free from snow. This explains why it remains for the most part in the United States during winter, and moves northward as soon as the snow disappears from its usual haunts.

There is one danger to which the meadow lark is exposed. As its flesh is highly esteemed, the bird is often shot for the table, but it is entitled to all possible protection, and to slaughter it for game is the least profitable way to utilize a valuable species.

THE BALTIMORE ORIOLE.

(Icterus galbula.)

Brilliancy of plumage, sweetness of song, and food habits to which no exception can be taken are some of the striking characteristics of the Baltimore oriole. In summer this species is found throughout the northern half of the United States east of the Great Plains, and is welcomed and loved in every country home in that broad land. In the Northern States it arrives rather late, and is usually first seen, or heard, foraging amidst the early bloom of the apple trees, where it searches for caterpillars or feeds daintily on the surplus blossoms. Its nest commands hardly less admiration than the beauty of its plumage or the excellence of its song. Hanging from the tip of the outermost bough of a stately elm, it is almost inaccessible, and so strongly fastened as to bid defiance to the elements.

By watching an oriole which has a nest one may see it searching among the smaller branches of some neighboring tree, carefully examining each leaf for caterpillars, and occasionally trilling a few notes to its mate. Observation both in the field and laboratory shows that caterpillars constitute the largest item of its fare. In 113 stomachs they formed 34 per cent. of the food, and are eaten in varying quantities during all the months in which the bird remains in this country, although the fewest are eaten in July, when a little fruit is also taken. The other insects consist of beetles, bugs, ants, wasps, grasshoppers, and some spiders. The beetles are principally click beetles, the larvæ of which are among the most destructive insects known ; and the bugs include plant and bark lice, both very harmful, but so small and obscure as to be passed over unnoticed by most birds. Ants are eaten mostly in spring, grasshoppers in July and Augnst, and wasps and spiders with considerable regularity throughout the season.

Vegetable matter amounts to only a little more than 16 per cent. of the food during the bird's stay in the United States, so that the possibility of the oriole doing much damage to crops is very limited. The bird has been accused of eating peas to a considerable extent, but remains of peas were found in only two stomachs. One writer says that it damages grapes, but none were found. In fact, a few blackberries and cherries comprised the only cultivated fruit detected in the stomachs, the remainder of the vegetable food being wild fruit and a few miscellaneous seeds.

THE CROW BLACKBIRD, OR GRACKLE.

(Quiscalus quiscula.)

The crow blackbird or one of its subspecies is a familiar object in all of the States east of the Rocky Mountains. It is a resident throughout the year as far north as Southern Illinois, and in summer extends its range into British America. In the Mississippi Valley it is one of the most abundant birds, preferring to nest in the artificial groves and windbreaks near farms instead of the natural "timber" which it formerly used. It breeds also in parks and near buildings, often in considerable colonies. Farther east, in New England, it is only locally abundant. though frequently seen in migration. After July it becomes very rare, or entirely disappears, owing to the fact that it collects in large flocks and retires to some quiet place where food is abundant and where it can remain undisturbed during the molting season, but in the latter days of August and throughout September it usually reappears in immense numbers before moving southward.

It is evident that a bird so large and so abundant may exercise an important influence upon the agricultural welfare of the country it inhabits. The crow blackbird has been accused of many sins, such as stealing grain and fruit and robbing the nests of other birds; but the farmers do not undertake any war of extermination against it, and, for the most part, allow it to nest about the premises undisturbed. An examination of 2,258 stomachs showed that nearly one-third of its food consists of insects, of which the greater part are injurious. The bird also eats a few snails, crayfishes, salamanders, small fish, and occasionally a mouse. The stomach contents do not indicate that it robs other birds' nests to any great extent, as remains of birds and birds' eggs amount to less than one-half of 1 per cent.

It is, however, on account of its vegetable food that the grackle is most likely to be accused of doing damage. Grain is eaten during the whole year, and during only a short time in summer is other food attractive enough to induce the bird to alter its diet. The grain taken in the winter and spring months probably consists of waste kernels gathered from the stubble. The stomachs do not indicate that the bird pulls sprouting grain; but the wheat eaten in July and August, and the corn eaten in the fall, are probably taken from fields of standing grain. The total grain consumed during the year constitutes 45 per cent. of the whole food, but it is safe to say that at least half is waste grain, and consequently of no value. Although the crow blackbird eats a few cherries and blackberries in their season, and some wild fruit in the fall, it apparently does no damage in this way.

Large flocks of crow blackbirds no doubt do considerable injury to grain crops, and there seems to be no remedy except the destruction of the birds, which is in itself expensive. During the breeding season, however, the species does much good by eating insects and by feeding them to its young, which are reared almost entirely upon this food. The bird does the greatest amount of good in spring, when it follows the plow in search of large grub worms, of which it is so fond that it sometimes literally crams its stomach full of them. The farmer must decide for himself whether or not these birds cause more damage than can be repaid by insect destruction; but when they destroy an entire crop it is no consolation to know that they have already eaten a multitude of insects which, if left alone, would have accomplished the same result.

THE SPARROWS.[1]

Sparrows are not obtrusive birds, either in plumage, song or action. There are some forty species, with nearly as many subspecies, in North America, but their differences, both in plumage and habits, are in most cases too obscure to be readily recognized, and not more than half a dozen forms are generally known in any one locality. All the species are more or less migratory, but so widely are they distributed that there is probably no part of the country where some can not be found throughout the year.

While sparrows are noted seed eaters, they do not by any means confine themselves to a vegetable diet. During the summer, and especially in the breeding season, they eat many insects, and probably feed their young largely upon the same food. An examination of the stomachs of three species—the song sparrow *(Melospiza)*, chipping sparrow *(Spizella socialis)*, and field sparrow *(Spizella pusilla)*—shows that about one-third of the food consists of insects, comprising many injurious beetles, such as snout-beetles or weevils, and leaf-beetles. Many grasshoppers are eaten, and in the case of the chipping sparrow these insects form one-eighth of the food. Grasshoppers would seem to be rather large morsels, but the bird probably confines itself to the smaller species; indeed, this is indicated by the fact that the greatest amount (over 36 per cent.) is eaten in June, when the larger species are still young and the small species most numerous. Besides the insects already mentioned, many wasps and bugs are taken. Predaceous and parasitic Hymenoptera and predaceous beetles, all useful insects, are eaten only to a slight extent, so that as a whole the sparrows' insect diet may be considered beneficial.

[1] The sparrows here mentioned are all native species. For a full account of the English sparrow, including its introduction, habits, and depredations, see Bull. No. 1 of the Division of Ornithology, published in 1889.

Their vegetable food is limited almost exclusively to hard seeds. This might seem to indicate that the birds feed to some extent upon grain, but the stomachs examined show only one kind—oats—and but little of that. The great bulk of the food is made up of grass and weed seed, which form almost the entire diet during winter, and the amount consumed is immense.

Anyone acquainted with the agricultural region of the Upper Mississippi Valley can not have failed to notice the enormous growth of weeds in every waste spot where the original sward has been disturbed. By the roadside, on the borders of cultivated fields, or in abandoned fields, wherever they can obtain a foothold, masses of rank weeds spring up, and often form impenetrable thickets which afford food and shelter for immense numbers of birds and enable them to withstand the great cold and the most terrible blizzards. A person visiting one of these weed patches on a sunny morning in January, when the thermometer is 20° or more below zero, will be struck with the life and animation of the busy little inhabitants. Instead of sitting forlorn and half frozen, they may be seen flitting from branch to branch, twittering and fluttering, and showing every evidence of enjoyment and perfect comfort. If one of them be killed and examined, it will be found in excellent condition—in fact, a veritable ball of fat.

The snowbird (*Junco hyemalis*) and tree sparrow (*Spizella monticola*) are perhaps the most numerous of all the sparrows. The latter fairly swarms all over the Northern States in winter, arriving from the north early in October and leaving in April. Examination of many stomachs shows that in winter the tree sparrow feeds entirely upon the seeds of weeds; and probably each bird consumes about one-fourth of an ounce a day. In an article contributed to the New York *Tribune* in 1881 the writer estimated the amount of weed seed annually destroyed by these birds in the State of Iowa. Upon the basis of one-fourth of an ounce of seed eaten daily by each bird, and supposing that the birds averaged ten to each square mile, and that they remain in their winter range two hundred days, we shall have a total of 1,750,000 pounds, or 875 tons, of weed seeds consumed by this one species in a single season. Large as these figures may seem, they certainly fall far short of the reality. The estimate of ten birds to a square mile is much within the truth, for the tree sparrow is certuinly more abundant than this in winter in Massachusetts, where the food supply is less than in the Western States, and I have known places in Iowa where several thousand could be seen within the space of a few acres. This estimate, moreover, is for a single species, while, as a matter of fact, there are at least half a dozen birds (not all sparrows) that habitually feed on these seeds during winter.

Farther south the tree sparrow is replaced in winter by the white-throated sparrow, the white-crowned sparrow, the fox sparrow, the song sparrow, the field sparrow and several others; so that all over the country there are a vast number of these seed eaters at work during the colder months reducing next year's crop of worse than useless plants.

In treating of the value of birds, it has been customary to consider them mainly as insect destroyers; but the foregoing illustration seems to show that seed eaters have a useful function, which has never been fully appreciated.

THE ROSE-BREASTED GROSBEAK.

(Zamelodia ludoviciana.)

The beautiful rose-breasted grosbeak breeds in the northern half of the United States east of the Missouri River, but spends its winters beyond our boundaries. Unfortunately, it is not abundant in New England, and nowhere as plentiful as it should be. It frequents groves and orchards rather than gardens or dooryards, but probably the beauty of the male is the greatest obstacle to its increase; the fully adult bird is pure black and white, with a broad patch of brilliant rose color upon the breast and under each wing. On account of this attractive plumage the birds are highly prized for ladies' hats; and consequently have been shot in season and out till the wonder is not that there are so few, but that they remain at all.

When the Colorado potato beetle first swept over the land, and naturalists and farmers were anxious to discover whether or not there were any enemies which would prey upon the pest, the grosbeak was almost the only bird seen to eat the beetles. Further observation confirmed the fact, and there can be no reasonable doubt that where the bird is abundant it has contributed very much to the abatement of the pest which has been noted during the last decade. But this is not the only good which the bird does, for many other noxious insects besides the potato beetle are also eaten.

The vegetable food of the grosbeak consists of buds and blossoms of forest trees, and seeds, but the only damage of which it has been accused is the stealing of green peas. The writer has observed it eating peas and has examined the stomachs of several that had been killed in the very act. The stomachs contained a few peas and enough potato beetles, old and young, as well as other harmful insects, to pay for all the peas the birds would be likely to eat in a whole season. The garden where this took place adjoined a small potato field which earlier in the season had been so badly infested with the beetles that the vines were completely riddled. The grosbeaks visited the field every day, and finally brought their fledged young. The young birds stood in a row on the topmost rail of the fence and were fed with the beetles which their parents gathered. When a careful inspection was made a few days later, not a beetle, old or young, could be found; the birds had swept them from the field and saved the potatoes.

It is not easy to advise measures either for increasing the numbers of this bird or inducing it to take up its residence on the farm. Naturally it inhabits thin, open woods or groves, and the change from such places to orchards would be simple—in fact, has already been made in some parts of Pennsylvania and Ohio. In New England the bird is somewhat rare, and perhaps the best that can be done here or elsewhere is to see that it is thoroughly protected.

THE SWALLOWS.

There are seven common species of swallows within the limits of the United States, four of which have, to some extent, abandoned their primitive nesting habits and attached themselves to the abodes of men. As a group, swallows are gregarious and social in an eminent degree. Some species build nests in large colonies, occasionally numbering thousands; in the case of others only two or three pairs are found together; while still others nest habitually in single pairs.

Their habits are too familiar to require any extended description. Their industry and tirelessness are wonderful, and during the day it is rare to see swallows at rest except just before their departure for the South, when they assemble upon telegraph wires or upon the roofs of buildings, apparently making plans for the journey.

A noticeable characteristic of several of the species is their attachment to man. In the eastern part of the country the barn swallow (*Chelidon erythrogastra*) now builds exclusively under roofs, having entirely abandoned the rock caves and cliffs in which it formerly nested. More recently the cliff swallow (*Petrochelidon lunifrons*) has found a better nesting site under the eaves of buildings than was afforded by the overhanging cliffs of earth or stone which it once used, and to which it still resorts occasionally in the East, and habitually in the unsettled West. The martin (*Progne subis*) and white-bellied swallow (*Tachycineta bicolor*) nest either in houses supplied for the purpose, in abandoned nests of woodpeckers, or in natural crannies in rocks. The other species have not yet abandoned their primitive habitats, but possibly may do so as the country becomes more thickly settled.

Field observation will convince any ordinarily attentive person that the food of swallows must consist of the smaller insects captured in mid-air, or perhaps in some cases picked from the tops of tall grass or weeds. This observation is borne out by an examination of stomachs, which shows that the food consists of many small species of beetles which are much on the wing; many species of Diptera (mosquitoes and their allies), with large quantities of flying ants and a few insects of similar kinds. Most of them are either injurious or annoying, and the numbers destroyed by swallows are not only beyond calculation, but almost beyond imagination.

The white-bellied swallow eats a considerable number of berries of the bayberry, or wax myrtle. During migrations and in winter it has a habit of roosting in these shrubs, and it probably obtains the fruit at that time.

It is a mistake to tear down the nests of a colony of cliff swallows from the eaves of a barn, for so far from disfiguring a building, the nests make a picturesque addition, and their presence should be encouraged by every device. It is said that cliff and barn swallows can be induced to build their nests in a particular locality, otherwise suitable, by providing a quantity of mud to be used as mortar. Barn swallows may also be encouraged by cutting a small hole in a gable of the barn, while martins and white-bellied swallows will be grateful for boxes like those for the bluebird, but placed in some higher situation.

THE CEDAR BIRD.

(Ampelis cedrorum.)

The cedar waxwing, or cherry bird, inhabits the whole of the United States, but it is much less common in the West. Although the great bulk of the species retires southward in winter, the bird is occasionally found in every State during the colder months, especially if wild berries are abundant. Its proverbial fondness for cherries has given rise to its popular name, and much complaint has been made on account of the fruit eaten. Observation has shown, however, that its depredations are confined to trees on which the fruit ripens earliest, while later varieties are completely untouched. This is probably owing to the fact that when wild fruits ripen they are preferred to cherries, and really constitute the bulk of the cedar bird's diet.

In 152 stomachs examined animal matter formed only 13 and vegetable 87 per cent., showing that the bird is not wholly a fruit eater. With the exception of a few snails, all the animal food consisted of insects, mainly beetles—and all but one more or less noxious, the famous elm leaf-beetle being among the number. Bark or scale lice were found in several stomachs, while the remainder of the animal food was made up of grasshoppers, bugs and the like. Three nestlings were found to have been fed almost entirely on insects.

Of the 87 per cent. of vegetable food, 74 consisted entirely of wild fruit or seeds and 13 of cultivated fruit, but a large part of the latter was made up of blackberries and raspberries, and it is very doubtful whether they represented cultivated varieties. Cherry stealing is the chief complaint against this bird, but of the 152 stomachs only 9, all taken in June and July, contained any remains of cultivated cherries, and these aggregate but 5 per cent. of the year's food. As 41 stomachs were collected in those months, it is evident that the birds do not live to any great extent on cultivated cherries.

Although the cherry bird is not a great insect destroyer it does some good work in this way, since it probably rears its young mostly upon insect food. On the other hand, it does not devour nearly as much cultivated fruit as has been asserted, and most, if not all, of the damage can be prevented. The bird should therefore be considered a useful species, and as such should be accorded all possible protection.

THE CATBIRD.

(Galeoscoptes carolinensis.)

The catbird, like the thrasher, is a lover of swamps, and delights to make its home in a tangle of wild grapevines, greenbriers and shrubs, where it is safe from attack and can find its favorite food in abundance. It is found throughout the United States west to the Rocky Mountains; occurs also in Washington, Idaho and Utah, and extends northward into British America. It winters in the Southern States, Cuba, Mexico and Central America.

The catbird always attracts attention, and the intruder upon its haunts soon understands that he is not welcome. There is no mistaking the meaning of the sneering voice with which he is saluted, and there is little doubt that this gave rise to the popular prejudice against the bird; but the feeling has been increased by the fact that the species is sometimes a serious annoyance to fruit growers. All such reports, however, seem to come from the prairie country of the West. In New England, according to the writer's experience, the catbird is seldom seen about gardens or orchards; the reason may possibly be found in the fact that on the prairies fruit-bearing shrubs which afford so large a part of this bird's food are conspicuously absent. With the settlement of this region comes an extensive planting of orchards, vineyards and small fruit gardens, which furnish shelter and nesting sites for the catbird, as well as for other species, with a consequent large increase in their numbers, but without providing the native fruits upon which they have been accustomed to feed. Under these circumstances, what is more natnral than for the birds to turn to cultivated fruits for their supplies? The remedy is obvious; cultivated fruits can be protected by the simple expedient of planting wild species or others which are preferred by the birds. Some experiments with catbirds in captivity showed that the Russian mulberry was preferred to any cultivated fruit that could be offered.

The stomachs of 213 catbirds were examined and found to contain 44 per cent. of animal (insect) and 56 per cent. of vegetable food.[1] Ants, beetles, caterpillars and grasshoppers constitute three-fourths of the animal food, the remainder being made up of bugs, miscellaneous insects and spiders. One-third of the vegetable food consists of cultivated fruits, or those which may be cultivated, such as strawberries, raspberries and blackberries; but while we debit the bird with the whole of this, it is probable—and in the eastern and well-wooded part of the country almost certain—that a large part was obtained from wild vines. The rest of the vegetable matter is mostly wild fruit, such as cherries, dogwood, sour gum, elder berries, greenbrier, spice berries, black alder, sumac and poison ivy.

Although the catbird sometimes does considerable harm by destroying small fruit, the bird can not be considered injurious. On the contrary, in most parts of the country it does far more good than harm, and the evil it does can be reduced appreciably by the methods already pointed out.

[1] The investigation of the food of the catbird, brown thrasher, and house wren was made by Mr. Sylvester D. Judd and published in the Yearbook of the Department of Agriculture for 1895, pp. 405-408.

THE BROWN THRASHER.

(Harporhynchus rufus.)

The brown thrasher breeds throughout the United States east of the Great Plains, and winters in the South Atlantic and Gulf States. It occasionally visits the garden or orchard, but nests in swamps or in groves standing upon low ground. While it generally prefers a thickly grown retreat, it sometimes builds in a pile of brush at a distance from trees. On account of its more retiring habits it is not so conspicuous as the robin, although it may be equally abundant. Few birds can excel the thrasher in sweetness of song, but it is so shy that its notes are not heard often enough to be appreciated. Its favorite time for singing is the early morning, when, perched on the top of some tall bush or low tree, it gives an exhibition of vocal powers which would do credit to a mockingbird. Indeed, in the South, where the latter bird is abundant, the thrasher is known as the sandy mocker.

The food of the brown thrasher consists of both fruit and insects. An examination of 121 stomachs showed 36 per cent. of vegetable and 64 of animal food, practically all insects, and mostly taken in spring before fruit is ripe. Half the insects were beetles, and the remainder chiefly grasshoppers, caterpillars, bugs and spiders. A few predaceous beetles were eaten, but, on the whole, its work as an insect destroyer may be considered beneficial.

Eight per cent. of the food is made up of fruits like raspberries and currants which are or may be cultivated, but the raspberries at least are as likely to belong to wild as to cultivated varieties. Grain, made up mostly of scattered kernels of oats and corn, is merely a trifle, amounting to only 3 per cent., and though some of the corn may be taken from newly planted fields, it is amply paid for by the May beetles, which are eaten at the same time. The rest of the food consists of wild fruit or seeds. Taken all in all, the brown thrasher is a useful bird, and probably does just as good work in its secluded retreats as it would about the garden, for the swamps and groves are no doubt the breeding grounds of many insects that migrate thence to attack the farmers' crops.

THE HOUSE WREN.

(Troglodytes aëdon.)

The diminutive house wren frequents barns and gardens, and particularly old orchards in which the trees are partially decayed. He makes his nest in a hollow branch where perhaps a woodpecker had a domicile the year before, but he is a pugnacious character, and if he happens to fancy one of the boxes that have been put up for the bluebirds, he does not hesitate to take it. He is usually received with favor, and is not slow to avail himself of boxes, gourds, tin cans, or empty jars placed for his accommodation.

As regards food habits, the house wren is entirely beneficial. Practically, he can be said to live upon animal food alone, for an examination of 52 stomachs showed that 98 per cent. of the stomach contents was made up of insects or their allies, and only 2 per cent. was vegetable, including bits of grass and similar matter, evidently taken by accident with the insects. Half of this food consisted of grasshoppers and beetles; the remainder of caterpillars, bugs and spiders. As the house wren is a prolific breeder, frequently rearing from twelve to sixteen young in a season, a family of these birds must cause considerable reduction in the number of insects in a garden. Wrens are industrious foragers, searching every tree, shrub, or vine for caterpillars, examining every post and rail of the fence and every cranny in the wall for insects or spiders. They do not, as a rule, fly far afield, but work industriously in the immediate vicinity of their nests. In this way they become valuable aids in the garden or orchard, and by providing suitable nesting boxes they may be induced to take up residence where their services will do most good. Their eccentricities in the selection of a home are well known. Almost anything, from an old cigar box to a tomato can, an old teapot, a worn-out boot, or a horse's skull, is acceptable, provided it be placed well up from the ground and out of reach of cats and other prowlers.

It does not seem possible to have too many wrens, and every effort should be made to protect them and to encourage their nesting about the house.

THE ROBIN.

(Merula migratoria.)

The robin is found throughout the United States east of the Great Plains, and is represented farther west by a slightly different subspecies. It extends far north through Canada, and is found even in Alaska. Although the great bulk of the species leaves the Northern States in winter, a few individuals remain in sheltered swamps, where wild berries furnish an abundant supply of food.

The robin builds its nest in orchards and gardens, and occasionally takes advantage of a nook about the house, or under the shelter of the roof of a shed or outbuilding. Its food habits have sometimes caused apprehension to the fruit grower, for it is fond of cherries and other small fruits, particularly the early varieties. For this reason many complaints have been lodged against it, and some persons have gone so far as to condemn the bird. The robin is, however, too valuable to be exterminated, and choice fruit can be readily protected from its depredations

An examination of 330 stomachs shows that over 42 per cent. of its food is animal matter, principally insects, while the remainder is made up largely of small fruits or berries. Over 19 per cent. consists of beetles, about one-third of which are useful ground beetles, taken mostly in spring and fall, when other insects are scarce. Grasshoppers make up about one-tenth of the whole food, but in August comprise over 30 per cent. Caterpillars form about 6 per cent., while the rest of the animal food, about 7 per cent., is made up of various insects, with a few spiders, snails and angle-worms. All the grasshoppers, caterpillars and bugs, with a large portion of the beetles, are injurious, and it is safe to say that noxious insects comprise more than one-third of the robin's food.

Vegetable food forms nearly 58 per cent. of the stomach contents, over 47 being wild fruits and only a little more than 4 per cent. being possibly cultivated varieties. Cultivated fruit amounting to about 25 per cent. was found in the stomachs in June and July, but only a trifle in August. Wild fruit, on the contrary, is eaten in every month, and constitutes a staple food during half the year. No less than forty-one species were identified in the stomachs; of these, the most important were four species of dogwood, three of wild cherries, three of wild grapes, four of greenbrier, two of holly, two of elder; and cranberries, huckleberries, blueberries, barberries, service berries, hackberries and persimmons, with four species of sumac, and various other seeds not strictly fruit.

The depredations of the robin seem to be confined to the smaller and earlier fruits, and few, if any, complaints have been made against it on the score of eating apples, peaches, pears, grapes, or even late cherries. By the time these are ripe the forests and hedges are teeming with wild fruits, which the bird evidently finds more to its taste. The cherry, unfortunately, ripens so early that it is almost the only fruit accessible at a time when the bird's appetite has been sharpened by a long-continued diet of insects, earthworms and dried berries, and it is no wonder that at first the rich juicy morsels are greedily eaten. In view of the fact that the robin takes ten times as much wild as cultivated fruit, it seems unwise to destroy the birds to save so little. Nor is this necessary, for by a little care both may be preserved. Where much fruit is grown, it is no great loss to give up one tree to the birds; and in some cases the crop can be protected by scarecrows. Where wild fruit is not abundant, a few fruit-bearing shrubs and vines judiciously planted will serve for ornament and provide food for the birds. The Russian mulberry is a vigorous grower and a profuse bearer, ripening at the same time as the cherry, and, so far as observation has gone, most birds seem to prefer its fruit to any other. It is believed that a number of these trees planted around the garden or orchard would fully protect the more valuable fruits.

Many persons have written about the delicate discrimination of birds for choice fruit, asserting that only the finest and costliest varieties are selected. This is contrary to all careful scientific observation. Birds, unlike human beings, seem to prefer fruit like the mulberry, that is sweetly insipid, or that has some astringent or bitter quality like the chokecherry or holly. The so-called black alder *(Ilex verticillata)*, which is a species of holly, has bright scarlet berries, as bitter as quinine, that ripen late in October, and remain on the bushes through November, and though frost grapes, the fruit of the Virginia creeper, and several species of dogwood are abundant at the same time, the birds eat the berries of the holly to a considerable extent, as shown by the seeds found in the stomachs. It is moreover a remarkable fact that the wild fruits upon which the birds feed largely are those which man neither gathers for his own use nor adopts for cultivation.

THE BLUEBIRD.

(Sialia sialis.)

The common and familiar bluebird is an inhabitant of all the States east of the Rocky Mountains, from the Gulf of Mexico northward into Canada. It winters as far north as Southern Illinois, in the Mississippi Valley, and Pennsylvania in the east; in spring it is one of the first migrants to arrive in the Northern States, and is always welcomed as an indication of the final breaking up of winter. It frequents orchards and gardens, where it builds its nest in hollow trees, or takes advantage of a nesting box provided by the enterprising farmer's boy.

So far as known, this bird has not been accused of stealing fruit or of preying upon any crops. An examination of 205 stomachs showed that 76 per cent. of the food consists of insects and their allies, while the other 24 per cent. is made up of various vegetable substances, found mostly in stomachs taken in winter. Beetles constitute 28 per cent. of the whole food, grasshoppers 22, caterpillars 11, and various insects, including quite a number of spiders, comprise the remainder of the insect diet. All these are more or less harmful, except a few predaceous beetles, which amount to 8 per cent., but in view of the large consumption of grasshoppers and caterpillars, we can at least condone this offence, if such it may be called. The destruction of grasshoppers is very noticeable in the months of August and September, when these insects form more than 60 per cent. of the diet.

It is evident that in the selection of its food the bluebird is governed more by abundance than by choice. Predaceous beetles are eaten in spring, as they are among the first insects to appear; but in early summer caterpillars form an important part of the diet and are replaced a little later by grasshoppers. Beetles are eaten at all times, except when grasshoppers are more easily obtained.

So far as its vegetable food is concerned, the bluebird is positively harmless. The only trace of any useful product in the stomachs consisted of a few blackberry seeds, and even these more probably belonged to wild than cultivated varieties. Following is a list of the various seeds which were found : Blackberry, chokeberry, juniperberry, pokeberry, partridgeberry, greenbriar, Virginia creeper, bittersweet, holly-strawberry bush, false spikenard, wild sarsaparilla, sumac (everal species), rose haws, sorrel, ragweed, grass and asparagus. The list shows how little the bluebird depends upon the farm or garden to supply its needs, and indicates that by encouraging the growth of some of these plants, many of which are highly ornamental, the bird can be induced to make its home on the premises.

Bluebirds are so well known that it seems unnecessary to urge anything more in their favor ; but in view of the fact that large numbers were destroyed during the storm of 1895, more than ordinary vigilance should be exercised in protecting them until they have regained their normal abundance.

Book Notices.

High School Botany.[1] —In any new edition of a text-book one naturally seeks to discover (1) what extensions have been made, and (2) how far the errors and objectionable features of earlier editions may have been corrected.

The first part of the book before us, embracing 226 pages, is devoted to the general principles of Morphology and Physiology, with a discussion of type forms of the lower groups of plants, ranging from a fern to Chara. The principles of classification are also dealt with, and the three concluding pages are devoted to directions for the collection of plants and the formation of herbaria. In this portion of the book no extension or alteration has been made ; it remains as in the previous revised edition of 1887.

The second part, dealing with the Flora of Canada, has been extended from 162 to 271 pages, and now "includes most of the wild plants of Manitoba and the prairie region generally, as well as those of the older provinces." We observe also, the introduction of a separate and much better glossary, and an alphabetical list of common cultivated plants, which are designated by both common and scientific names. It is in this portion of the book that we note the only extensions and

[1] The Elements of Structural Botany, with special reference to the study of Canadian Plants. H. B. Spotten, M.A., F.L.S. W. J. Gage & Co., Toronto, new edition, pp. 237 and 308, 1897.

improvements. Such a manual tends to meet a long-felt want among Canadian botanists, and will serve a most useful purpose.

As a text book for the use of schools, however, interest centres chiefly in the first portion of the book. For purposes of elementary education, where controversial questions have no place, the value of such a text-book is to be measured very largely by the directness and accuracy with which recognised facts are stated. To continue the presentation of views which have been recognised as erroneous for many years, imposes upon those who are engaged in teaching the higher aspects of the subject the difficult task of undoing the teaching of the schools. Thus on pages 208-209 we are informed that Dicotyledons are either angiospermous or gymnospermous, a statement which wholly destroys the educational value of the classification employed, since it introduces an absolutely incorrect idea of relationship.

An appendix gives a "Selection from Examination Papers," the obvious purport of which appears to be to give the prospective student some notion of the ground covered in the university work. A revised edition of a text-book might be supposed to include such an item in the up-to-date changes. It is, therefore, a matter of some surprise to find that these selections are the same as those which appeared in 1887, and in one case at least they represent work of a character which has been unknown for the last fourteen years. It is to be regretted that the author could not see his way to fully justify the use of the term *revised.* D. P. P.

VEGETABLE PHYSIOLOGY.[1] —In the form of a small pamphlet of 32 pages, Dr. Arthur has brought together directions for a number of experiments illustrative of the most prominent functions of the plant as employed by him in connection with his classes at Purdue University. No attempt is made to introduce the student to an elaborate course in plant physiology, the directions being adapted rather to the needs of an elementary course. By suggestion, rather than detailed direction, the student is led to exercise his own powers of observation, develop originality, and realize that there is a much larger field for inquiry beyond.

D. P. P.

BOTANICAL TEXT-BOOK.[2] —The rapidity with which new text-books of Botany are being prodnced at the present time is not always a matter for congratulation either in the interests of the student, the teacher or the science, since, in the majority of cases, they either perpetuate erroneous ideas or show little, if any, special adaptation to the

1 Laboratory Exercises in Vegetable Physiology by Dr. J. C. Arthur. Kinney and Herbert, Lafayette, Ind., 32 p., 1897.

2 Elementary Botany, Percy Groom, M.A., F.L.S. Geo. Bell & Sons, London, 252 pp., 275 ill., 1898.

object in view ; there is, therefore, no proper justification for their appearance.

When, however, a book offers an illustration in exception to this statement, it is especially welcome, and such an instance is to be met with in the book under consideration. The author has approached his task from the double standpoint of an experienced botanist trained in modern methods, and of one who has had large acquaintance with the requirements of secondary school work, through his experience as an examiner.

The work is divided into three parts :—I. General Morphology, II. Classification of the Angiosperms, III. Physiology. No attempt whatever is made to go beyond the limits of the seed plants, and for the class of students for whom the book is written, this is a wise limitation. While the many topics dealt with are necessarily treated somewhat briefly, the statements are accurate, concise and lucid. The pupil is led on by suggestion, and is certain to have a good grounding when the by no means difficult subject matter is fully mastered. Great aid to a clear understanding of the various problems discussed, is given by the numerous very excellent illustrations which, it is to be noted, are not of the stereotyped class, but possess a desirable degree of freshness.

The material selected for study is of a character readily available, and nothing has been introduced which calls for the use of more than a simple pocket lens. A feature which will commend the book to many is the avoidance of technical terms, the undue use of which in elementary works, has often proved a most serious stumbling block to those who otherwise might have been attracted to the study. All such burdensome details as the forms and margins of leaves are relegated to an appendix which provides an admirably arranged dictionary where special terms are grouped under general headings.

The work is thoroughly modern in its presentation of the subjects and is exceptionally free from objectionable features. It will doubtless serve an admirable purpose in elementary schools as the basis of more advanced work.

D. P. P.

ABSTRACT FOR THE MONTH OF DECEMBER, 1897.

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

DAY	THERMOMETER.				BAROMETER.				†Mean pressure of vapor.	‡Mean relative humidity.	Dew Point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	§Max.	§Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	19.57	26 6	8 8	17.8	30.0100	30 248	29.869	.379	.0978	89 5	16.5	S	13.42	9.0	10	4	00	....	4.3	0.33	1
2	10.78	18.6	3.6	15.0	30.4410	30.525	30.217	.308	.0583	81.7	6.2	S.W.	16 92	0 2	1	0	91	....	0.0	0.00	2
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13	28.60	31.3	25.6	5.7	30.2482	30.342	30.120	.222	.1283	81.5	23.8	S.W.	9.25	4.7	10	0	59	....	....	....	13
14	31.27	34.7	24.5	10.2	30.1118	30.311	29.862	.449	.1598	90.3	29.0	N.E.	13.17	9.8	10	9	00	0.77	....	0.77	14
15	34.45	35.7	33.2	2.5	29.6405	29.752	29.554	.198	.1922	96.5	33.3	S.W.	20.33	9.0	10	4	00	1.06	....	1.06	15
16	36.22	39.3	33.0	6.3	29.8713	29 958	29 812	.146	.1900	88.7	33.0	S.W.	20.44	9.3	10	6	00	0.02	....	0.02	16
17	30.70	38.6	27.1	11.5	30.0312	30.187	29.776	.411	.1358	79.5	25.2	S.W.	15.63	8.2	10	3	7	....	2.9	0.30	17
18	12.48	29.0	3.1	25.9	30.1437	30.372	29.935	.437	.0635	81.0	7.7	S.W.	29.46	0 7	4	0	89	....	0.1	0.01	18
SUNDAY........19	.....	6.7	—2.8	9.5	......	......	......	......	......	....	....	S.W.	15.38	....	..	..	91	....	....	....	19 ....SUNDAY
20	5.48	9.9	—0.8	10 7	30.2395	30.498	29.918	.580	.0518	92 5	3 7	N.	8.21	7 0	10	0	00	....	1.8	0 12	20
21	11.90	16.8	9.1	7.7	29.8501	29.898	29.811	087	.0670	89.8	9.5	S.W.	13.46	3.7	10	2	27	....	2.0	0.15	21
22	9.58	12.5	4.3	8.2	29.8117	29.901	29.700	.201	.0645	95.5	8 7	S.	6.79	5.5	10	0	9	....	0.5	0.03	22
23	12.03	13.8	9.3	4.5	29 5837	29 642	29.511	.131	.0698	93.0	10.5	N	8.13	10.0	10	10	00	....	5.3	0.40	23
24	—1.10	10.8	—7.1	17.9	30.1050	30 326	29.796	.530	.0373	89 7	—3 2	S.W.	29.43	5.3	10	0	16	....	0.5	0.03	24
25	1.63	17.8	—11.1	28.9	30.0907	30.354	29 842	.512	.0437	87.0	—1.5	S. E.	19.83	5 3	10	0	00	....	....	....	25
SUNDAY........26	.....	30.3	8.5	21.8	......	......	......	......	......	....	....	S.	11 25	...	..	..	1	....	1.3	0.10	26...........SUNDAY
27	16.02	28.3	4.0	24.3	29.9610	30 220	29.778	.442	.0785	82.3	11 8	S.W.	19.50	3.5	10	0	88	....	0.0	0.00	27
28	1.52	5.1	—2.7	7.8	30 4052	30.448	30.335	.113	.0402	87.2	—1.5	S.W.	17.54	0.0	4	0	89	....	....	....	28
29	10 77	22.3	—1.8	24 1	30.0867	30.380	29.714	.666	.0680	91.0	8.7	E.	12.42	7.8	10	0	1	....	0.8	0.07	29
30	31.42	35.9	23.7	12.2	29.5485	29 640	29 458	.182	.1595	89.8	28.8	S.	19.09	9.5	10	7	5	....	9.7	0.78	30
31	23 20	30.3	17.2	13.1	29 7423	29.808	29.624	.184	.1102	87.0	20.0	N.	19.88	8 5	10	1	00	....	1 1	0.03	31
Means......	20.07	26.57	13.27	13.30	30.0319	30.1676	29.8751	.2925	.1105	88.55	17.22	S. 23¼° W.	15.46	6.55	9.1	3.0	22.1	2.76	39 2	5.91	....Sums.
23 Years means for and including this month	18.95	26.07	11.76	14.31	30.0352	......	......	.2946	.1001	82.87			s 16.53	6.87	.	..	¶29.46	1.34	23.53	3.61	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	1155	400	837	1428	1604	5799	205	75	
Duration in hrs..	94	33	67	93	107	327	16	7	
Mean velocity....	12.29	12.12	12.49	15.35	14 99	17.73	12.81	10.71	

Greatest mileage in one hour was 49, on the 24th.

Greatest velocity in gusts 54 miles per hour on the 24th.

Resultant mileage, 5682.

Resultant direction, S. 23½ W.

Total mileage, 11,503.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 16 years only. s 11 years only.

The greatest heat was 47.7° on the 11th; the greatest cold was —11.1° on the 25th, giving a range of temperature of 58.8 degrees.

Warmest day was the 10th. Coldest day was the 24th. Highest barometer reading was 30.583 on the 3rd. Lowest barometer was 29.330 on the 5th, giving a range of 1.253 inches. Maximum relative humidity was 100 on the 4th. Minimum relative humidity was 62 on the 25th.

Rain fell on 6 days.

Snow fell on 19 days.

Rain or snow fell on 23 days.

Hoar Frost on the 4th.

Lunar halo on the 6th and 13th. Lunar corona on the 2nd and 3rd.

Fog on 9 days.

Meteorological Abstract for the Year 1897.

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 23 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	13.54	+ 1.62	47.5	— 23.5	13.84	30.0269	30.720	29.321	.308	.0812	85.0	10.0	S. 7¼° W.	17.7	59	42.6	0.41	4	26.1	15	3.03	2	18	January
February	18.12	+ 2.66	37.7	— 5.3	11.88	30.0864	30.587	29.514	.221	.0896	82.1	13.5	S. 81½° W.	16.0	51	51 2	0.48	4	16.5	16	2.12	3	16	February
March	26.60	+ 2.42	46.2	— 9.7	13.43	29.9922	30.857	29.076	.361	.1237	80.1	21.0	S. 68¼° W.	15 6	60	41 6	1.80	12	23.7	14	4.05	6	20	March
April	41 71	+ 1.57	74.3	10.9	16.88	30.0268	30.558	29.444	.222	.2070	74.5	33.9	S. 56¼° W.	16.5	57	45.4	3.02	18	1.9	2	3.27	1	19	April
May	53.11	— 1.56	72.1	33.8	16.99	29.9192	30.395	29.475	.179	.2984	72.6	43.6	S. 67¼° W.	14 7	61	43.9	3.74	22	....	..	3.74	..	22	May
June	61.21	— 3.63	81.6	41 5	16.12	29.8765	30.215	29.604	.133	.3877	71.4	51.2	S. 77° W.	13 6	54	49.3	3.76	20	...	..	3.76	..	20	June
July	70.96	+ 2.13	93.0	54.5	16.04	29.9064	30.343	29.599	.117	.5933	78.5	63.3	S. 18¼° E.	10.7	54	56.5	4.42	19	...	..	4.42	..	19	July
August	63.94	— 2.65	82.0	44.9	14.82	29.9057	30.190	29.514	.128	.4633	77.1	56.4	S. 47½° W.	12 5	49	55.5	1.95	21	..	..	1.95	..	21	August
September	57.80	— 0.69	86.8	35.5	16.88	30.1072	30.421	29.640	.173	.3687	73.4	49.0	S. 63½° W.	14.6	37	59 2	1.15	18	....	..	1.15	..	18	September
October	49.39	+ 3.96	77.8	26.0	18.21	30.0666	30.644	29.525	.247	.2690	71.8	40.4	S. 54¾° W.	14.7	38	57.3	0.65	9	....	..	0.65	.	9	October
November	30.62	— 1.83	54.2	8.5	11.84	29.9928	30.588	29.100	.279	.1562	83.7	26.3	S. 35½° W.	16.9	69	27.9	2.66	11	16.9	11	5.03	4	18	November
December	20.07	+ 1.12	47.7	— 11.1	13.30	30.0319	30.583	29.330	.293	.1105	88.6	17.2	S. 23¼° W.	15.5	66	22 1	2.76	6	39.2	19	5.91	2	23	December
Sums for 1897	...	....	....	....	....	....	....	....	....	....	...	....		....	....	....	26.80	164	126.3	77	39 08	18	223	Sums for 1897
Means for 1897	42.26	+ 0.418	....	....	15.02	29.9949	....	....	.2218	.2624	78.23	35.48	S. 57° W.	14 90	54.6	46.04	....	....	....	..	3.27	..	..	Means for 1897
Means for 23 years ending Dec. 31, 1897.	41.84	....	....	....	...	29.9802	....	....	....	.2525	75.02	....	....	*a* 15.11	60.4	§45.77	28.17	134	118.0	78	39.74	16	201	Means for 23 years ending Dec. 31, 1897.

* Barometer readings reduced to 32° Fah. and to sea level. † Inches of mercury. ‡ Saturation 100. § For 16 years only. ¶ "+" indicates that the temperature has been *higher*: "—" that it has been *lower* than the average for 23 years inclusive of 1897. 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 11 years only.

The greatest heat was 93.0° on July 5: the greatest cold was 23.5° below zero on January 25. The extreme range of temperature was therefore 116.5°. Greatest range of the thermometer in one day was 50.8° on January 18; least range was 2.5° on December 15. The warmest day was July 5, when the mean temperature was 82.6°. The coldest day was January 19, when the mean temperature was 12.7° below zero. The highest barometer reading was 30.857 on March 7, lowest barometer reading was 29.076 on March 25, giving a range of 1.781 inches for the year. The lowest relative humidity was 27 on May 6. The greatest mileage of wind recorded in one hour was 66 miles on January 26, and the greatest velocity in gusts was at the rate of 66 miles per hour on January 26. The total mileage of wind was 130,565. The resultant direction of the wind for the year was S. 57° W., and the resultant mileage 48,320. Auroras were observed on 11 nights; fog on 30 days; thunder storms on 19 days; lunar halos on 10 nights; lunar coronas on 34 nights; mock suns on 1 day. The sleighing of the winter commenced in the city on December 1. The first appreciable snowfall of the autumn was on November 9. Earthquakes were recorded on March 23rd, March 26th, and May 27th, all moderately severe.

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, 1898.

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

DAY	THERMOMETER.				BAROMETER.				†Mean pressure of vapor.	‡Mean relative humidity.	Dew Point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	§Max.	§Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	9.63	17.2	—0 7	17.9	29.6602	29 898	29.505	.393	.0612	88 7	7.0	S.W.	26.00	7.0	10	0	00	....	10.6	0.94	1
SUNDAY........2	.....	13.7	—9 6	23.3	......	.....	......	.....	......	....	....	S.W.	23.38	...	..	..	76	....	0.3	0.03	2 ....SUNDAY
3	4.55	19.3	—5.8	20.1	29.9078	30.288	29.537	.751	.0500	86 5	1.2	S. W.	25.29	3 3	10	0	79	....	1.6	0.13	3
4	—4.50	0.8	—10.7	11 5	30.2388	30 383	30.013	.370	.0328	92.3	—6.2	S.W.	10 63	5.0	10	0	59	....	0 5	0.04	4
5	10.55	22.3	—1.2	23.5	30.0315	30.099	29 976	.123	.0078	91.0	8.5	S.W.	15 25	9 3	10	5	00	....	1.3	0.11	5
6	30 90	33.4	27.9	5.5	29.8987	30 109	29 654	.455	.1520	87.3	27 8	S	17.54	10.0	10	10	00	....	2.4	0.20	6
7	29.93	34 7	21.0	13 7	29.8205	29.935	29.665	.270	.1437	85.0	26.2	S. W.	16 92	7.8	10	0	29	....	0.5	0.06	7
8	30.58	37.3	20.7	16 6	29 4763	29.784	29.246	.538	.1487	86 8	27.3	S. W.	27 54	9.5	10	7	00	0.00	0.6	0.05	8
SUNDAY.........9	.....	29.2	12.7	16.5	......	......	......	....	......	....	...	W.	16 96	....	..	..	91	....	...	....	9 ....SUNDAY
10	20.32	25.9	9.4	19.5	30 0382	30 221	29.951	.270	.1013	89.8	18.0	S W.	15.67	0 8	3	0	68	....	....	.	10
11	3.45	10.9	—0.3	11.2	30.2093	30 326	30.007	.3 9	0425	84.0	—0.7	N	13 17	2.3	10	0	89	....	0.0	0.00	11
12	19.47	29.0	1.5	27.5	29 6860	29.928	29 440	.483	.1030	95.5	18.3	S	12.33	10.0	10	10	00	0.35	0.8	0 46	12
13	17.08	29.2	7.0	22.2	29 9035	30 171	29 520	.651	.0365	86.5	14 0	N.	14.42	3.3	10	0	83	0.18	....	0.18	13
14	15.50	22.4	6.2	16 2	30.2145	30.276	30.167	.109	.0802	88.2	12.7	S.W.	12 88	7.5	10	5	32	....	0.0	0.00	14
15	18.00	24.5	12.5	12.0	29.8673	30.103	29.690	.418	.0943	95 0	17 0	N.	8.83	10.0	10	10	00	....	8.5	0.63	15
SUNDAY........16	.... .	22.5	4.3	18.2	......	......	......	......	......	....	....	N.W.	11.13	....	..	..	83	....	0 0	0.00	16 ....SUNDAY
17	1.98	5.9	—3.7	9.6	30 4103	30 464	30 299	.165	.0425	91 2	—0.4	S	8.04	1.7	10	0	68	....	...	....	17
18	17.45	23.8	2.7	21.1	30.4088	30 481	30.363	.113	.0901	90 2	15.2	S.W.	17.53	5.5	10	0	10	....	0.6	0.01	18
19	22.63	.27.9	14.1	13.8	30.4118	30.513	30.275	.238	.1108	90 7	20.2	S.	13.03	2 0	10	0	63	....	....	....	19
20	21.40	30.8	11.6	19.2	29.8455	30.201	29 528	.673	.1113	93 3	19 8	N.	14.83	8 3	10	0	00	0.01	10.4	0 08	20
21	20.75	27.3	19.1	8.2	30 0543	30.288	29.724	.564	.1007	89.8	18 5	N.	12.00	10.0	10	10	00	....	0.9	0.09	21
22	16.18	20.2	13.4	6.8	30 2540	30.345	30 031	.264	.0848	93 7	14.8	N.	8.25	10.0	10	10	00	....	0.3	0.02	22
SUNDAY........23	.....	29.0	13.0	16.0	......	......	......	......	......	....	....	N.	18.58	....	..	..	00	....	16.9	1.67	23...........SUNDAY
24	13.93	17.3	11.6	5.7	30 0230	30 214	29.739	.475	.0715	87.2	11 0	S. W.	16.38	3.3	10	0	73	....	0 4	0 04	24
25	12 85	18.5	6.5	12.0	30.0375	30.231	29.676	.555	.0710	90 5	10 7	S.W.	13.46	4.2	10	0	49	....	....		25
26	16.77	22.3	8.5	13 8	29.6405	29 779	29 524	.255	.0790	84 7	13.3	N.	17 21	6.3	10	3	54	....	2.2	0.22	26
27	1.30	16.1	2.0	14.1	29.8710	29 979	29.830	.149	.0412	89 7	—0 7	S.W.	12 00	0.2	1	0	94	....	....	......	27
28	—5.45	0 3	—8.5	8.8	30 0672	30 138	29.989	.149	.0305	89.7	—7.5	S. W.	8.79	0.0	0	0	94	....	....	...	28
29	—4.68	3.9	—11.9	15 8	30.0457	30 217	29 973	.244	.0313	88 2	—6.8	N.	14.03	3.3	10	0	77	....	....	....	29
SUNDAY........30	.....	—8.5	—20 9	12 4	......	......	......	......	......	...	....	N.	9 04	....	..	..	93	....	....	....	30...........SUNDAY
31	—4.20	8.3	—20.7	29.0	29.9213	30.073	29.776	.297	.0362	93.2	—5.7	N.	17.88	8 3	10	0	00	....	3 9	0.38	31
Means......	12.94	19.95	4.22	15.73	29.9978	30.1711	29.8136	3575	.0796	89.57	10.52	S. 76½ W.	15 13	5.73	9.0	2.7	44.0	0.57	62 7	6.17	....Sums.
24 Years means for and including this month	12.06	20.35	4.34	16.09	30.0557	......	......	.325	.0732	82.02			s 16.14	6.30	.	.	¶34 99	0.79	30.83	3 63	24 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	3320	309	28	21	1815	4393	529	844	
Duration in hrs..	250	18	2	2	136	251	33	48	4
Mean velocity....	13.28	17.17	14.00	10.50	13 35	17.50	16.03	17.58	

Greatest mileage in one hour was 47, on the 8th.

Greatest velocity in gusts 54 miles per hour on the 8th.

Resultant mileage, 4035.
Resultant direction, S. 76½ W.
Total mileage, 11,259.
Average velocity 15.13 m. p. h.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 17 years only. *s* 12 years only.

The greatest heat was 37.3° on the 8th; the greatest cold was —20.9° on the 30th, giving a range of temperature of 58.2 degrees.

Warmest day was the 6th. Coldest day was the 30th. Highest barometer reading was 30.513 on the 19th. Lowest barometer was 29.246 on the 8th, giving a range of 1.267 inches. Maximum relative humidity was 100 on the 30th. Minimum relative humidity was 68 on the 8th.

Rain fell on 4 days.

Snow fell on 21 days.

Rain or snow fell on 22 days.

Lunar halo on 4 nights. Lunar coronas on 5 nights.

Fog on 4 days.

Mock moons on the 8th.

ABSTRACT FOR THE MONTH OF FEBRUARY, 1898.

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

DAY	THERMOMETER.				BAROMETER.				†Mean pressure of vapor.	‡Mean relative humidity.	Dew Point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	§Max.	§Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	7.70	10.7	3.5	7.2	29.6925	29.829	29.593	.236	.0577	93 7	6.2	N	25.08	10.0	10	10	00	....	4.5	0.43	1
	—8.98	3.5	—15.3	18.8	30.0448	30.082	29 948	.134	0262	90 8	—10.7	S.W.	14.71	5.5	10	0	51	....	0.0	0.00	2
3	—2.32	2.0	—10.7	12.7	30.2110	30 303	30 066	.237	.0322	81.8	—6 7	S	18.42	5 3	10	2	52	....	0.1	0.01	3
4	11 95	16.8	2 0	14.8	30 4353	30 496	30.374	.122	.0583	78.5	6.5	S.	18.29	6.5	10	2	58	....	0.0	0.00	4
5	25.73	32.5	13.0	19 5	30.1018	30 294	30.005	.289	.1298	89.7	23.2	S.	21.04	9 2	10	5	00	....	2.5	0.25	5
SUNDAY.........6	.....	32.5	3.8	28.7	......	.....	....	.....	......	....	....	S.	9.38	...	..	..	89	....	0.0	0.00	6 ....SUNDAY
7	16.82	25 1	6.0	19.1	30.3435	30.364	30.320	044	.0842	88 7	14 2	S.	8.42	6.2	10	0	33	....	...	....	7
8	20.15	26.8	12.8	14.0	30.3148	30 356	30 280	.076	.1008	91.3	18.3	N.	5.42	4.7	10	0	25	....	....	...	8
9	21.18	29.8	10.8	19.0	30 2870	30.362	30.171	.191	.1103	93 8	19 8	S.	6.25	6.8	10	0	28	0.08	...	0.08	9
10	36.43	40.7	29 5	11 2	30.2375	30.333	30.129	.204	.1968	91.2	34.2	S.W.	13.67	8 3	10	0	19	0.00	....	0.00	10
11	37.03	40 3	33.3	7.0	30 1417	30.296	30.000	.296	.1397	85.8	33.2	S.	21.79	8 0	10	5	31	...	....	....	11
12	36 62	39.5	33.6	5.9	29 8753	29.986	29.781	.205	.2060	94 5	35 2	S.W	24.96	8 3	10	0	00	0.47	0.1	0 48	12
SUNDAY.........13	....	34.7	23.7	11.0	......	......	......	....	......	....	...	S.W.	10 50	...	..	..	99	....	....	....	13 ....SUNDAY
14	29.22	36.7	17.7	19.0	29 7377	29 956	29.672	.284	.1342	82 7	24 5	S	19 92	7.5	10	0	00	....	0.6	0.06	14
15	26.65	30.9	22.0	8.9	29 6685	29.847	29 434	.413	.1203	82.5	22.5	N.	14 67	8.8	10	7	37	....	1.6	0.13	15
16	11.72	22.0	7.6	14.4	29 5108	29.804	29.338	.466	.0673	91 2	9.8	N.W.	30.92	10.0	10	10	00	....	12.3	1.23	16
17	0.97	8.7	—7.7	16.4	30 1537	30 261	29.972	.289	.0583	83 0	—2.8	S.W.	29.83	0.0	10	0	99	...	....	...	17
18	13 70	17.8	5.2	12.6	30.2165	30.270	30.164	.106	.0742	90 8	11.7	N.	7.79	10.0	10	10	00	....	0 0	0.00	18
19	19.25	25.8	11.9	13 9	30.4428	30 473	30 375	.098	.0937	88 3	16 5	N.	9 17	1.8	10	0	97	....	0 0	0.00	19
SUNDAY. 20	.....	19.8	15.9	3.9	......	......	......	......	......	....	....	N.	27 13	..	.	..	00	....	10 5	1.30	20 ....SUNDAY
21	20.85	24.5	16.0	8.5	30 0428	30.164	29 960	.204	.1045	93 2	19.2	N.	31 67	10.0	10	10	00	....	6.5	0.93	21
22	23.82	26.9	20 4	6.5	29.9455	29.999	29.899	.100	.1207	93 5	22.3	N.	23.29	9.7	10	8	00	....	2.2	0 22	22
23	27.07	30.2	25.0	5.2	29.8790	29.950	29 830	.120	.1387	93.8	25.5	N.	12 67	10.0	10	10	00	....	2.0	0.20	23
24	28.40	33.5	24.8	8.7	29.8390	29.902	29 838	.064	.1360	86 7	24.8	S.W.	10 92	8 0	10	2	19	....	0.9	0.09	24
25	25 35	29.4	22.0	7.4	29 9695	30.022	29.940	.082	.1157	84.8	21 5	S.W.	5 29	7.3	10	2	05	....	0.5	0.04	25
26	26.05	31.5	21 0	10.5	30 0058	30.037	29.968	.069	.1257	87.3	23.2	W.	9 38	9.2	10	5	00	....	1 4	0.14	26
SUNDAY.........27	.....	31.8	23.2	8 6	......	.....	.....	......	.....	...	....	S W.	17.83	....	..	.	35	....	0 5	0.05	27.........SUNDAY
28	20 08	24.6	14.4	10 2	29.9048	29 931	29.866	.065	0907	83.0	16 2	S.W.	24.21	2 3	10	0	81	...	0.1	0 01	28
29	.....	....	....	....	......	......	......	......	......	....	....	....	....	...	..	..	..	....	....	......	29
30	.....	....	....	....	......	......	......	......	......	....	....	....	....	....	..		..	....	....	...	30
31	.....	....	....	....	......	.....	......	....	......	....	....	....	....	....	..	..	..	....	....	....	31
Means......	19.81	26 03	13.76	12.27	30 0447	30.1382	29.9551	.1831	.1063	88.36	17 01	S. 64° W.	16.88	7.23	9 6	3.7	30.7	0.55	46 3	5.65	...............Sums.
24 Years means for and including this month	15.64	23.71	7.30	16.41	30.0304	......	......	.309	.0837	80.28	....	....	s 18.14	5.93		.	¶41.53	0.74	23 37	3 04	24 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	3791	56			3226	3491	218	559	
Duration in hrs..	200	2			222	192	22	28	6
Mean velocity....	18.96	28.00			14 53	18.18	9.91	19.97	

Greatest mileage in one hour was 43, on the 17th and 21st.

Greatest velocity in gusts 60 miles per hour on the 1st.

Resultant mileage, 3370.
Resultant direction, S. 64° W.
Total mileage, 11,341.
Average velocity 16.88 m. p. h.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 17 years only. s 12 years only.

The greatest heat was 40°.7 on the 10th; the greatest cold was —15°.3 on the 2nd, giving a range of temperature of 56.0 degrees.

Warmest day was the 11th. Coldest day was the 2nd. Highest barometer reading was 30.496 on the 4th. Lowest barometer was 29.338 on the 16th, giving a range of 1.158 inches. Maximum relative humidity was 100 on the 6th. Minimum relative humidity was 71 on the 4th and 14th.

Rain fell on 3 days.

Snow fell on 21 days.

Rain or snow fell on 23 days.

Lunar halo on 4 nights. Lunar coronas on 3 nights.

Hoar frost on 2 days.

Fog on 3 days.

Mock moons on the 24th.

ABSTRACT FOR THE MONTH OF MARCH, 1898.

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	22.32	29.3	13.1	16.2	29.9725	29 994	29.951	.043	.0930	77 7	16.7	S	12.62	0.5	3	0	82	....	..	......	1
2	21.03	28.5	14.2	14.3	30.1013	30.148	30 057	.091	.0923	81 3	16.3	W.	8.83	0.0	0	0	92	....	....	...	2
3	20.77	28.4	13.0	15 4	30 2295	30.285	30 164	.121	.0883	78.8	15.5	N.	10.05	0 0	0	0	96	....	....	....	3
4	24 65	34.0	12 9	21.1	30 1992	30 281	30.104	.177	.1132	82 8	20.5	S	8.79	3.5	9	0	86	...	....	....	4
5	26.95	32.8	21.8	11 0	30.1492	30 231	30.091	.140	.1103	75 2	20.5	S W.	20.42	0.0	0	0	97	....	....	....	5
SUNDAY........6	.....	35.7	22.0	13.7	......	....		.....	......	....	....	S.W.	28.75	....	..	..	97	....	....	..	6..........SUNDAY
7	32.85	40 3	23.0	17.3	30.4140	30.454	30.382	072	.1465	78 5	26.7	S.	16.42	1.2	3	0	84	....		....	7
8	33.08	41.3	24.4	16.9	30.3115	30 383	30 244	.139	.1468	77 7	26.8	S.	5.63	1.0	3	0	76	....	....	....	8
9	37.90	43.7	28.4	15.3	30.2250	30.247	30.191	.056	.1682	73 5	30 2	S.	12 38	4.2	8	0	54	....	...	....	9
10	41.53	47.1	36.0	11 1	30.2477	30.281	30.214	067	.1930	73.3	33.5	S.	13.00	2 8	9	0	28	....	..	....	10
11	44.12	48.7	38.4	10.3	30 1157	30 223	29.952	.271	.2205	70.2	36.8	S.	21.03	6 3	10	0	78	0.01	....	0.01	11
12	42.18	45.8	39.7	6.1	29.8790	29.923	29.854	.069	.2513	93 5	40.3	S.	20.59	10.0	10	10	00	0.54	....	0 54	12
SUNDAY........13	....	46.5	35.6	10.9	......	......	......	....	.....	....	..	S.	30 54	....	..	..	00	0.33	....	0.33	13 ....SUNDAY
14	31.70	35.3	26.5	8.8	30 0100	30.216	29.797	.419	.1322	73 7	24.3	S. W.	36 71	0.8	5	0	99	....	....	....	14
15	25.83	31.3	18.9	12.4	39 3798	30.426	30 337	.089	.1082	75.8	19.5	N.	10.75	0.0	0	0	90	....	....	.	15
16	34 95	39.3	25.9	13.4	30 1077	30.220	29.871	.349	.1537	77 2	28.5	S	22.46	5 3	10	0	34	....	0 9	0.09	16
17	39. 5	45.2	35.4	9.8	29 8372	30 065	29.689	.376	.1784	73 3	31.5	W.	26.79	3.7	10	0	88	0.22	....	0.22	17
18	36 27	39.8	31.0	8.8	30.1943	30.271	30 088	.183	.1370	63 7	25 5	W.	11.33	4.7	10	0	72	...	....	....	18
19	40.90	49.0	32.5	17.5	29.7207	29.988	29.482	.506	.2305	87 3	37 4	S.E.	15 88	10.0	10	10	00	0.28	....	0.28	19
SUNDAY........20	..	51.1	30.6	20.5	......	......	......	......	......	....	....	W.	22 31	. ..		..	54	0 00	0 0	0 00	20..........SUNDAY
21	28.39	33.2	24.2	9.0	30 2445	30.277	30 222	055	.1098	69 8	20.3	N.	7.42	3.8	10	0	52	....	...	....	21
22	33.68	41.6	22 3	19.3	29.9833	30.261	29.645	.615	.1367	69 8	24.5	S.E	19 71	8.0	10	0	00	0 00	...	0 00	22
23	33 38	42.9	25.4	15.5	29.7702	30.036	29 423	.673	.1488	74.7	26 0	S.E.	20 13	4.3	10	0	75	0.17	....	0.17	23
24	29 18	38.1	18.8	19.3	30.1682	30.204	30 124	.080	.1145	69 8	21.0	S E.	5 03	0 0	0	0	94	....	....	....	24
25	36 35	43.8	29.9	13.9	30 4413	30.574	30.268	.306	.1543	71.8	28 0	W.	6 92	0.7	2	0	94	....	....	...	25
26	42.47	53.5	31.0	22.5	30 6048	30.648	30.582	.066	.1745	64.7	31.0	S.E.	16 38	3.0	9	0	58	....	....	....	26
SUNDAY........27	....	58.3	36.5	21.8	......	......	....	......	.....	...	....	S E	18.03	....	..	..	83	....	....	....	27..........SUNDAY
28	46 08	49.3	43.8	5.5	30.2472	30 316	30.181	.135	.2607	83.8	41.2	S.E.	27.42	10 0	10	10	00	0.37	....	0 37	28
29	40.48	4.7	34.8	9.9	30 2122	30.266	30.194	.072	.2298	90.3	37.7	S.	21 38	8.0	10	0	00	0.63	...	0.63	29
30	35.93	42 4	30 0	12.4	30.1882	30.269	30.115	.154	.1385	65.3	25.7	S.W.	15.71	4.3	10	0	86	....	....	..	30
31	33 97	44.9	28 5	16.4	30.0723	30.192	30.002	.190	.1110	56.3	20.3	N.W.	14.17	5.7	10	0	58	....	....	..	31
Means......	33.95	41 41	27.37	14.04	30.1492	30.2495	30.0453	.2042	1536	75.40	26 89	S. 18° W.	17 32	3.77	6.7	1.1	61.5	2.55	0 9	2.64	....Sums.
24 Years means for and including this month	24 59	31.75	17.15	14.60	29.9759	......	....	.265	.1108	76.43	....	....	§17.83	5.89	.	.	¶47.32	1.10	22 64	3 38	24 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	437		188	2855	3831	3067	2274	232	
Duration in hrs..	47		12	160	234	136	125	15	15
Mean velocity....	9.30		15 67	17.84	16 37	22.55	18.19	15.47	

Greatest mileage in one hour was 55, on the 13th.

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

Resultant mileage, 7,865.
Resultant direction, S. 18° W.
Total mileage, 12,884.
Average velocity 17.32 m. p. h.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 17 years only. § 12 years only.

The greatest heat was 58°.3 on the 27th; the greatest cold was 12°.9 on the 4th, giving a range of temperature of 45.4 degrees.

Warmest day was the 28th. Coldest day was the 2nd. Highest barometer reading was 30.648 on the 26th. Lowest barometer was 29.391 on the 13th, giving a range of 1.257 inches. Maximum relative humidity was 98 on the 12th, 13th and 29th. Minimum relative humidity was 45 on the 26th.

Rain fell on 10 days.

Snow fell on 2 days.

Rain or snow fell on 11 days.

Auroras were observed on 3 nights.

Lunar halo on 3 nights. Lunar coronas on 9 nights.

Fog on 7 days.

ABSTRACT FOR THE MONTH OF APRIL, 1898.

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	27.02	34.6	19.0	15.6	30.0400	30.103	29.992	.111	.0870	58.2	14.8	W.	20.46	0.2	1	0	96	....	0.3	0.03	1
2	27.80	37.5	20.1	17.4	29.9122	30.041	29.803	.238	.1067	68.8	19.2	W.	12.54	3.7	7	0	51	....	....	......	2
SUNDAY........3	.....	23.5	14.1	9.4	......	......	....	.....	......	....	....	W.	11.83	....	..	..	65	....	0 9	0.08	3............SUNDAY
4	22.63	30.8	16.4	14.4	30.0362	30.114	29.999	.115	.0927	73.5	15.8	N.	10.42	7.5	10	0	15	....	0.4	0.03	4
5	25.08	30.6	17 7	12.9	30.0648	30.132	29.975	.157	.1007	75.3	18.5	S.W.	6.75	6.0	10	0	45	....	0.1	0.01	5
6	30.67	35.8	22.5	13.3	29.8897	29.960	29.817	.143	.1230	71.8	22.7	S.W.	13.92	6.3	10	0	56	....	....	....	6
7	39.28	47.5	30.8	16.7	29.9212	29.967	29.826	.141	.1318	56.0	24.3	W.	18.00	5.2	10	0	90	....	....	....	7
8	43.35	54.2	34.7	19.5	30.0258	30.110	29.992	.118	.1238	44.2	22.8	W.	11.88	2.5	10	0	87	....	....	....	8
9	45.60	56.7	33.0	23.7	30.0925	30.153	30 043	.110	.1650	54.3	29.8	S.W.	8.96	1.0	4	0	95	....	...	....	9
SUNDAY.......10	.....	61.5	35.2	26.3	......	......	......	....	......	....	....	N.	7.79	....	..	..	96	....	....	...	10 ....SUNDAY
11	50.73	62.2	36.5	25.7	30.1725	30.208	30 145	.063	.1765	45.0	31.3	E.	3.79	0.2	1	0	97	....	...	....	11
12	53.70	63.8	43.3	20 5	30.1513	30.237	30.058	.179	.1928	46.5	33.2	E.	6.08	0.3	2	0	92	....	....	....	12
13	53.83	66.6	40.8	25.8	29.8975	30.052	29.747	.305	.2203	54.5	37.0	N.	11.96	2.3	7	0	77	....	....	....	13
14	51.30	62.2	41.2	21.0	29.6727	29.756	29.603	.153	.2037	55.5	34.8	N.	21.03	4.5	9	0	28	....	... .	....	14
15	47.25	55.7	38.4	17.3	29.6478	29.678	29.622	.056	.2100	63.7	35.0	N.	21.04	8.3	10	0	2	0.00	....	0.00	15
16	48.55	58.6	38.6	20.0	29.6027	29.638	29.552	.086	.2463	72.7	39.8	N.	10.84	6.2	10	0	61	....	....	....	16
SUNDAY.......17	.....	63.0	34.8	28.2	......	......	......	......	......	....	....	S.W.	14.58	....	..	..	65	....	....	....	17...........SUNDAY
18	42.18	50.3	34.3	16.0	30.0722	30.203	29.925	.278	.1352	50.2	25.0	N.W.	17.75	3.5	10	0	97	....	....	....	18
19	46.52	55.3	37.2	18.1	30 0655	30.211	29.888	.323	.1563	50.8	27.8	S.E.	13.21	5.3	10	0	63	0.03	....	0.03	19
20	39.65	44.4	36.2	8.2	29.6963	29.764	29.646	.118	.2288	93.3	37.8	S.E.	12.88	10.0	10	10	00	0.70	....	0.70	20
21	43.22	49.5	38.3	11.2	29.6815	29.864	29 598	.266	.2357	84 7	38.8	S.W.	12.67	9.5	10	7	37	0 20	....	0.20	21
22	47.22	57.7	36.0	21.7	29.9323	29.989	29.892	.097	.2148	67.3	36.3	S.W.	21.54	4.7	10	0	74	....	....	....	22
23	49.89	59.8	43.0	16.8	29.9025	29.937	29.880	.057	.2570	72.7	41.0	S.E.	7.88	5.8	10	0	60	....	...	....	23
SUNDAY.. 24	.....	54.2	41.5	12.7	......	......	......	......	......	...	....	N.	20.21	....	..	..	00	....	....	....	24...........SUNDAY
25	46.72	55.3	39.8	15.5	30.0203	30.150	29.913	.237	.1942	61.5	33.7	N.	23.50	5 3	8	2	50	....	....	....	25
26	46.12	55.3	36.0	19.3	30.2397	30.290	30.189	.101	.1703	56.0	30.5	N.	14.38	2.0	6	0	74	....	....	...	26
27	47.02	58.0	33.3	24.7	30 2790	30.370	30.211	.159	.1725	55.3	30.8	N.	9.00	1.2	3	0	96	...	....	...	27
28	48 98	59.8	35.0	24.8	30.0677	30.225	29.891	.334	.1432	42.5	26.2	N.W.	16.75	3.3	8	0	72	...	....	....	28
29	40.83	47.1	36.5	10.6	29.8070	29.863	29.754	.109	.2087	81.5	35.5	N	16.67	9.5	10	7	00	0.07	....	0.07	29
30	48.70	56.7	39.0	17.7	29.9498	30.091	29.875	.216	.2280	67.7	37.8	N.W.	18.63	7.7	10	0	17	0.00	....	0.00	30
Means....	42.84	51.61	33.44	18.17	29.9554	30.0425	29.8783	.1642	.1740	62.44	30 01	N. 44° W.	13.89	4.69	7.9	1.0	58.6	1.00	1 7	1.15	....Sums.
24 Years means for and including this month	40.25	48.80	32.46	16.34	29.9604	......	......	.202	.1729	66.97	....	....	s 16.46	5.74	..	..	¶51.52	1.64	5.63	2.21	24 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	3904	225	283	519	177	2049	1504	1337	
Duration in hrs..	255	27	44	40	20	141	101	85	7
Mean velocity....	15.31	8.33	6.43	12.98	8.85	14.53	14.89	15.73	

Greatest mileage in one hour was 30, on the 25th.

Greatest velocity in gusts 42 miles per hour on the 25th.

Resultant mileage, 4,315.
Resultant direction, N. 44° W.
Total mileage, 9,998.
Average velocity 13.89 m. p. h.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 17 years only. s 12 years only.

The greatest heat was 66°.6 on the 13th; the greatest cold was 14°.1 on the 3rd, giving a range of temperature of 52.5 degrees.

Warmest day was the 13th. Coldest day was the 3rd. Highest barometer reading was 30.370 on the 27th. Lowest barometer was 29.552 on the 16th giving a range of 0·818 inches. Maximum relative humidity was 97 on the 20th. Minimum relative humidity was 30 on the 28th.

Rain fell on 6 days.

Snow fell on 4 days.

Rain or snow fell on 10 days.

Auroras were observed on 2 nights.

Lunar halo on 1 night. Lunar coronas on 5 nights. Solar halo on 1 day.

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