Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- [ ] Coloured covers/ Couverture de couleur
- [ ] Covers damaged/ Couverture endommagée
- [ ] Covers restored and/or laminated/ Couverture restaurée et/ou pelliculée
- [ ] Cover title missing/ Le titre de couverture manque
- [ ] Coloured maps/ Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black)/ Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations/ Planches et/ou illustrations en couleur
- [x] Bound with other material/ Relié avec d'autres documents
- [x] Tight binding may cause shadows or distortion along interior margin/ La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure
- [ ] Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/ Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.

- [ ] Coloured pages/ Pages de couleur
- [ ] Pages damaged/ Pages endommagées
- [ ] Pages restored and/or laminated/ Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- [ ] Pages detached/ Pages détachées
- [x] Showthrough/ Transparence
- [ ] Quality of print varies/ Qualité inégale de l'impression
- [x] Continuous pagination/ Pagination continue
- [ ] Includes index(es)/ Comprend un (des) index

Title on header taken from:/ Le titre de l'en-tête provient:

- [ ] Title page of issue/ Page de titre de la livraison
- [ ] Caption of issue/ Titre de départ de la livraison
- [ ] Masthead/ Générique (périodiques) de la livraison

- [ ] Additional comments:/ Commentaires supplémentaires:

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X		14X		18X		22X		26X		30X	
	12X		16X		20X	✓	24X		28X		32X

THE

CANADIAN RECORD

OF SCIENCE.

VOL. III. APRIL, 1889. NO. 6.

Glaciation of Eastern Canada.

By Robert Chalmers,

Of the Geological Survey of Canada.

The investigations hitherto made in regard to the glaciation of Eastern Canada show that, instead of its having been caused by a continental ice-sheet moving over the region from north to south, as has been supposed, local glaciers upon the higher grounds, and icebergs or floating ice striating the lower coastal and estuarine tracts, during a period of submergence, were agents sufficiently powerful to produce all the phenomena observed. The latter theory, with some modifications, is the one so long maintained by Sir William Dawson, who has studied the glaciation of this country for forty years or more.[1] A number of other observers have, of late years, been at work, however, and Sir William's views are now, it would seem, about to receive abundant confirmation. The large

[1] Acadian Geology, 2nd and 3rd eds., Chap. on Post-Pliocene; Notes on the Post-Pliocene Geology of Canada, *Canadian Naturalist*, 1872; Geological Magazine, March, 1883, and numerous addresses and papers in *Canadian Naturalist, &c.*

mass of new evidence obtained, and now available for co-ordination and study is, however, so scattered through the reports of the Geological Survey and various scientific periodicals, as to be somewhat difficult of access. A good deal of unpublished material, too, relating to this subject, is now in the hands of the Geological Survey staff. My object in this paper therefore is simply to collect and correlate all the main facts within reach relating to this important question, briefly summarizing the results, and referring the student for fuller details to the reports and publications alluded to.

Commencing in the extreme eastern part of Canada I shall give a brief statement of the facts observed in each province, correlating those pertaining to each of the larger centres of dispersion for local glaciers, such as the Cobequid Mountains in Nova Scotia, the main central water-shed in New Brunswick, the Notre Dame or Shickshock Mountains in the province of Quebec, etc. Each of these centres formed a gathering ground for its own glaciers, discharging them on either side, or in various directions according to the slopes of the land.

It is, perhaps, necessary at the outset to define the term "local glacier," as I understand it. By a local glacier I mean an ice-sheet limited in extent, that is, confined to one valley or hydrographic basin, whether large or small, and influenced in its movement by local topographic features, such as mountains, water-sheds, hills, or river valleys.

NOVA SCOTIA.

In Nova Scotia it is found that ice moved in different directions in different localities, the slopes of the country having largely controlled it. The Cobequid Mountains shed ice from their summits on either side, that is, northward and southward; and the South Mountain likewise discharged glaciers off its slopes. Observations on the glaciation of that province by Sir William Dawson show a wide divergence in the courses of striæ met with in a number of different places. This seems explicable only on the theory of local glaciers and icebergs as held by him.[1] Dr. Honeyman gives several lists of striæ also, from various parts of the province, and discusses the phenomena pertaining thereto, adhering however, to the view of a continental glaciation. He notes however the northward transportation of boulders from the South Mountain at Nictaux, Berwick, etc.[2] Mr. Chas. Robb,[3] and Mr. Hugh Fletcher, especially the latter gentleman, have made numerous observations on striæ, etc., in Cape Breton and in the eastern and north-eastern part of the peninsula. Mr. Fletcher's lists are given independent of any theoretical views, which makes them, perhaps, all the more valuable. They show that ice moved down the slopes from the higher grounds everywhere, usually following river valleys.[4] Dr. R. W. Ells investigated the glacial phenomena of Cumberland county to some extent.[5] Between River Herbert and South Joggins he found striæ in the direction of S 63° W, the ice producing these having apparently come from the higher grounds north-east of Maccan and flowed towards Chiegnecto Bay. In the pass in the Cobequids, through which the Spring Hill and Parrsboro' Railway runs, striæ indicating the passage of ice through it and flowing towards Minas Basin were observed. On the south slope of these mountains, at New Mines, an escarpment of rock has its face striated by ice which flowed towards the outlet of Minas Basin. At New Annan, on the north side, grooves and striæ were seen with a course of N. 10° E., showing that ice flowed northward from their summits down the French River valley towards Tatamagouche Bay. Mr. E. R. Faribault of the Geological Survey, who has been studying the gold regions in eastern Nova Scotia, also

[1] Acadian Geology, 2nd ed., p. 62.

[2] Nova Scotia Institute of Natural Science, Proceedings of, Vols. IV., V., VI. and VII.

[3] Report of Progress, Geol. Surv. of Canada, 1874-75.

[4] Reports of Progress, Geol. Surv. of Canada, from 1875-76 to 1882-83-84, also Annual Report, 1886, Vol. II., p. 104 P.

[5] Annual Report, Geol. Surv. of Can., 1885, Vol. I, 63-64 E.

informs me that he finds the striæ, generally, running down hill towards the coast.

From all the data before us, therefore, it would appear that ice which accumulated on the surface of the province moved from the higher grounds down the slopes in the nearest direction to the sea. This certainly is not the action of other than local glaciers. Some of the coastal tracts have, no doubt, been glaciated by icebergs or floating ice, however, similarly to the sea and estuarine borders in New Brunswick and Quebec, as shown by Sir William Dawson.[1]

New Brunswick.

The glacial phenomena of New Brunswick have been studied, perhaps, in greater detail than those of any other part of Eastern Canada. A number of observers have, from time to time, published lists of striæ, among whom may be mentioned the late Prof. James Robb,[2] G. F. Matthew,[3] Prof. H. Y. Hind,[4] Dr. R. W. Ells,[5] and the writer,[6] The greater number of striæ recorded in the publications referred to, however, occur on the southern slope of the main central water-shed traversing the province from north-west to south-east, and were supposed to lend support to the theory of a continental, or very large ice-sheet, passing over the country south-eastwardly, that being the average trend of the striæ in that part of New Brunswick. My own investigations, continued for more than fifteen years, and extending to all parts of the province, have, however, led me to a different conclusion. North of the

[1] Notes on the Post-Pliocene Geology of Canada, *Canadian Naturalist*, 1872.

[2] Proceedings of the Am. Ass. for Advancement of Science, 1850.

[3] Report of Progress, Geol. Surv. of Can., 1877-78, part EE.

[4] Preliminary Report on the Geology of New Brunswick, 1864.

[5] See list of Striæ, Annual Report, Geol, Surv. of Canada, 1885, Vol. I, part GG.

[6] Report of Progress, Geol. Surv. of Canada, 1882-84, part GG; Annual Report, 1885, Vol. I, part GG; Annual Report, 1886, Vol. II., part M; *Canadian Naturalist*, Vol. X, Nos. 1 and 4.

principal water-shed referred to, it was found the striæ had an entirely different course from those south of it, indicating ice-movement eastwardly and north-eastwardly towards the Gulf of St Lawrence. This was especially noticeable in the Baie des Chaleurs and Miramichi basins, on the south and south-western sides of which striæ occur trending towards all points of the compass between north and east. Hence I inferred that the chief water-shed of the province referred to shed the ice in both directions as indicated by the striæ.[1] The striæ follow the river valleys, however, to a large extent, the ice producing them having been influenced more or less also by the minor topographic features of the slopes.

Considerable areas in the interior and also upon the Carboniferous plain are found to be unglaciated. In the former, no ice action whatever was apparent, the rocks standing up with jagged, broken surfaces, and covered with their own debris, while nothing like boulder-clay can be seen. On the coastal area of the Carboniferous plain I observed boulder-clay and transported blocks overlying decomposed rock *in situ*.

From these facts I conclude that the ice-covering of the province during the glacial period consisted of local glaciers only, the central area being mainly a gathering ground for the snow and ice, which sent off glaciers in opposite directions. Some of these glaciers, however, must have been quite large. The western end of the Baie des Chaleurs basin appears to have been occupied with one which drew its supplies from the west, north and east, *i. e.* from the Restigouche, Nouvelle and Cascapedia valleys, etc.[2] But the largest local glaciers were, undoubtedly, those which occupied the southern slope of the New Brunswick water-shed. They probably filled the St. John valley and spread over the minor water-shed, between it and the Bay of Fundy. Impinging against the coast hills of St. John

[1] Annual Report Geol. Surv. of Canada, Vol. I, part GG.

[2] Annual Report, Geol. Surv. of Canada, 1886, Vol. II, part M; *Canadian Naturalist*, Vol. X, Nos. 1 and 4.

and Charlotte counties they must have partly over-ridden some of these in their passage to the Bay of Fundy, and were, at least, two to four hundred feet in thickness. Striæ are found on the north-west flanks of these hills three to four hundred feet above the general level of the district to the north, over which the ice approached them. This district, now nearly level, or but slightly undulating, and extending from the interior of the province, or the central water-shed, to the coast hills mentioned, forms an inclined plane, along which the moving glaciers must have acquired great momentum. Passes exist in these coast hills, through which the glaciers sought outlet to the bay, but some portions of them must have been shoved up on the northern flanks of the elevations between these passes to a height nearly equal to its source on the upper slopes of the central water-shed. These facts and others, which cannot here be given in detail, go to show that the glaciers of this slope must have been quite large, at least in this particular area. The coast hills referred to broke them up, however, as the ice passed through these gaps, as is shown by the wide deviations in the courses of the striæ before their final disappearance on the shores of the Bay of Fundy.[1]

Numerous moraines exist in the western part of the province which could only be formed by local glaciers descending from the hilly tracts into the valleys, as, for example, into the basin of the Chiputnecticook Lakes, or the valley of the Magaguadavic River, etc.[2] Considerable deviations in the courses of striæ occur in the hilly district further east.[3] Near the lower St. John, and along the Kennebeckasis valley, as well as in the highland region between the latter and the Bay of Fundy, striæ are seen running in various directions. The glaciers here must have been small and apparently independent of each other. The

[1] These remarks are based on observations made by the Geol. Surv. staff, but not yet published.

[2] Report of Progress, Geol. Surv. of Can., 1882-84, part GG.

[3] From data obtained in the field by the writer during the seasons of 1887 and 1888, not yet published.

divergent courses of striæ, often seen upon the same rock surface, are, however, sometimes explicable on the theory of their having been produced by successive portions of the diminishing glaciers conforming, in their motions, more closely to the surface features during the period of melting. Along valleys, which were under the sea during the latter part of that period, as, for instance, those of the Petitcodiac and Kennebeckasis rivers, the striæ, which in some cases are parallel thereto, may have been produced by floating ice, and the same remark applies to striæ met with on the isthmus of Chiegnecto.[1] Certain fine ice markings, found also on the immediate coast of the Baie des Chaleurs, seem attributable to the same cause. It is probable that during the ice age the eastern part of this bay, at least, was open, and that floating ice grated the rocks along its shores.

PRINCE EDWARD ISLAND.

Prince Edward Island has probably been glaciated similarly to the coastal areas of New Brunswick and Nova Scotia. Sir William Dawson gives the courses of striæ observed in two places; but it is an open question whether local glaciers of its own or icebergs produced them.[2] Other phenomena noted by Sir William rather point to the latter as the probable cause of these.

QUEBEC.

The glaciation of the Province of Quebec presents much greater complexities than are to be found in that of the Maritime Provinces of Canada. It would seem that the estuarine portion of the St. Lawrence River, at least, was partially open during the period of extreme cold, similarly to the Baie des Chaleurs, as just stated. The Notre Dame range of mountains, or the water-shed adjacent thereto, shed the ice northward and southward, part of which *debouched* into these waters. Observations made by Dr. R. W. Ells

[1]Annual Report, Geol. Surv. of Can., 1885, Vol. I, part GG.; list of striæ.

[2]Supplement to Acadian Geology, p. 25.

and the writer abundantly prove this.[1] In 1872 Sir William Dawson pointed out that "local glaciers had "*debouched* into the St. Lawrence valley from the north "following the valleys of the Saguenay and Murray Bay "rivers, etc., and *possibly also from the south*."[2] But it was not until the year 1885 that positive evidence of a northward ice movement on the southern slope of the St. Lawrence valley was found by the writer.[3] The following year Dr. Ells discovered similar evidence in the Eastern Townships confirming, beyond doubt, the above conclusion.[4] From a large number of facts adduced in the report referred to he infers that "local glaciers were shed on either side "from the great mountain ridge along the Maine and New "Hampshire boundary. On the sonth-east slope of the "boundary chain the striæ are found to be about S. 65° E., "while on the Quebec slope the general course is the "reverse, or N. 65° W. (true meridian.) About Lake "Megantic and further south, in Ditton and Emberton, "however, a general N.-W. course was observed. Along "the Chaudiere and Du Loup rivers, the striæ, in general, "trend N. 55° W."[5] During the two seasons since, Dr. Ells has obtained a large number of additional facts in this region, corroborating the foregoing conclusion and showing that local glaciers alone must have produced all the striation from the summit of the Notre Dame or Appalachian mountain range to the St. Lawrence valley

The grooves recorded in *Geology of Canada,* 1863, pages 890-92, as occurring in this region, have also, it appears, been produced by northward moving ice.[6]

[1] Annual Report, Geol. Surv. of Can. 1886, Vol. II, 44-51 J; ibid., 5-20 M; also Transactions Royal Soc. of Can., 1886, Sec. IV, Art. X.

[2] Notes on the Post-Pliocene Geology of Canada, 1872. *Canadian Naturalist,* Vol. IV, No. 1, p. 30.

[3] Transactions Royal Soc. of Canada, 1886, Sec. IV., Art. X. Geol. Surv. of Can. 1886, Vol. II, part M.

[4] Ibid., part J.

[5] Annual Report, Geol. Surv. of Can., 1886, Vol. II, 45 J.

[6] Transactions Royal Soc. of Can., 1886, Vol. IV, Art. X.

Further to the east, at Lake Temiscouata and vicinity, Prof. L. W. Bailey and Mr. W. McInnes, of the Geological Survey, found striæ and transported blocks, evidencing north-westerly ice movement from the summits of the water-shed.[1]

On the south-east slope of the mountain range mentioned, abundant evidence has been obtained in Canadian territory showing a general south-eastward ice-flow. Besides the striæ met with in the Temiscouata Lake valley,[2] I found others in the Madawaska River valley,[3] also on the Quatawamkedgewick, a branch of the Restigouche River.[4] Striæ have been seen also near the Matapedia Lake,[5] and further east, near the mouth of the Restigouche, as well as in numerous places along the north side of the Baie des Chaleurs,[6] all of which have a general south-easterly course. There were local deflections, however, caused by hills and river valleys, and especially by the slopes of the Baie des Chaleurs district.

In the St. Lawrence Valley, on ledges below the 350 to 375 contour line, striæ and polishing were observed, indicating ice movement in the general direction of the valley, that is, about north-east and south-west. These must have been caused by drift ice, as shown by Sir William Dawson.[7]

Co-ordinating all the phenomena relating to the glaciation of that portion of Quebec lying south of St. Lawrence River, we find that local glaciers upon the higher grounds and slopes and drift ice on the lower are sufficient to

[1]Science, Vol. VIII, p. 412.

[2]Geology of Canada, 1863, pages 890-92.

[3]Annual Report, Geol. Surv. of Can., 1885, Vol. 1, list of striæ, part GG.

[4]Annual Report, 1886, Vol. II, List of Striæ, part M.

[5]Geology of Canada, 1863, pages 890-92.

[6]Annual Report, Geol. Surv. of Can., 1886, Vol. II, list of striæ, part M.

[7]Acadian Geology, 3rd ed. Notes on the Post Pliocene Geology of Canada, 1872, *Canadian Naturalist.* Transactions Royal Soc. of Can., 1886, Sec. IV, Art. X. Annual Report Geol. Surv. of Can., 1886, Vol. II, part M.

account for them. These local glaciers drew their supplies from large gathering grounds on the water-shed along the Notre Dame or Green Mountain Range. Generally speaking, they were shed on either side of the Appalachians, nearly at right angles to their axis, which accounts for the parallelism or correspondence in direction of the striæ referred to by Dr. Ells.[1] The river valleys and minor ridges and hills on the slopes, however, caused many local deviations from the normal course. On the south-east slope, their movements were, perhaps, subjected to greater local deflections than in the north-west, caused by the rugged topographic features which are upon it. For example, the chief water-shed of New Brunswick, already referred to as lying between the St. John valley and the Baie des Chaleurs and Gulf of St. Lawrence, shed the ice of the southern slope of the Notre Dame mountains once more in nearly opposite directions, or north-eastward and south-eastward.[2] On these minor slopes, local surface inequalities again swerved the ice-masses, in a greater or less degree, from the courses given to them by the New Brunswick water-shed, etc. For the most part, they followed the nearest slopes or river valleys, thus showing their essentially local character. During the period of melting or retirement of the glaciers, this became more and more apparent.

The Laurentian or Archæan Area.

The glacial phenomena of the Archæan Area north of the St. Lawrence and great lakes, have also undergone investigation by the Geological Survey staff, and a large number of facts collected relating thereto, in addition to those recorded in *Geology of Canada*, 1863, and in Sir William Dawson's Notes on the Post-Pliocene, etc. Along the St. Lawrence valley, the general parallelism of the Laurentide slope to that of the Notre Dame Range opposite caused the striæ to have nearly a similar south-east and north-west

[1] Ibid., part J.

[2] Annual Report, 1885, Vol. I, part GG.

course,[1] the ice producing them having moved down the slope mentioned in the St. Lawrence valley from the north. But south of the water-shed, separating the waters of the Ottawa River from those of the great lakes, the striæ are found to swerve more to the south and south-west. Immediately north of lakes Huron and Superior they have a south-westerly trend,[2] and this appears to be the normal course along the border of the Archæan Area to Lake of the Woods, and as far as Lake Winnipeg, in the latter region, perhaps, having a little more westing.[3] On the east side of Hudson Bay, striæ have been observed by Dr. R. Bell[4] and Mr. A. P. Low of the Geol. Survey (report of latter gentleman not yet published) to run westwardly into its basin mainly following the valleys. On islands in the northern part of Hudson Bay, Dr. Bell found striæ indicating a northward flow of ice;[5] while at Hudson Straits, the course appears to have been north-east and east.[6]

On the east and south-east coast of Labrador there is evidence, according to Packard, that the ice followed the valleys and nearest slopes to the sea.[7]

It would seem therefore, that there was an outward flow of ice radially around the margin of the great Archæan Area. Whether the whole area was occupied by glaciers moving from the centre towards the circumference, or the central portion was largely covered with masses of snow

[1] Geolgy of Canada, 1863, pp. 890–92, Notes on the Post-Pliocene, &c. *Can. Naturalist,* 1872.

[2] Geol. of Can., 1863, pp. 890–92. Dr. R. Bell, Report of Progress, Geol. Surv. Can. 1869; Report of Progress, 1873; Annual Report, 1886, Vol. II, part G.

[3] Dr. G. M. Dawson, Geology and Resources of the Forty-ninth Parallel; Dr. Bell, Report of Progress, 1877–78, part CC.; A. P. Low, Annual Report, 1886, Vol. II, part F. Dr. A. C. Lawson, Annual Report, Vol. I, part CC.

[4] Report of Progress, Geol. Surv. Can. 1877–78, part C.

[5] Annual Report Geol. Surv. Can., 1885, Vol. I, p. 14 DD.

[6] Report of Progress, Geol. Surv. Can. 1882–83–84, p. 36 DD.

[7] See paper by A. S. Packard, Jr., M.D. *Silliman's Journal,* and re-published in *Can. Naturalist,* Vol. II, 1865, p. 441.

and ice only, and formed a gathering ground which sent out local glaciers in all directions, as seems more probable, is a question to be decided by future investigations. The southern or southwestern portions are intensely glaciated, especially in the Lake Superior and Lake of the Woods regions.[1] There seems no doubt that the glaciers there were large and probably became confluent.

General Conclusions.

Summing up the data thus far obtained, I conclude that the glaciation of Eastern Canada has been effected by local glaciers on the higher grounds, and drift-ice or ice-bergs on the lower coastal areas. In their movements, the glaciers, generally speaking, followed the slopes of the land, or the drainage channels. They seem to have had extensive gathering grounds upon the more elevated parts of the country where snow-fields and *nevé*-ice existed. Whenever motion began, these became converted into glacier-ice. Upon those areas where the snow never underwent change into ice no striation of the rocks is found. Some of the glaciers appear to have been quite large, and those from adjacent drainage areas may have coalesced on the lower grounds and become confluent. At all events, the slopes and coastal tracts are, generally speaking, more glaciated than the interior and higher grounds. Each area or centre of dispersion has, however, had its own glacier or glaciers. In Nova Scotia there was a shedding of the ice from the Cobequid Mountains northward and southward; and probably the elevation known as the South Mountain likewise sent glaciers down its slopes on either side. In New Brunswick, the low water-shed running across it from north-west to south-east, sent off glaciers in opposite directions, or north-eastwardly on the northern slope and south-eastwardly on the southern, these courses being deviated from in a greater or less degree, however, according as the ice was influenced by local topographic features. The Shickshock or Notre

[1] Dr. G. M. Dawson, Geology and Resources of the Forty-ninth Parallel. Annual Report Geol. Surv. of Canada, 1885, Vol. I, part CC.

Dame Range, in Quebec, and its continuation south-westwardly along the International boundary, likewise shed the ice in both directions at about right angles to the main axis of the chain, that is, nearly south-eastward and north-westward; while the Archæan Area north of the St. Lawrence and great lakes sent sheets of ice down its slopes in all directions around its circumference. On the east side of Hudson Bay, the ice moved directly westward into its basin according to Dr. R. Bell and Mr. A. P. Low.

Considerable areas of rock surface in the interior and more elevated portions of Eastern Canada, where gathering grounds for glaciers may be supposed to have existed, are without striæ or other evidence of glaciation, the decomposed rock lying undisturbed, except from subærial action, and boulder-clay being absent. Occasional smaller patches of similar character are met with near the coast. These during the ice age were probably covered by snow only, or by ice which had little or no motion.

The extent and thickness of the glaciers cannot as yet be satisfactorily determined from the data at hand. But it is evident some of them were quite large, and the larger ones appear to have been on the southern slopes of the Appalachians and Laurentides. The cause of this is not apparent, but as regards those of the former mountain range, it may be due, in some measure, to the difference in the steepness of the slopes on either side of it. The south-eastern slope is long, much broken, and has numerous comparatively level areas upon it. As the rate of motion would be slower on this slope, the ice would necessarily accumulate in larger sheets in the depressions and on level tracts. On the shorter and more abrupt slope of the St. Lawrence the motion of the glaciers would be more rapid, they would more readily *debouch* in the estuary or sea, and hence there would be less chance for accumulation in large sheets.

The evidences of the action of icebergs or floating ice observed by Sir William Dawson[1] and the writer[2] are chiefly in the St. Lawrence valley and on the Baie des Chaleurs coast. In the former the markings produced by these occur, so far as I have observed them, only on rock surfaces below the 350 to 375 contour line above sea level, while on the coast of the bay referred to they were not seen higher than 200 feet above its surface.

Icebergs or drift-ice played an important part in striating the ledges on these lower levels and in transporting boulders. On the isthmus of Chiegnecto the striation of some rock surfaces is attributable to them.[3]

The facts briefly outlined in the foregoing pages will doubtless receive large additions within a few years; and the inferences deduced therefrom may consequently undergo some modifications as the glacial phenomena of the region comes to be studied in detail. This remark has reference more especially to the glaciation of the great Laurention or Archæan Area. I venture to think, however, that the main conclusions herein advanced will stand.

NEWFOUNDLAND.

Newfoundland, although not forming part of Canada is geographically connected with it and a passing reference may here be made to its glacial phenomena. According to the late Alex. Murray, C.M.G., Director of the Geological Survey of that Colony, its surface every where shows marks of glacier-ice.[4] These are well described in the paper referred to below. Mr Murray held to the theory of a continental glacier, however, but his facts indicate that ice movements have been quite variable, following river valleys,

[1]Acadian Geology, 2nd and 3rd eds. Notes on the Post Pliocene Geology of Can., 1872, *Can. Naturalist*, etc.

[2]Annual Report Geol. Surv. of Can., 1886, Vol. II., part M. Transactions of the Royal Soc. of Canada, 1886, in a paper on *The Glaciation and Pleistocene subsidence of Northern New Brunswick and South-Eastern Quebec.*

[3]Annual report, Geol. Surv. of Can. 1885, Vol. I, part G.G.

[4]Glaciation of Newfoundland. Transactions of Royal Soc. of Canada, 1882.

depressions, etc., in several directions. It seems probable therefore, that here, as in Eastern Canada, local glaciers descending from the higher gathering grounds towards the coast, as pointed out by the late Capt. Kerr, R. N.[1] were the principal agents at work. But from its insular position, and lying as it does in the track of the Arctic currents, the coastal areas, at least, must have been subjected to intense erosion from icebergs and floating ice.

THE FOOD OF PLANTS.[2]

By D. P. PENHALLOW.

An old proverb informs us that one-half of the world continues in ignorance of how the other half lives. If we accept this in the broadest sense, as applying to all organic life, we have a present illustration of its correctness in the fact that, with few exceptions, man knows little or nothing of the vital processes upon which the growth of the members of the more humble vegetable kingdom depend; and he thus fails to grasp a knowledge of those important laws by which plants are enabled to afford him an abundance of sustenance and raiment. It is in relation to purposes of nutrition, that plants may be considered to bear the greatest importance to man, and in this respect, they are to be regarded from a two-fold point of view.

First, they convert the crude mineral constituents of the soil, which would otherwise be wholly unavailable, into forms which enable them to become of direct value for purposes of animal nutrition. They thus afford to man, his principal supply of food. But they also constitute the entire source of nourishment for those animals upon which man subsists, and through the medium of which they undergo further special modifications, by virtue of which

[1] Ibid, p. 68.

[2] Sommerville Lecture delivered March 28th, 1889.

they become yet more fully adapted to special requirements of the human system. Man is therefore dependent upon plants as the great preparers of his food, both directly and indirectly.

With a more thorough knowledge of animal nutrition, we have come to recognize more generally than in the past, that the quality of the food supply effects a pronounced and most important influence upon both the physical and mental condition, and this influence must be exerted both directly and indirectly by the vegetation upon which man feeds. We are therefore brought to yet another principle, that any improvement in the character of the food supply, must operate advantageously for man, in a corresponding systematic improvement.

But the great biological laws are not adapted with sole reference to particular forms of life—they admit of general application, and, as we learn from vegetable physiology, the character of the plant is subject to the influence of variable nutrition, in a manner quite parallel to that which we observe in animals. In this, therefore, we discover the possibility of a means of making plants more perfectly adapted to the highest physical wants of man, and any study which tends to promote this end, cannot fail to be of the greatest interest, bringing us, as it inevitably must, into closer relationships with those forms of life upon which we are so largely dependent for health, comfort, and enjoyment.

The subject we have chosen for discussion this evening, is one of considerable magnitude—embracing considerations of the greatest practical and scientific interest—and could readily be dealt with from several points of view. Perhaps many would consider that a mere statement of the articles which constitute plant food, together with the fact that the earth and air are the great sources of supply, would fully exhaust the subject, but an enlarged view discloses the fact that the sources of food supply; the preparation of food for the use of the plant; the general process of waste and repair; the selective power of plants in relation to food supply; the number, character and special functions of the elements appropriated; the relations of food supply and nutrition to conditions of health and disease; the relations of food supply to improved qualities of plants for purposes of human food; the special capacity of the plant for digestion, and its relation to the character of food used, are all so intimately connected with the subject as a whole and with each other, that no complete statement can be made without taking some account of all these considerations. Concerning some of them, we are forced to admit that as yet, but little real progress has been made in the direction of their correct elucidation, nor can we look for a final solution until such time as chemistry shall make us more fully acquainted with the composition of plants in various stages of development, and under widely different conditions of growth, and thus provide the key which shall unlock the door to those now mysterious physiological changes peculiar to nutrition.

In the process of nutrition, certain substances enter directly into the composition of various parts of the plant, to the formation of which they are absolutely essential. There can, therefore, be no doubt that they are food substances. Others, however, although taken into the plant, do not enter as an essential ingredient into the construction of parts. Nevertheless, it is found that their elimination from the food supply so disturbs the normal processes of growth, as to leave no doubt in our minds concerning their necessity in what are termed the metabolic processes, or the chemical changes incident to nutrition. It is therefore as proper to regard them as food substances as the former.

In order to determine what elements may be properly regarded as plant food, we first of all resort to chemical analysis, and in the second place to special methods of cultivation. When a plant is burned, or when it suffers the slower oxidation of decay—the final results being the same in each case—we find that by far the greater part of the original structure disappears in the form of aqueous vapor, carbon dioxide gas and volatile acids, while a very small proportion remains as an unoxidisable or incombustible residue—the ash.

The relative proportions of combustible and ash constituents, are subject to wide variations, not only as between different species, but even in the same species under different conditions of growth and of food supply, An illustration of this law may serve to make our statement more clear. In the Tenth Census Report of the United States for 1880, Prof. Sargent gives the ash percentages for somewhat more than four hundred species of woods. Selecting from these the extremes, we find the following:—

	Org. Mat	Ash.
Yucca elata	90.72	9.28
Pseudotsuga Douglassii	99.98	0.02

Again, between these and herbaceous plants, in which relatively less mineral matter is observed, the difference would be more striking, Another illustration of the law stated, is afforded by the results obtained by Arendt in his analysis of 1000 oat plants selected at different periods of growth, with intervals of about twelve days. His results were as follows:—

	June 18. 3 leaves open.	June 30. Heading.	July 10. Blossoming.	July 21. Ripening.	July 31. Ripe.
SO_3	1.06	2.71	2.68	4.83	5.34
P_2O_5	3.27	5.99	10.32	12.90	14.23
K_2O	17.05	31.11	40.20	44.33	43.76
CaO	4.48	8.50	11.60	14.94	14.71
MgO	1.53	2.71	3.71	5.42	6.45
Fe_2O_3	0.20	0.46	0.61	0.83	0.58
SiO_2	6.39	15.82	25.45	34.66	36.32
Na_2O	0.86	1.28	1.47	1.12	0.87
Cl	2.28	3.62	5 32	5.96	5.78
Total grammes	37.12	72.20	101.36	124.54	128.04
Gain for each period		35.08	29.16	23.18	3.50

If we now turn our attention more particularly to the elements of the first group, or those which disappear in the process of combustion, we find them to be carbon, hydrogen, sulphur, nitrogen, phosphorus, oxygen and chlorine. In the process of rapid combustion, the hydrogen is converted into water and passes off as aqueous vapor. The carbon becomes changed into carbon dioxide—a gas prejudicial to animal life—and disappears in part into the surrounding atmosphere, the remainder being fixed in the ash residue, where we also find the acids of sulphur, nitrogen and phosphorus combined with the mineral constituents to form the corresponding salts. In decay or slow combustion, the same changes are finally accomplished, with the additional formation of volatile sulphur and ammonia compounds. The loss or diminution in volume which a plant suffers in the process of combustion, will thus be seen to correspond, in general terms, to the elimination of the organic matter, which consists almost wholly of carbon, hydrogen and oxygen, with very small quantities of the other elements mentioned.

If we next inquire into the composition of the second or incombustible group, we find it to contain potassium, sodium, calcium, magnesium, iron and silicon. These elements, as already stated, are found in combination with the acids derived from combustion of the elements of the first group. In exceptional cases, manganese, bromine and iodine, as well as arsenicum, copper and other metals may be found in the ash, but for various reasons which need not be dealt with at the present time, they are usually not regarded as constituting elements of plant food. It thus appears that of the sixty-seven chemical elements known to science, only thirteen are to be regarded as of importance in the economy of the plant.

With these general facts before us, we are now prepared to inquire into the sources whence they are derived; and in this respect we may again divide them into two groups, those derived from—1st, the air, and 2nd, the soil.

To the first group belong only two elements, carbon and oxygen. These are presented to the plant and taken up in the form of carbon dioxide. Oxygen is also absorbed in the free state, but in this respect it is concerned in the process of respiration, and not of digestion, and therefore is not to be considered in the present connection.

Carbon dioxide is, as we know, a peculiar product of organic combustion, including respiration of both plants and animals, and when produced in excess, is as prejudicial to one form of life as to the other. Its elimination from the atmosphere in the process of vegetable growth, constitutes one of the most important relations in which plants stand towards the higher forms of animal life. During the Carboniferous age, when life was of a much lower type than now generally exists, plants attained to a luxuriance of growth with which but few modern plants can compare, and while this was the direct result of the peculiar conditions under which they were placed, it also adapted them to the more rapid elimination of carbon dioxide—thereby causing a return of oxygen to the air, and a fixation of the carbon, which, in course of time, became transformed into coal and graphite as we find them to-day. Thus the atmosphere became adapted to an improved type of animal life; the plants themselves, being brought under new conditions of environment, suffered important changes, and man is now enabled to convert to his own needs the transformed energy derived from the sunbeams of that remote past.

To the second group of elements, those derived from the soil, belong all the others that have been enumerated. It should be observed here, however, that oxygen is also derived from the soil, both as water and as acids in combination with the earthy elements.

The appropriation of food is provided for by means of specialized organs. The gaseous elements of the air are absorbed by the leaves, in which specialized openings or mouths, called stomata, are developed. Through these, the gases of the atmosphere penetrate the interior structure by a process of diffusion, and are there absorbed by the living cells. It is of interest to note, however, that the ability of plants to use the gases which have thus penetrated their structure, is dependent upon certain important conditions, viz:—1st, a favorable temperature, (2) the presence of the ordinary green coloring matter of plants—the chlorophyll—and (3) the direct influence of sunlight, or at least of its luminous rays. Neglecting further consideration of temperature which is essential to all functional activity, it should be pointed out that plants devoid of chlorophyll, such as mushrooms and other colorless plants, are incapable of obtaining carbon from the atmosphere. They are therefore forced to obtain their supply of this important element either from other plants upon which they feed as parasites, or from the organic products of decay, upon which they feed as saprophytes. Moreover, the power of green plants to appropriate carbon and liberate oxygen is arrested under conditions of darkness—as at night—when the mode of growth is precisely the same as in colorless plants.

The whole relation of light to the appropriation of carbon, is one of the most interesting with which the physiologist has to deal, but it would lead us too far from our present purpose were we to consider it more in detail, though it may be as well to point out that, if ordinary white light be replaced by such luminous rays, as the orange and yellow, this function is not impeded in any way; while on the other hand, the rays of higher refrangibility such as the blue, indigo and violet, arrest this function and thus bring ordinary green plants under abnormal conditions of growth, in which functional disturbance is the unavoidable result.

In this particular connection, it only remains for us to indicate what changes take place when carbon dioxide is taken up by the leaves. Under the influence of chlorophyll this gas suffers decomposition. The liberated oxygen returns to the atmosphere, while the carbon, uniting with the elements of water already present, becomes transformed into starch, sugar and oils,—substances which not only provide for the nutrition of growing parts, but, when formed in excess of the requirements of growth, supply a most important item of food for man.

Various observations have been made to determine the amount of carbon dioxide which plants are capable of appropriating. The results obtained by Boussingault are among the most instructive, from which we quote the following:—

	Area of leaf.	Decomp. of CO_2 per hour.
Cherry-laurel....	109 sq. c.m.	3.0 c.c.
Pine............	204 " "	1.1 "
Oak............	224 " "	1.6 "
Holly	52 " "	1.8 "
Mistletoe.......	100 " "	2.0 "
or for equal areas		
Cherry-laurel....	100 " "	2.750 "
Pine	100 " "	0.539 "
Oak	100 " "	0.714 "
Holly...........	100 " "	3.460 "
Mistletoe	100 " "	2.000 "

In this connection it should also be noted that the presence of carbon dioxide in the air, beyond a certain limit, causes it to exert a deleterious effect. This limit is of necessity variable, but observation has shown that in those plants which are most nearly allied to the coal plants, e.g., ferns, ten per cent. is fatal, while for the majority of plants, a much smaller quantity will produce the same result. The general process thus described, constitutes one of the leading features of the so-called digestive function, and as this takes place in the leaves (chiefly), they are usually designated the digestive organs.

All the elements enumerated, except carbon, enter the roots which are specially adapted to the purpose of taking up food in a liquid form, and may therefore be designated the special organs of absorption. The power of roots in this respect, is nevertheless extremely limited with reference to their total area, being confined to a narrow tract near the extreme tips, and is accomplished chiefly through the medium of root hairs.

The fluid thus absorbed by the roots, and containing various mineral substances in solution, now constitutes what is commonly designated the crude sap, inasmuch as the substances held by it are not in such chemical condition as will enable them to directly participate in the nutrition of growing parts. This sap, however, passes upward through the outer layers of the woody tissue or sapwood, until it reaches the leaves, where it is distributed among the ramifications of the veins to the active, chlorophyll-containing cells, in which it becomes involved in the process of digestion. In the course of this process it suffers increase of density, due in part to the fact that a large portion of water is liberated as aqueous vapor into the surrounding air, while another volume is used up in the various chemical changes, and the fluid, now distributed from the leaves to the various centres of active growth, is said to be digested and capable of directly promoting the formation of new structure.

Although plants in general may be said to be the special agents whereby the crude material of the soil and air is converted into that which is of direct value in animal nutrition, yet we find the law subject to certain important exceptions, since in their power of appropriating and converting food, they exhibit a wide difference.

We are all familiar with the fact that in the animal kingdom, certain forms live upon and draw their entire sustenance from other animals, in consequence of which they are termed parasites. Parasitism is also a common feature of plant life, and in each case the relations of supply and demand conform to the same general laws. The parasitic plant fastens itself upon its host and draws its nourishment from it. The latter is therefore forced to yield a portion of the food prepared for its own use, and in consequence of this unusual demand upon its resources, it sooner or later becomes diseased, exhibits malformations and may eventually be killed. Under these conditions of growth the parasite does not require to produce its own food; we therefore find that it has no roots, its leaves are imperfectly formed, and it may contain no chlorophyll. Just in proportion, therefore, as the digestive function of such plants is reduced, do they become incapable of fixing carbon and forming the ordinary carbohydrate products such as starch and sugar. Some of the most notable of parasites are to be found in the celebrated banyans of India, which often begin their growth in the tops of lofty trees, upon which they feed until killed.

We again find a very large class of plants feeding upon the products of organic decay. These contain no chlorophyll, have no proper roots and no leaves, or at most mere rudiments of such organs. Like the parasites, they cannot appropriate carbon, except in the form of organic compounds; their existence thus implies their dependence upon previous life. They do not liberate oxygen, but eliminate carbon dioxide as one of their characteristic products. Such plants are designated by botanists *saprophytes,* and are represented by the mold of stale bread and cheese, by the common mushroom and puff-ball, and also by the Indian pipe, one of our common wild flowers.

We thus find that any extended consideration of the subject with which we are now dealing, must recognise the special characteristics of plants in their relation to the appropriation of food, but as more detailed statement would lead us too far from our main purpose, we shall for the remainder of our discussion, confine ourselves to those plants in which the digestive function is fully developed, and with which we are more largely concerned as the producers of our food.

The special functions of the various elements appropriated by the plant, are not at all well understood, but the results of investigations so far made, indicate their value in a general way and show in what direction other inquiries should be made. For the purpose of determining how far each element present is essential to growth, we resort to special methods of culture, either in water or pure quartz sand, under such conditions that the number of elements and the exact quantity of each may be known and controlled.

From such a series of investigations we learn that potash is absolutely indispensable; that under certain circumstances, soda may be eliminated without injury; that iron is essential to the formation of chlorophyll; that calcium performs a function somewhat similar to that of the potash; that it may to some extent replace it, and that it is possibly connected with the formation of tissues; that chlorine, and in some cases, sulphuric acid, is essential to the proper transfer of the substances digested in the leaves, to the parts where required by growth; that magnesium is an element of uncertain value in the internal physiological processes, but that it has a definite value in the soil, where it aids in the distribution, and thus in the more complete appropriation of potash; that silica cannot be eliminated without materially affecting the strength of the plant, and that phosphorus bears an important relation to the various processes of ripening in the fruit.

Another very important lesson to be derived from such special cultures, especially when combined with chemical analysis, is the fact that plants exercise a selective power with reference to the food supply; that is to say, if a plant were grown in a solution containing exactly the same proportions of all the elements entering into its composition, it would be found not to absorb them all in the same quantity, but some would be used much more largely than others. This becomes more obvious if we inspect the composition of the ash of different plants, or even of the same plant under different conditions or at different stages of growth.

It thus appears that some plants are special potash feeders, others use more lime, yet others an excess of soda, and this fact constitutes the foundation on which the well known system of rotation of crops is based. This briefly stated, is as follows:—When plants are grown continuously upon the same piece of land for a number of years, those elements upon which that particular class most largely feeds, will be withdrawn in excess of the ability of the soil and the natural chemical processes there taking place, to restore them. The soil is therefore said to suffer special exhaustion, because it is deficient in one or two elements required for a particular crop, but contains an abundance of other elements required by other crops. If these latter are now planted, the soil, in course of time, suffers special exhaustion with reference to their requirements, while it regains its ability to produce the crop of the first kind. Thus, by a judicious system of rotation, land may be kept in a constant state of productiveness. It is only when food elements are so completely withdrawn that no one class of plants can be brought to perfection, that the soil is said to be generally exhausted. Therefore, when we speak of the fertility of a soil, or the exhausted condition of a soil, it must always be with direct reference to the particular requirements of the plants we wish to cultivate. And I cannot let this part of my subject pass without pointing out that a large part of the difficulty in successfully combating some of the most destructive diseases of the orchard and garden, arises from a failure to properly appreciate and apply the principles stated.

It is impossible to give more detailed consideration to these aspects of our subject in the brief space allotted to us, important though they are. There are, nevertheless, two features of this question to which I would particularly draw your attention, and from their very important bearing upon the economic side of horticulture, I feel that their somewhat detailed statement will not be out of place. I refer, in the first place, to the relation of nutrition to conditions of health and disease; and in the second place, to the relation of nutrition to improved qualities of fruits.

For many years, the Germans have been among the foremost investigators in efforts to determine the special functional value of the various food elements of plants. The method usually selected has been that of water culture already described, through the medium of which the effect of eliminating any given element, or of varying its proportion and particular chemical combination in the food supply, could be accurately ascertained. From a series of such experiments made as long ago as 1871, in which buckwheat was the particular plant employed, it was observed that in those plants from which potash was eliminated, there was a most marked deficiency in growth. This was traceable to the fact that in the absence of potash; the plant was incapable of fixing carbon, and therefore unable to produce the ordinary products of digestion, such as starch, sugar and oils, and hence was practically in a condition of starvation. In a second series of experiments, potash was supplied in the requisite quantity, but chlorine was eliminated from the food supply. A most curious result was found. While an abundance of starch was produced in the first instance, it was unable to reach those parts where growth was most active, and thus became accumulated in unusual quantity in the leaves and other green tissues where formed. A secondary effect of this was a change of color from green to yellow, whereby the further formation of starch was arrested, and the final result was a general arrest of growth. So that there was established the anomalous condition of a plant containing an excess of tissue-forming material, but unable to use it for want of a certain element in the food supply, which would effect a transfer of that material to the centres of active growth. Further observations confirmed the view that chlorine was the particular element needed for this purpose.

Acting upon the suggestions contained in these results, Dr. Goessmann, the foremost agricultural chemist in the United States, and Director of the Massachusetts Experiment Station, a few years since, in company with other investigators, undertook to apply these principles of nutrition to the treatment of certain diseases of plants, which, up to that time, had baffled all attempts at control, and which, in the seriousness of their operations, threatened to destroy some of the most important fruit interests of the country.

It was found, in the first place, that in the common and destructive disease known as Peach Yellows, there were conditions of growth in all essential respects the same as those artificially produced in buckwheat by elimination of chlorine. It was therefore assumed for the purposes of experiment, that this element was exhausted from the soil and that potash might also be supplied in insufficient quantity. A number of trees were therefore carefully pruned to remove as much as possible of the diseased structure, and muriate or chloride of potassium was supplied to the trees as a special food, together with other elements to make a complete fertilizer. It was now found that the new growth was of a totally different character, and, so far as could be determined from mere external inspection, perfectly healthy. But more than this, the fruit, instead of being utterly worthless, as before, now became of high quality, and the life of the tree was so far prolonged that, instead of dying at the end of nine years, as was usually the case, the identical trees thus restored to health are bearing first quality fruit to this day, or twenty years after their period of first treatment.

But this result alone, important as it is, does not fully answer the question from a scientific point of view, and we are therefore called upon to see what changes, if any, were effected in the chemical constitution of the ash, and also in the cellular structure and distribution of the digested products. With reference to the first, the results are most significant, and tend to indicate that the supply of potash bears a direct relation to the normal condition. Thus Goessmann found the ashes to be constituted as follows:

	Fruit.		Wood.	
	Diseased.	Healthy.	Diseased.	(Restored.) Healthy.
Fe_2O_3	0.46	0.58	1.45	0.52
CaO	4.68	2.64	64.23	54.52
MgO_2	5.49	6.29	10.28	7.58
P_2O_5	18.07	16.02	8.37	11.37
K_2O	71.30	74.46	15.67	26.01

From this it also appears that, with a deficiency of potash, lime increases, but does not replace it in functional value.

Referring now to the internal structure, we also find most important changes accomplished. In the diseased tree, the general structure of the bark becomes altered in a conspicuous manner, while in both bark and leaves, the accumulation of starch is most unusual. These features are so characteristic of the disease, and appear so early in its development, that a correct diagnosis may be made through the aid of the microscope, even before the external evidences of disease are pronounced. In the new wood formed after treatment, the bark presents all the features of normal structure, both with reference to tissue and distribution of starch.

We thus note certain important facts as the result of these experiments :

1st. That a specific disease is cured by a certain course of treatment.

2nd. That potash and chlorine are essential to restored functional activity.

3rd. The disease may be regarded as primarily due to deficiency of these elements in the food supply.

But we should also point out that for this disease, any salt of potash will not answer, *i.e.* the sulphate or the phosphate will not be equally efficacious with the muriate, but that does not permit us to infer that diseases of other plants may be similarly cured by the same salt of potash, for on the contrary, the same investigations have shown that for different plants, different salts of potash must be used, so that while in some cases the chloride is best, in others it is the sulphate or nitrate.

We have here, however, a definite fact established, namely, that the nutrition of the plant bears a most important relation to its normal condition, and while we do not wish to rashly assert that all diseases to which plants are subject may be cured in this way, yet we do feel confident that, when the bacteria craze has passed its fever heat, and the pulse of the investigator has once more returned to a normal rate, he will turn his attention more fully to the question of nutrition as affording a rational explanation of many of the vexed problems which now confront him.

Before taking final leave of this part of our subject, I will point the general principles indicated by one more fact. The ravages of the Phylloxera have for many years proved a most serious obstacle to the successful cultivation of the vine in many parts of Europe, and the French Government have at various times had their attention seriously drawn to the devastations of this insect; but the efforts thus far made, appear to have led to no very substantial results. In the course of investigations relative to the nutrition of the grape, Dr. Goessmann found that an abundant supply of food of an available form, served in a most marked degree to overcome the ravages of the Phylloxera. The results were of so striking a character as to attract the attention of the French Commissioner then inspecting the vineyards of the United States, and he freely expressed the opinion that, although the vines were fairly over-run with the pest, he had never seen more healthy looking foliage, better growth or finer looking fruit. The whole principle underlying this result is that, if we can feed the plant, and at the same time provide an abundance of food for the parasite in excess of what the plant needs for its own growth, the latter will be much less liable to suffer.

In conclusion, I would direct attention to one more of the many interesting aspects which this subject presents, and that is the relation of nutrition to improvements in plants, and more particularly of their fruits or seed bearing parts—those products of the vegetable world which are of the highest value to man as articles of diet.

We commonly speak of plants as cultivated and uncultivated or wild, and in doing so we make a broad distinction even between plants of exactly the same species. This distinction is that, under certain improved conditions of life, the plant has become so modified as to present peculiarities which it did not possess in the wild state, while it also has an increased capacity as a food producer. Such a change, under the ordinary conditions of cultivation, is in most cases a very slow process, but as an essential factor, we recognise the supply of food of better quality and in more available form—in general terms, improved conditions of nutrition. Science has repeatedly shown that an increase of sugar percentage in the beet, or of starch in the potato, is directly related to the supply of potash to the plant and the condition of availability in which that element is presented, and the question has therefore more than once been asked,—is it not possible by a judicious control of the food supply, to bring about, more quickly, those changes which are known to have taken place between the wild and cultivated plants, and in the latter to still farther improve their qualities? I think the results so far obtained justify us in answering this question in the affirmative, but before so doing, I must briefly refer to the relative value of nitrogenous and non-nitrogenous food substances in the two phases of growth through which all plants pass, namely, the purely vegetative, or that period during which mere extension of parts, as stem and leaves, takes place; and the reproductive, or that period in which the flowers are produced and the seed is formed for the growth of succeeding generations. The elaborate series of investigations conducted by the Germans for many years, as well as the very notable investigations of Lawes and Gilbert at Rothamstead, England, in which continuous observations have been made upon various field crops grown on the same land and under the same conditions since 1835—all these results establish the general law that those foods in which nitrogen is in relative excess, promote the mere extension of structure and tend to retard the reproductive function. While on the other hand, those foods in which the mineral substances are in relative excess, tend to retard vegetation, induce an earlier maturity, and thus hasten the formation of seed. Probably many of you have observed how a plant fed with ammonia makes a most vigorous growth of leaf and branch, and acquires a deeper and richer hue, and how also, trees are similarly influenced when located in exceptionally rich places. A notable illustration of this was brought to my notice a few years since. The ground in a small peach orchard was utilised as a kitchen garden, and for this purpose annually received a heavy dressing with nitrogenous manures. The effect upon the trees was most marked. The leaves were of an unusual size and depth of color, and the growth of each year was far in excess of any other trees. But, although twelve years old at the date of last observation, and thus nine years older than the age at which fruit should be formed, they had not produced a single peach, nor did there appear to be any likelihood of their doing so. In other words, under the special conditions of growth established, the fruit producing function had been wholly arrested, and the trees were therefore worthless. A remedy for this would be found in a reduction of the nitrogenous foods, and a greater supply of mineral foods. A still further application of this principle will probably permit us to bring fruits to maturity more perfectly than now, and also enable us to overcome the disastrous effects of early frost where trees tend to continue their growth too late in the season. These facts therefore suggest one important direction in which these laws of nutrition may be applied.

We will now turn our attention more particularly to a consideration of improved varieties and the relation of such improvement to the composition of the ash, and in doing so we shall make use of results obtained by the investigator already quoted. The fruit of the wild strawberry (*Fragaria vesca*) contains, according to the analysis of Richardson, 0.41 per cent. of ash. In this we find

Potash	22.06
Soda	29.79
Lime	14.88
Magnesia	traces
Iron	6.07
Phosphoric acid	14.47
Silica	12.62

this calculation being made after deducting sulphuric acid and chlorine, for reasons which need not be specified at the present time.

As determined by Goessmann, the fruit of the cultivated strawberry contains from 0.41—0.63 per cent. of ash, and this includes.

Potash	40.24
Soda	3.23
Lime	13.47
Magnesia	8.12
Iron	1.74
Phos. acid	18.50
Silica	5.66

A comparison of these figures shows that under the ordinary conditions of cultivation, the plant utilises much less silica, iron and soda, but makes greatly increased demands upon potash, magnesia, and phosphoric acid. In view of these facts, it can hardly be doubted that these elements are essential to a higher state of development, more especially as we observe that when the conditions of cultivation are reduced and the supply of these elements is diminished, the plant reverts to its original condition, both with reference to its general characteristics and the chemical constitution of its ash. These changes may be regarded as effected slowly, as in the ordinary transition from the wild to the cultivated forms. Let us now see how the special application of food will influence a similar result. An exhaustive statement of the results obtained by Goessmann cannot be made here, but the following are the essential facts.

Observations were made upon the Concord Grape as a cultivated variety, and upon the *Vitis labrusca* as the wild species from which the Concord originated. In each case certain plants were grown without special fertilisers, while others were treated with fertilisers of three separate combinations. With these latter we will not deal separately, as we desire now to discuss only the general results.

The ash of the Concord Grape was found to contain when unfertilised

	Sept. 13.
Potash	57.15
Soda	4.17
Lime	11.30
Magnesia	3.10
Iron	0.40
Phos. acid	12.47
Silica	11.83

In the ash of the fertilised grape there were

	Oct. 3.
Potash	64.65
Soda	1.42
Lime	9.13
Magnesia	3.63
Iron	0.50
Phos. acid	14.87
Silica,	5.80

But these changes in ash composition are found to be directly associated with an increase of sugar, a decrease of free acid and a general improvement in the quality of the berry.

Turning now to the wild grape, we find at the end of four years growth, that changes in the ash, were accomplished as indicated by a comparison with the ash constituents of the uncultivated wild grape :—

	Unfertilized.	Fertilized.
Potash	50.93	62.65
Soda	0.15	0.85
Lime	22.23	14.24
Magnesia	5.59	3.92
Iron	0.79	0.53
Phos. Acid	17.40	13.18
Silica	2.93	4.63

While the organic matter stood in the following relation:

Organic matter	16.31	19.55

and this striking increase was found to relate chiefly to an increased percentage of sugar and reduction of acid in the juice as follows :—

Sugar	8.22	13.510
Acid	9.84	1.149

Thus as the direct result of special feeding, the sugar percentage of the wild fruit is increased from eight to thirteen per cent., a quantity nearly as great as that found in the cultivated Concord Grape at the same season.

The significance of these results must be apparent to every intelligent cultivator, and to quote the words of the investigator above cited, "The ability to effect such decided changes in the composition of our fruits, cannot but be of the greatest importance to horticulturists in improving the the quality of the new cultivated varieties, and in producing new varieties of a desired quality. If we can change the composition of our fruits in one or two elements, by the application of the proper food, why cannot we change the proportion of any element? In the seed is stored np the element of the new plant, and the varied compositions may be accompanied by certain physiological changes which shall determine the character of the variety."

My object for presenting the facts to which I have called your attention this evening has been, not to bring forward any detailed exposition of scientific observations, but rather to draw your attention more prominently to the general principles underlying the laws of growth and nutrition, and to show that our modern horticulture has entered upon an entirely new phase, in which scientific observation is the basis; and he who wishes to reap the large benefits to be derived from the intelligent pursuit of horticulture in any one of its important branches, must recognize the necessity of securing for himself, as a necessary preliminary to his work, an accurate, though general scientific culture. If my object in this respect be gained, even in a remote degree, the law of compensation may be considered as having found its application.

Gypsum Deposits in Northern Manitoba.

By J. B. Tyrrell, B. A., F. G. S., *of the Geological and Natural History Survey of Canada.*

On the Little Saskatchewan River, which carries the overflow of Lake Manitoba into the western side of Lake Winnipeg, there is a comparatively small shallow lake which has been known since the time of the early voyageurs as Lake St. Martin. It lies in latitude, 51° 30′, longitude, 98° 40′, has an area of 115 square miles, a greatest depth of about fifteen feet, and an approximate elevation above the sea of 790 feet.

Lying to the north-west of this lake, there is an area of level or very gently sloping country, which is now covered by extensive natural meadows, separated by groves of poplar and birch, as well as occasional forests of spruce and tamarac. This country is as yet in its native beauty, being entirely untouched, either by the woodman's axe or the plough of the farmer; but the time cannot be far distant when a thriving agricultural population will occupy the district, reaping from the fertile soil bountiful and continuous harvests.

In the early part of the past summer, the writer made a short journey on foot into this country, from the shore of the lake, in order to determine the question of the existence or non-existence of beds of gypsum in the vicinity.

Starting from the north-west corner of the Indian Reserve at present held by the Saskatchewan Band of Saulteaux Indians, we travelled in a general north-westerly direction for five miles, till we reached a rounded gravel ridge, rising from fifteen to twenty feet above the general level of the country to the north-west of it, and along the foot of which, on the alluvial plain, are scattered numbers of rounded, weather-worn, gneissoid erratics. This ridge represents a beach of the extended Lake Winnipeg, called by Mr. Warren Upham Lake Agassiz, when it covered the whole of this area, and when the surrounding fertile alluvial deposits were being laid down near its gradually receding shore. The height of this ridge, as shown by aneroids read simultaneously on it and on the lake, is about 840 feet, being fifty feet above Lake St. Martin, and thirty feet above Lake Manitoba. Its chief interest, however, did not centre in the fact that it had once represented a lake-shore line, for these shore-lines are very commonly to be met with in all this apparently level Manitoba plain, but that in little holes and caves in it were to be seen small exposures of soft, compact, snow-white gypsum.

Following the ridge, still in a north-westerly direction, for a mile, the surface becomes very rugged and irregular, being broken by deep pits with steeply sloping sides. In this rough country, gypsum may be seen in numerous outcrops, being usually soft and crumbling from the effect of weathering, but in some cases it is still quite hard. The height of the tops of the knolls in this hilly area is about thirty-five feet above the eastern level plain, or sixty feet above Lake St. Martin. The breadth of the hilly country was not determined, but an Indian who accompanied us stated that it extended in a south-westerly direction, as far as a certain point on our journey of that day, which was about a mile and a half distant from where we were then standing, beyond which the level country began again.

In a north-westerly direction the ridge was followed for two miles further, to a rather conspicuous hill a short distance north of the Ninth Base Line in section 2, township 33, range 9, west of the Principal Meridian. In this distance it appeared to be broken through by considerable gaps in several places, but where it was well marked, it invariably showed the irregular surface so characteristic of country underlain by gypsum deposits. In many places, small caves would extend in from the bottoms or sides of the pits, some of which held beautifully clear, cold water, a luxury of which we were able to appreciate the value, after tramping for the greater part of a sweltering July day through meadows, forests and swamps, where the mosquitoes and black flies did not attempt to treat us any the more tenderly because we were strangers.

This country is a famous winter hunting-ground for the Indians, for in the autumn the bears retire to these caves, as being comfortable quarters in which to pass the time until the following spring, and many of them are killed every year. Around the mouths of several of the caves could be seen marks of the axe, where the hunter had been obliged to widen the entrances to the cave to be able to get into it to secure his prey. The thickness of the exposures of gypsum in these holes and caves was nowhere very great, ranging as a rule from three feet to six feet six inches, but in none of them was the total thickness of the deposit seen.

The hill at the furthest point to which the ridge was followed, rises as a rounded knob, twenty feet above its general level. This hill, like the others, appears to be composed of gypsum, as on its sides are holes extending down twenty feet below its top in which beds of gypsum are well exposed.

In the north-west corner of township 32, range 8, west of the Principal Meridian, is a rounded hill rising thirty-five feet above the plain, its greatest length being about 600 feet, and its greatest breadth 150 feet. Its surface is overgrown with small canoe-birch Two holes, each about eight feet deep, have been dug by prospectors in this hill. One at the top shows, below a foot of decomposed material, seven feet of hard, compact, white anhydrite or "bull plaster," exhibiting a more or less nodular structure, and breaking on the surface into small irregular fragments. Very little bedding can be detected in the mass. The other hole is in the side of the hill fifteen feet lower down, and shows on top two and a half feet of white clay, consisting of decomposed anhydrite, below which is five and a half feet of white nodular anhydrite similar to that in the other hole. This gives a thickness, almost certainly, of twenty-two feet of this rock, and it is not improbable that the hill is composed entirely of it.

Again, just north of the Ninth Base Line, and two miles east of the township corner, between ranges 8 and 9, is a poplar-covered hill or ridge, thirty feet high. In various places on this hill are exposures of snow-white gypsum, similar to what has been described above, showing in some cases a thickness of ten feet in one section. The most of it is massive or crypto-crystalline, and lies in regular beds which dip slightly towards the west. Some of the beds or layers, however, consist of beautifully crystalline, clear, colourless selenite, which is easily broken out in lamellar masses of considerable size. This is the mineral which in the west, has been so often mistaken for mica.

The above is a brief statement of the known extent of the deposits of gypsum in this district, but it is highly probable that further investigation will prove them to extend over a much larger area. The Indians of the

Saskatchewan Band, who live on the western shore of Lake St. Martin, informed me that similar rock was to be found in several places further north, and they have named a lake on a tributary of Warpath River, which flows into Lake Winnipeg north of the mouth of the Little Saskatchewan, Ka-ka-wusk Sa-ka-higan (translated in English as Mica Lake) from the alleged presence of selenite in its vicinity.

Towards the south-west, at a distance of ninety miles in a straight line, in the bore that was sunk on the bank of Vermilion River by the Manitoba Oil Company, a bed of gypsum fifteen feet in thickness was struck between 550 and 565 feet, at approximately the same geological horizon as that of the gypsum beds above described. Gypsum deposits are therefore in all probability very widely distributed throughout Northern Manitoba.

As far as examined they preserve a pretty constant character. Where they immediately underlie the surface the country is very rough and hilly, and the prevailing poplar of the region is mixed with birch, or the spruce of the adjoining low-lying land is replaced by Banksian pine. The gypsum itself is generally very pure, of a dead white colour, and usually stratified in rather thin beds, which are either horizontal or dipping at a low angle. Among the massive beds, however, are many others, composed of crystals or crystal-masses, in which the crystals usually stand transverse to the plains of bedding. Some plates could doubtless be obtained from the crystal-masses sufficiently clear for optical purposes. No anhydrite was seen mixed with the gypsum, but one of the hills, as above stated, appeared to be composed entirely of it. It is much harder and tougher than the gypsum or hydrated sulphate of lime, is considerably heavier, has a roughly nodular, rather than a distinctly stratified structure, and is of a decidedly bluish tint.

Of the exact geological age of the deposit it is difficult to speak as yet with certainty, as the strata have not been continuously traced into any others, and no beds immediately under or overlying them have been seen. There is little doubt, however, that they occupy either the summit of the Silurian or the base of the Devonian limestones. All the evidence that we have on the point has not as yet been perfectly elaborated, but it consists in the general horizontality of the beds wherever seen throughout the whole area, and in the existence of limestones holding fossils on Lake Manitoba, twelve miles distant in a south-westerly direction, and of limestones holding fossils on Lake St. Martin, eleven miles distant in a south-easterly direction. Also reference might be made to the above-mentioned bore on Vermilion River, where the gypsum was at the base of a bed of Devonian limestone one hundred and thirty feet in thickness. Thus these deposits are practically of about the age of the Onondaga Formation of New York and Western Ontario, in which rocks plaster-quarries have been worked for many years. This Formation also contains the great salt deposits of Ontario, and it is a significant fact, that a short distance to the west of the area under consideration, around the shores of lakes Manitoba and Winnipegosis, many brine springs are known to occur. In the State of Michigan, many of the plaster-quarries are also in rocks of about the same age. In Nova Scotia, the gypsum deposits are of lower Carboniferous age, and in Iowa they are stated to belong to a still higher horizon.

The general hilly and irregular character of the surface underlain by the plaster beds, and the fact that isolated hills of gypsum rise above the surface of the otherwise level plain, make it appear probable that the deposits occur as lenticular masses in the beds of limestone which seem to compose the general floor of this whole area, though in most places the limestone is covered either by a mass of glacial till, or by the alluvial deposits laid down on the bottom of the ancient Lake Agassiz. The gypsum also resembles the limestone in being clearly stratified horizontally or at a very low angle. Besides this, some of the limestone of Northern Manitoba contains a large amount of sulphur scattered throughout its mass in the form of very minute grains of iron pyrites. The iron pyrites readily oxidises into a sulphate or double sulphate of iron which combining with the carbonate of lime give as products of the double decomposition, sulphate of lime or gypsum, and carbonate or possibly sulphate of iron. In the Cretaceous shales of the Duck and Riding Mountains and of the Plains further west, this process is clearly seen to have gone on. Iron pyrites is constantly present, and the shells of Inocerami, Ammonites, Baculites, &c., furnish an abundant supply of carbonate of lime. This shale is therefore often filled with minute, or sometimes even large crystals of gypsum, and side by side with them are masses of ironstone or impure carbonate of iron, which, after being formed in the above-described way, has collected in rounded or lenticular nodules about a shell, fragment of a crayfish, or other nucleus. In the case of the Paleozoic limestones, however, no trace is found of the carbonate or other salt of iron which would have resulted from the double decomposition, and if it was ever formed in the rock, it has since been dissolved away by water percolating through the strata.

The gypsum may, however, have been formed in a different way. The whole of this country has undoubtedly suffered very considerable erosion since Cretaceous times, the shales and marls of the Duck and Riding Mountains having almost certainly extended much further east than Lake St. Martin. Many of the springs that now flow from these shales are strongly impregnated with sulphuretted hydrogen, which might readily be oxidized into sulphuric acid. This acid acting slowly on the beds of limestone would alter them into sulphate of lime without disturbing the stratification at all.

Of the uses of gypsum it is unnecessary to speak. In the Western States, where the air is dry and atmospheric erosion is very small, it is used as a building stone, being very easily worked, and sufficiently durable and strong for residences and all ordinary buildings.

By roasting, its water of crystallization is driven off and it is reduced to the fine powder commonly known as Plaster of Paris. By grinding the crude gypsum as it comes from the quarries between ordinary burr-stones, land-plaster is obtained, a substance of which it is difficult to over-estimate the value in a country whose resources are almost entirely agricultural. The soil of Manitoba and the North-West Territories is very fertile now, but a time will come when having raised crop after crop it will need replenishing. The value of this extensive gypsum deposit will then be thoroughly realised. Lying as it does within twelve miles of Lake Manitoba, a navigable stretch of open water extending southward almost to the Manitoba and North-Western Railway, it can readily be brought to all parts of the province. It is also on the line of the projected railway from Winnipeg, between Lakes Winnipeg and Manitoba, to Hudson's Bay, and by this railway would be within one hundred and fifty miles from Winnipeg, and as the intervening country is very level, the cost of carrying it there would not be great.

Notes on Shepherdia Canadensis.

By D. P. Penhallow.

During the past summer I received from a correspondent —Dr. M. S. Wade, of British Columbia—some specimens of plants for identification. Among the number was *Shepherdia Canadensis*, the berries of which are used somewhat extensively as an article of food, and as they possess properties which do not appear to be generally recognized in published accounts of the plant, it seems desirable to make some statements of the facts brought to my notice. Dr. Wade writes as follows :—

" The *Shepherdia Canadensis* is called *Le Bron* and also *Sopolallie.* The latter name is the Chinook word for it, sop meaning *soap*, and olallie *berry.* Thus it is termed the Soap-berry, from its property, when triturated, to form a mass of stiff foam or lather. The Indian name for it is *Squazsham.* The natives dry it on hay or straw, and thus preserve it for making the soap in the winter months. Several of the white residents, myself included, like the peculiar product from this berry. We preserve it with sugar as other fruits."

On referring to various publications, I find but brief and unsatisfactory statements with reference to the properties and uses above indicated.

Macoun[1] refers to it as known locally as "Soopoolalie," and on the authority of Mr. James Fletcher, states that the Indians make a cooling drink from the berries.

In answer to inquiries, Mr. Fletcher has kindly forwarded a letter from one of his correspondents, Mr. J. D. Tolmie, of Clovendale, B. C., who writes as follows :—

"The Soapoolalie is not used as a drink that I know of. The berries are beaten with a little water in a basin until they froth up like the whites of eggs, and when the basin is quite full, the preparation is eaten with long sticks for spoons. These sticks are shaped something like an oar, are very light and highly polished. When the contents of the basin get low, they are again and again beaten until all the guests are satisfied. I believe the H. B. Co. people called this preparation *La brue* (?), why I know not. When it is sweetened, it resembles in taste and appearance rose or pink cream, and is not unpleasant to take. I have often, in my younger days, partaken of it, and one has the sensation of being quite bloated or puffed out after eating even a small quantity. A strange thing about this dish is that if the smallest particle of cream, grease or fat gets into it, the foam, froth or fluff goes down and will not come up again, leaving only the seeds and a small quantity of reddish water in the basin."

Gray[2] simply refers to the fruit as being yellowish-red and insipid. Bessey[3] speaks of the plant as frequently

[1] Cat. Can. Plants, 421.

[2] Manual, p. 425.

[3] Text Book of Botany, p. 492.

cultivated for its acid fruit. Provancher[1] says the jelly made from its fruit is often preferred to that made from the gooseberry.

("On fabrique avec leurs fruits des gelées que plusieurs préfèrent à celles des groseilles.")

We are indebted to Dr. Wade for a specimen of the jam made from these berries. His directions for the preparation of the soap from it are as follows :—

"Place the jam in a bowl and add an equal quantity of cold water. Take an egg-beater and very *slowly* agitate it for two or three minutes, and then beat more quickly. It will speedily froth up and become quite thick. When so stiff that it will keep its shape pretty well, add a table-spoonful of sugar, and then resume beating with the egg-beater, and continue until the substance is quite thick and firm. At first the preparation may not be liked, but the taste grows on one. Two things must be carefully seen to, to ensure success: first, every article used must be quite free from even a suspicion of grease, and second, the beating must be very slowly done at first."

"The fruit is preserved either by drying in cakes or by boiling, like jam, when the seeds are sometimes removed. I have always seen it beaten up with the hand."

We find that the fresh jam is in appearance, about the color of currant jam, and possesses a somewhat astringent and well-pronounced bitter taste, the latter being rather persistent. Following the directions given above, we found five minutes ample time in which to convert the jam into a cream of the color of strawberries and of about the same texture and firmness as the whipped white of eggs. The most conspicuous feature of the cream is its pronounced bitter taste, which persists for some time. There is, however, a secondary flavor of an agreeable nature and very similar to that of the high bush cranberry. As one becomes accustomed to its use, the bitter taste is rather lost sight of, and the more agreeable flavor becomes more conspicuous.

[1] Flore Canadienne, p. 505.

Nevertheless, we should hardly care to use the jam in large quantity, unless all other material failed.

The dried berries also sent by Dr. Wade, were found to be very sticky and formed a compact mass. They closely resemble dried currants, though much more sticky. The mass contained leaves of the same plant and small fragments of straw; otherwise the material was very clean. To the taste, the berries are sweetish and acid like a currant,—the bitter taste being again most pronounced.

As we have been unable to find an analysis of these berries, we have, through the kind assistance of Dr. Harrington, made determinations of the bitter principle or saponin with the following result:—

Water in air dried berries at 100° C = 23·46 p. c.
Saponin in berries dried at 100° C = 0·74 p. c.

Both the bitter quality and saponification depend upon the saponin, which, though present in rather small quantity, is still ample to give an abundant froth, as copious saponification will occur with only 0.10 p. c.[1]

The *Shepherdia Canadensis* is very widely distributed through Canada from New Brunswick to British Columbia, although it is nowhere locally abundant. Its congener the Buffalo-berry (*Shepherdia argentea*), possesses similar properties, but is much more restricted in its distribution, occurring only in the Northwest, where its centre of distribution is found in the valley of the South Saskatchewan, extending thence along the tributary and adjacent streams.

[1] Wittstein. Org. Constit. of Plants, p. 201.

Forestry for Canada.[1]

By H. G. Joly de Lotbinière.

The forest does not only supply the invaluable commodities of fuel and lumber, it exercises a great influence on the climate, and on agriculture. If science has not yet admitted that the presence of forests increases the rainfall (by condensation of vapour held in the atmosphere, owing to the lower temperature of the forest land, or by other means), it is universally admitted that the forest regulates, throughout the year, the distribution of water in our streams, contributes to retain the moisture favourable to vegetation, retards evaporation and checks the effects of drying winds.

Unfortunately, it is only after the forest is gone, that its value is truly appreciated, as in the South of France, Spain, Italy, Greece, and many other countries, once fertile, now barren and unproductive. The two great extremes, long drought and disastrous inundations, are due to the same cause, viz: the wholesale destruction of the forests, especially on the mountains, the birthplace of the streams. The soil of many a fertile valley is now hidden under a thick bed of sand, gravel and boulders (as we often see in Switzerland) brought down by torrents from the mountain slopes, where the trees which once retained the ground with their roots, have been destroyed. The rain, instead of soaking gradually through the moss, vegetable mould and roots, and feeding, by degrees, the springs and streams, as it did, while the forest lived, rushes down to the valleys below, as it falls, as from the sides of a roof, in irresistible torrents, carrying with it the ground that nothing now retains on the steep mountain side.

It is most interesting to follow the work of re-afforesting carried on, principally in France, on the Landes for nearly a century, and on the barren mountain slopes, and to notice their beneficial results. The efforts of the "Ligue du

[1] Sommerville lecture, delivered March 7th, 1889.

Reboisement de l'Algerie" to repair the harm done in Algeria, by the burning of the forests on the slopes of the Atlas, deserve the warm sympathy of all those who can appreciate perseverance and devotion to the public good.

But the subject before us to-day, is "Forestry for Canada." It is difficult to awaken any interest in the question among us. We are apt to consider Forestry as a superfluity, here, as if our forests were inexhaustible. They would be so (saving accidents by fire) with judicious management and sufficient protection. The aim of Forestry is not, as many believe, to preserve trees for ever, or until they decay and fall. Quite the reverse; it is to select and cut down every tree ripe for the axe, making room for the young growth, and thereby insuring a continued reproduction and a steady revenue. As it is, we are not only spending our revenue, we are drawing largely every year, upon our capital.

The pride of the Canadian forest, the white pine, is getting very scarce; the proportion of first.class wood is decreasing year by year, while the distance from which it is brought is increasing. How many mill owners, who would have scorned sawing spruce logs a few years ago, are only too glad to get them now, and though spruce reproduces itself much more readily than pine, we can foresee the time when it will get very scarce, at the present rate of cutting.

The late James Little, of Montreal, who was the first to sound the alarm, deserves to be gratefully remembered by Canada. When every one treated our pine as if the supply were inexhaustible, he was the first to call attention to its rapid disappearance. His warnings were met, not only with indifference, but with ridicule. Now, the eyes of the most sceptical are opened, and they must admit that he was right; but it is sad to see them turn round now and affirm that it is no use devising means for the protection of our forests, because there is nothing left in them worth protecting. There is still a great deal left worth caring for and improving. It is late, but not too late.

The great American forester, F. B. Hough, in his Report to Congress, draws attention to the fact that: "although "the system of management of the Canadian forests is crude "in its provisions, and destitute of any policy tending to "secure the growth of new forests, *it has one redeeming "feature,* as the title to the land itself remains vested in "the Government, and, after the expiration of the first "temporary leases, under which the native timber is cut, "it will be available for any course of management that "experience may suggest. This last consideration prepares "the way for any system of Forestry that the wants and "resources of the country may, in future, demand, and, "even without a system, the natural growth of a new forest, "where the old one has been cut away, especially where "the spruce timber prevailed, is, in many places, bringing "forward a supply for future use, although much less effec-"tually than under proper care would be obtained."

Mr. Hough was right to assume that the forests of Canada belong to the Crown, as the proportion in private hands is comparatively insignificant. The Government holds them in trust for the people and is answerable for their good management.

It is a good sign to find in the Dominion Statute Book, 47 Vict., cap. 25, sect. 5, proof that the importance of preserving the forests on the Rocky Mountains is well understood. The Governor-General-in-Council is empowered to make provisions "for the preservation of forest trees on the "crests and slopes of the Rocky Mountains, and for the "proper maintenance, throughout the year, of the *volume "of water* in the rivers and streams which have their "sources in such mountains."

In the absence of a regular system of Forestry, there are practical means of protecting our public forests which I will now review as briefly as possible.

First, and most important.—A careful *classification* of Public Lands, under two heads : Lands fit for agriculture, which alone ought to be opened to settlement—lands unfit for agriculture, which ought to be carefully closed against settlement and kept in forest. The best timber lands, especially the pineries, are generally totally unfit for agriculture, it is a cruelty to decoy settlers there. How many hard working men have wasted the best part of their lives in trying to get a living out of such poor soil, and are tied down to it, for want of means to move away with their families; the only result of their work being the ruin of a fine forest and their own ruin. The Quebec Legislature had enacted a wise law in 1883, the Timber Reserve Act, which, I regret to see, is on the point of being repealed. As to the relations between the settler and the lumberman, where there is good faith on both sides, those relations ought to be of the most friendly nature.

SECONDLY.—The Government ought not to force, every year, thousands of square miles of timber limits on the market in advance of the legitimate requirements of the trade, and with the unavoidable result of glutting the European market. The Province is interested in the successful carrying on of the timber trade, as it provides the whole of the raw material which keeps the trade going and ought to get returns for the value of that raw material, proportionate to the earnings of the trade. It will not come amiss here, to quote John Stuart Mill's opinion of the status of our timber trade, from his Principles of Political Economy: "The timber trade of Canada is one example of "an employment of capital, partaking so much of the "nature of a lottery, as to make it an accredited opinion "that, taking the adventurers in the aggregate, there is "more money lost by the trade than gained by it, in other "words, that the average rate of profits is less than nothing." Even supposing the timber trade firmer now than when John Stuart Mill wrote, the Government is not justifiable in encouraging over production, as it does, and it would appear wiser, not only for the sake of the forest, but for that of the Exchequer, if the Government kept the limits not actually required for the reasonable wants of the trade, so that the Province might hereafter benefit by the unavoidable rise in the price of those limits.

THIRDLY.—Strict regulations as to the *minimum size* of logs allowed to be cut, and encouragement to convert trees into saw logs, instead of square timber, which wastes one-third of the tree in the squaring.

FOURTHLY.—Protection against fire which destroys more trees than the axe, precautions in lighting fires in the woods and in clearing lands by fire, for settlement; this last subject is closely connected with the question of the *classification* of lands and the keeping of settlers from lands unfit for agriculture. Fires are more to be apprehended in pineries and among resinous trees, where the soil is very often unfit for agriculture, than among hardwood trees where the quality of the soil is much better as a rule. Our Provincial Legislature is now considering a good measure calling on the lessees of timber limits to contribute one-half of the costs of protecting their limits against fires, the Province paying the other half. It is, I think, the law in Ontario.

FIFTHLY.—Export duty on saw logs, a most important question. Sir John Macdonald was asked, a few weeks ago, by an influential deputation of lumbermen to repeal the export duty on round logs. He reminded them that in 1886 that export duty had actually been increased at their own request, and told them that the Government would consider before all, the good of the country at large.

We are striving to increase the numbers of our people; we deplore the large emigration from Canada to the United States. Shall we encourage that emigration, by sending away the logs which feed our saw-mills, so that they may get sawn by our neighbours? The sawyer will follow the logs, and we shall drive away thousands of industrious men who will follow the raw material in which they find their work. True, we are offered by the United States free entry for our sawn lumber (or rather there is a talk of its being offered) if we repeal our export duty on logs. On the other side, we are threatened with an addition to the present import duty on sawn lumber, equal to the amount of our export duty on logs, if we persist in retaining it.

Very likely that threat will not be carried out; but whatever happens, unless we give up forever all consideration for the welfare of our own country, we must retain our export duty on logs, thereby protecting our forests and securing work for our own people.

CREATION OF NEW FORESTS.

It is difficult to compress within the narrow limits of one lecture all the branches of Forestry. After considering the preservation of existing forests, we cannot ignore the necessity for creating new ones, on the prairies of the North-West and our old settlements, denuded of trees, in the East.

As for the North-West, what we want, first of all, is *practical experience.* Many theories have been propounded to explain the absence of trees on the prairies, and Mr. A. T. Drummond, of Montreal, a zealous worker in the cause of Forestry, has written some very interesting essays, on that subject.

No use dwelling on the benefits to accrue from the planting of trees on the North-West prairies. Let the Government make a beginning, by starting experimental Forestry stations, nurseries and plantations of trees, under the care of the Mounted Police, at every one of their permanent headquarters. It will be an example to the settlers; the young trees raised from seed, at a nominal cost in the nurseries, can be given to them. The work will not interfere with the duties of the Mounted Police, and it will interest and improve the men, in every way. *Practical experience* will soon indicate what trees to select, where and how to sow and plant.

I would recommend the *Ash-leaved Maple*, (*Acer negundo*) to start with. The rapidity of its growth, its resistance to the drought, the value of its sap for sugar, which has been scientifically demonstrated by Doctor B. J. Harrington, in a series of experiments, the results of which have been communicated by him to the Royal Society of Canada, in a most interesting paper; all these recommend its culture as a starting point. With that tree, plant cotton-wood, poplar, willow, every kind of fast-growing tree, however inferior in quality, so as to start wind screens, behind which slower growing but more valuable trees can be cultivated, and fields of grain sheltered from the baneful effects of the drying winds.

If, in the absence of any serious attempts at forest tree culture in the North-West, we are still puzzled how to proceed there, here, in the East, we know beforehand that we are bound to succeed, with proper judgment and care. We know that every soil here, whatever its nature, can grow some kind or other of tree, and that, in many instances, the intrinsic value of the tree is quite out of proportion with the value of the soil: pines on sandy soil; sugar maples on rocky hill sides; ash, on cold, wet soil; tamarac and cedar in swamps; white birch on the worst soil and under most unfavourable climate, and, of course, oak, elm, butternut, black birch, &c., &c., in good soil.

It appears logical to choose the most valuable of trees for a new plantation, when the nature of the soil admits of it, though we often see valueless willows and poplars planted on the best soil and even in gardens. I have tried the black walnut, which sells for a dollar a cubic foot, in Quebec—nearly the price of mahogany. Trees raised from the nut have given me nuts after twelve years growth, but, as my experiments do not extend over fourteen years, however satisfactory to myself, I cannot yet assert that the success is complete. Certainly it is very encouraging, and, I hope, will lead others to try the experiment, which is not an expensive one.

It is impossible to enter into the details of tree planting now, but there are two points which ought not to be overlooked: in our climate, experience shows that it is better to plant trees in the Spring, especially if the soil is in the slightest degree wet or even retentive of humidity, and, secondly, it is useless to attempt tree culture *without good fences*, as cattle will destroy all the young trees. In fact, there are thousands of spots where the cultivation of the soil has been given up, which, in a few years, would be covered with a growth of self sown trees, if the cattle were only kept out by fences.

The results of Forestry are so far removed, and, at the same time, of such national importance, as to make it incumbent on the Government to encourage it by every means: experimental stations, especially in the North-West, in charge of the Mounted Police and the Indian Agents and teachers, nurseries of forest trees and gratuitous distribution of the same, rewards in land grants or exemption from taxation, encouraging the observance of Arbor Day, a School of Forestry, or, until that point can be reached, sending some well qualified young men to study Forestry in the French and German schools, and last, but not least, educating the people, beginning with the children.

Teach, in all the schools, the elements of tree culture, joining practice with theory, whenever possible. No better way to develop in the child the qualities necessary to his success as a man. He will learn forethought, in choosing the proper season, the soil, the tree; care and patience, in digging up and transplanting that tree; perseverance in watching over it, watering it, supporting it, pruning it, cultivating the ground round it; unselfishness, in feeling that he works not only for himself, but that others will enjoy the fruits of his labour.

Supplementary Note to "Classification of Cambrian Rocks in Acadia."

By G. F. Matthew.

In the diagram at page 315, showing the relation of the several Cambrian faunas of the Atlantic and of the Pacific slope of America, the word *Ctenopyge* has been printed in error for *Ceratopyge.* Ctenopyge in Europe is an integral part of the Peltura fauna, and we have no reason to suppose that the vertical distribution of these trilobites differs on this side of the Atlantic from that in Europe.

A vertical line intended to divide three faunas of the Atlantic basin from two of the Pacific side of the American continent, has been omitted, and the brace which takes its place is misleading. The Olenellus-Bathyuriscus fauna should also be connected with No. 2, Middle Cambrian, rather than with No. 1, Lower Cambrian.

Other changes that should be made in the article are the following:—

Page 310, line 24, omit *System.*

In the table on page 313, as well as in the text on the same page, for *Agnostus intercinctus* read *Agnostus interstrictus.*

Page 314, line 8, after list, insert (*Bathyuriscus* and *Asaphiscus.*

Page 314, line 24, after great, insert vertical.

In the first article of this series (see Vol. III., No. 1, this journal), certain worm-tracks and casts are referred to as being plentiful in the Basal or Etcheminian series. But far more abundant and generally distributed than these are the remains of sponges. The gleaming reflections from their skeletons are common on the surfaces of the finer shales, and their spiculæ are very generally distributed in coarse deposits as well as fine.

Sponges are found in the first beds above the lowest conglomerate, a horizon which is about sixty feet from the base of the terrein, and about fifteen hundred feet below the Paradoxides beds. At various horizons in the Basal series have been found different kinds of sponges: some of the basket-sponge group; others of the ordinary silicious kinds. The latter present several varieties of form, some are tubular, others branching with a solid axis, and others again are amorphous with numerous orifices (cloaca) of irregular form.

Even the sandstones are replete with the debris of sponges, both silicious granules and fragments of the sponge cuticle and of spiculæ are plentiful among the sand grains, of which these beds are composed. So we may see that sponges have played an important part in the building up of sedimentary deposits at the very dawn of Palæozoic Time.

On Archæocyathus, Billings, and on other Genera allied thereto, or associated therewith from the Cambrian Strata of North America, Spain, Sardinia and Scotland.

By Dr G. J. Hinde, F.G.S.

(*Abstract.*)

A revision of the type specimens of the three species included by Mr. Billings in the genus *Archæocyathus* shows that each of the species represents a distinct genus. *Archæocyathus profundus*, having been selected by Mr. Billings in 1865 as the typical species, was retained as such, and the characters of the genus, as shown in this species were defined; *Arch. atlanticus*, Bill., was made the type of a new genus, *Spirocyathus;* and the third species, *Arch. minganensis*, which proves to be a siliceous sponge, was included in a new genus, *Archæoscyphia.*

Including the genera allied to *Archæocyathus*, described by Meek and Bornemann, the following constitute the family Archæocyathinæ, proposed by this last-named author; *Archæocyathus*, Bill.; *Ethmophyllum*, Meek; *Coscinocyathus*, Born.; *Anthomorpha*, Born.; *Protopharetra*, Born.; and *Spirocyathus*, g.n.

The genera of this family are characterized for the most part by turbinate or subcylindrical forms with stout walls enclosing an interior tubular or cup-shaded cavity. Their skeletons are carbonate of lime in a minutely granular condition. The walls in the first four of the above-named genera consist of an outer and inner lamina connected by vertical and radial septa; dissepiments are generally present between the septa; save in the genus *Anthomorpha*, the outer lamina of the wall is regularly and minutely perforate, and the inner lamina and septa are likewise cribriform; *Ethmophyllum* is particularly distinguished by oblique canals connecting the interspaces of the wall with the central cavity, *Coscinocyathus* by transverse, perforate tabulæ, and *Anthomorpha* by the apparently imperforate character of the surface-laminæ and septa. *Protopharetra* and *Spirocyathus*

are either non-septate, or very obscurely septate; their skeleton consists of anastomosing laminæ and fibres; in the latter genus the laminæ are remarkably thickened by successive secondary deposits of calcareous material.

The Archæocyathinæ are regarded as a special family of the *Zoantharia sclerodermata,* in some features allied to the group of perforate corals. The family is restricted, so far as is known at present, to the lowest fossiliferous zone of the Cambrian strata, that characterized by the genus *Olenellus,* Hall, and it occurs at Anse-au-loup, Labrador; Troy, New York State; Nevada; in the Sierra Morena, Spain, and in the south-west of the Island of Sardinia.

The genus *Archæoscyphia,* based on *Archæocyathus minganensis,* Bill., is shown to be a lithistid sponge, and *Nipterella,* g.n., based on *Calathium* (?) *paradoxicum,* Bill., belongs likewise to the same group of sponges. The genera *Calathium,* Bill., and *Trichospongia,* Bill., are also undoubted siliceous sponges. These various sponges, which were either included in *Archæocyathus* by Mr. Billings, or regarded as allied thereto, have no relation whatever to the genus, or to any member of the family in which it is included. They come from a higher geological horizon, the Calciferous formation of the Canadian geologists, which is probably the summit of the Cambrian. They occur in the Mingan Islands and in Newfoundland. *Archæoscyphia* and *Calathium* are present in the Durness limestones.—(*Proc. Geol. Soc., Lond., Dec. 9th,* 1888.)

Proceedings of the Natural History Society, Montreal.

The first monthly meeting of the Session was held on the evening of October 29th, 1888, at 20 o'clock

Attendance: 21 members.

On motion of Prof. Penhallow, seconded by J. S. Brown, Prof. Mills took the Chair in the absence of the President.

The Minutes of the April monthly meeting were read and approved, also those of the Council meetings held since that date.

Moved by J. S. Brown, seconded by S. Finley, that Mr. Brown's motion, *re* collection of fees as recommended by Council, be adopted. Carried.

The following donations were reported:—"Milk Snake," from Mr. James Ferrier; and the "Geological History of Plants," from Sir Wm. Dawson.

On motion of E. T. CHAMBERS, seconded by Prof. Penhallow, the thanks of the Society were tendered to the donors.

Members proposed:—Edgar Judge, Prof. H. T. Bovey, Chas. Patton, E. L. Bond, Dr. Stirling, as ordinary members; and Master H. J. M. Smith and Miss Annie Louise Smith as associate members.

On motion of Prof. Penhallow, seconded by R. W. McLachlan, the Rules were suspended and the above named ballotted for and elected.

A letter of resignation, from Mr. F. L. Wanklyn, was read and the resignation accepted.

Prof. Penhallow read a Paper entitled "Notes on Ringed Trees," by Prof. W. L. Goodwin, of Kingston, to which he added some very interesting and instructive remarks, which he also explained by diagrams.

The Paper was fully discussed by Prof. Mills, Dr. Wanless and other members.

In the absence of Mr. F. Adams, Prof. Penhallow read extracts from his Paper "On some Canadian Rocks containing Scapolite, and a few Notes on some Rocks associated with the Apatite deposits."

The thanks of the Society were tendered to Prof. Penhallow and the contributors of the above Papers.

(Signed,) J. W. DAWSON, Pres.

The second monthly meeting was held on the evening of November 26th, 1888, at 20 o'clock.

Present:—Sir Wm. Dawson (in the Chair), Prof. Penhallow, J. S. Shearer, J. A. U. Beaudry, Rev. J. G. Baylis, Dr. Harrington, R. W. McLachlan, Prof. Mills, J. H. R. Molson, P. S. Ross, and a number of visitors.

In the absence of the Secretary, Mr. J. S. Brown acted.

The Minutes of the last meeting were read and confirmed. The Minutes of last Council meeting were also read.

It was moved by Mr. Shearer, seconded by Mr. Beaudry, that a Conversazione be held in January, and that a special meeting of Council be called for Monday, 3rd December, for the purpose of organizing a Committee to carry out the same.

Sir Wm. Dawson presented for the Library a copy of his pamphlet, "Notes on Specimens of Eozoon Canadense," and Mr. Shearer presented a very fine specimen of Star Fish, *Astrophyton Agassizii*, for the Museum.

A vote of thanks was tendered to the donors.

The following names were proposed for membership:—Dr. Lovejoy, Alexander Henderson, Horace T. Martin.

On motion of Mr. Beaudry, seconded by Prof. Penhallow, the by-laws and ballot were suspended, and the above named gentlemen were elected by acclamation.

Rev. Prof. Kavanagh then read a very interesting Paper on "Modern Concretions from Boucherville," &c., illustrating his subject by specimens gathered from localities referred to.

The subject provoked considerable discussion by members present. A warm vote of thanks was tendered the author, with the request that he would again favour the Society on some future occasion.

Sir Wm. Dawson then addressed the Society, first upon "Pleistocene Fossils from River Beaudette," and afterwards upon "Recent and Fossil Species of Mya." The speaker was listened to with marked interest, and a general discussion followed these subjects.

At the close of his remarks, Sir William presented to the Museum, on behalf of Messrs. H. G. Stanton and A. W. McGoun, the specimens of *Balanus Hameri*, with which he had illustrated the first of his subjects, remarking that the thanks of the Society were due to these gentlemen for having brought to its notice an extremely interesting subject.

A formal and cordial vote of thanks was passed to the donors.

Mr. J. S. Shearer occupied the Chair while the President addressed the meeting.

Meeting adjourned.

(Signed,) J. W. DAWSON, Pres.

MONTREAL, 17th Dec., 1888.

The third monthly meeting was held on the evening of December 17th, 1888, at 20 o'clock.

Present:—Sir Wm. Dawson in the chair.

Minutes of last meeting were read and approved. The Minutes of the Council meeting were also read.

Mr. J. S. Brown reported the proceedings of the Conversazione Committee.

The Honorary Corresponding Secretary reported new exchanges received.

Mr. E. T. Chambers read his Paper, "Notes on Lake St. John District," giving a very interesting account of this region, and also exhibited specimens collected by him. He referred particularly to the natural history and geological formations of the country.

The President made some remarks on a fine specimen collected by Mr. Chambers at Lake St. John, which seemed to be a new species of Cryptozoon.

A cordial vote of thanks was tendered to Mr. Chambers for his interesting Paper.

Dr. Harrington was requested to ask Mr. Low to read a Paper before the Society on his trip to Lake Mistassini.

The President also made some remarks on a Paper on "The Classification of the Cambrian Rocks in Acadia," by G. F. Matthew, referring to new discoveries in the Lower

Cambrian of New Brunswick. The Paper was taken as read, as it will appear in the next number of the *Record of Science.*

In the absence of Mr. H. M. Ami, his paper on the "Flora of Montebello" was read by Prof. Penhallow. It referred to the collection made there by him on the "Field Day" of the Society in June last. One hundred and seventy-nine species in all were found in the vicinity, of which 163 were obtained in the Manor Grounds. The Paper called forth an interesting discussion on the laws of distribution of plants, and the relation of soil composition and geological formation to distribution and disease.

As the above Paper is to be published in the *Record of Science*, the Chairman of the Editing Committee was requested to send copies to Mr. Ami and the Hon. Mr. Papineau. A hearty vote of thanks was tendered to Mr. Ami and Mr. Matthew.

The fourth monthly meeting of the Society was held on the evening of January 28th, at 20 o'clock, Sir Wm. Dawson in the Chair.

The Minutes of last meeting were read and approved. The Minutes of Council meeting of 21st inst. were also read.

Dr. Harrington reported that all arrangements for the Sommerville Course of Lectures had been made, and that the first would be given on the 21st of February.

The Hon. Curator announced the following donations:—*Tamais striata*, Albino variety, from W. H. Rintoul. Specimens of Lepidoptera, Coleoptera. &c., from P. M. Dawson.

The following gentlemen were proposed: James Coristine, Wm. Euard, E. A. Small, J. H. Jones, E. F. Carter as ordinary members, and E. H. Carter as associate member, by J. S. Brown, seconded by J. S. Shearer.

Mr. Shearer proposed, seconded by Mr. Brown, the following as ordinary members:—J. C. Holden, S. Wentworth Hill, Wm. Minto, W. A. Stephenson, C. S. J. Phillips, Wm. Notman, Geo. Phelps.

Moved by Mr. Brown, seconded by P. S. Ross, that the rules be suspended and the above named be balloted for. Carried.

Mr. J. S. Brown reported favourably on the progress of the Conversazione Committee, stating that an invitation had been sent to the Governor-General and Lady Stanley.

The Hon. Librarian reported the donation of a Paper on "The Eozoic and Palæozoic Rocks of the Atlantic Coast of Canada," by Sir Wm. Dawson.

The thanks of the Society were tendered to the above donor.

Prof. T. Wesley Mills gave a very interesting address on "The Influence of the Nervous System on Cell Life."

Prof. Penhallow read "Some Notes on the Fruit of the *Sheperdia Canadensis*, which is largely used in the North-West as an Article of Food."

The President read a letter from Mr. E. Cuthbert, of Berthier, describing a remarkable land-slip which occurred in December on the River Bayonne.

A hearty vote of thanks was tendered the above gentlemen.

Mr. P. S. Ross showed some specimens of Limonite collected at Hopewell, N.S.

(Signed,) J. H. Joseph.

(Signed,) A. H. Holden,
Rec.-Sec.

The fifth monthly meeting was held on the evening of February 25th, 1889, at 20 o'clock.

In the absence of the President, Mr. J. H. Joseph was elected Chairman.

The Minutes of the last monthly meeting were read and approved, also the Minutes of Council meeting of 18th Feb.

The Hon. Curator reported the following donations: From Mr. Romeo Stephens, stone-gouges, &c., and from Mr. Van Horne a mounted Cariboo.

On motion of Prof. Penhallow, seconded by Dr. Harrington, the thanks of the Society were tendered these gentlemen.

The following were proposed for membership:—Leslie D. Skelton, T. E. Vasey, Percy M. Dawson, E. D. Lacey, W. A. Dyer, James Morgan, Jr., Hugh Paton, George Knowlton, Jas. Y. Gilmour, H. M. Belcher.

On motion of Mr. Brown, seconded by Mr. Sumner, the rules were suspended and the above gentlemen were duly elected.

Dr. Harrington gave a very interesting address on Coals from the North-West, illustrating his remarks by samples from a number of mines.

A vote of thanks was moved by Mr. J. S. Brown, seconded by Prof. Mills. Carried.

In the absence of Sir Wm. Dawson, Prof. Penhallow read a note by the President (Sir Wm. Dawson), on a new Devonian plant, *Dictyocordaites Lacoi*, which had been discovered by Mr. R. D. Lacoe, of Pittston, Pennsylvania, and appeared to be intermediate in characters between the ancient Gymnospermous genera known as Cordaites and Noeggerathia. A photograph of the plant was exhibited. It will be described more at length in a future number.

Prof. Penhallow also read "Supplementary Notes to Paper on Cambrian," by Mr. G. F. Matthew.

On motion of Mr. Sumner, seconded by Mr. Chambers, a vote of thanks was tendered to Sir Wm. Dawson and Mr. Matthew for these papers, and to Prof. Penhallow for his interesting remarks on the same.

Moved by Prof. T. Wesley Mills, seconded by Prof. D. P. Penhallow, that a special vote of thanks of the Society be tendered to Mr. Matthew for the above paper and for former contributions.

Meeting adjourned.

(Signed,) J. W. Dawson, Pres.

The sixth monthly meeting of the Society was held on the evening of March 25th, 1889, at 20 o'clock. Sir William Dawson in the chair.

The minutes of last meeting, as well as the minutes of Council meeting held on 18th March, were read and approved.

Mr. J. S. Brown reported that owing to the absence of the gentleman who had made the offer to subscribe $1000 on behalf of a Zoological Garden, he was unable to give any further information on the subject.

The Treasurer of the Conversazione Committee made an informal report that all accounts had been paid, leaving a cash balance of $100.79. Report adopted.

Moved by J. S. Brown, seconded by J. S. Shearer, that the thanks of the Society be tendered to the different contributors of exhibits to the Conversazione. Carried.

Mr. John Murphy was proposed for membership, and the rules being suspended, he was elected by acclamation.

Prof. T. Wesley Mills gave a very interesting "exhibition and explanation of specimens, bearing on reproduction in birds."

Dr. Harrington, in the absence of Mr. J. B. Tyrrell, and Mr. Robert Chalmers, read the following papers, "Gypsum deposits of Northern Manitoba" by the former, and "The Glaciation of Eastern Canada" by the latter. The latter paper went to show that the views laid down by Sir Wm. Dawson thirty years ago, had received ample confirmation by new discoveries.

The President made some very interesting remarks on the above papers, and the thanks of the Society were tendered to the contributors.

Mr. F. B. Caulfield announced that his paper for next meeting would be "On some birds observed at Montreal."

MISCELLANEOUS.

SPERRYLITE, A NEW CANADIAN MINERAL.—This remarkable mineral has recently been described by Professors Wells and Penfield, of the Sheffield Scientific School, New Haven, who received it from Mr. Francis L. Sperry, of Sudbury, Ontario, Chemist to the Canadian Copper Company. The mineral occurs at the Vermilion mine, Algoma, twenty-two miles west of Sudbury, and is associated with chalcopyrite, pyrrhotine, minute grains of cassiterite, &c. It consists of minute, brilliant grains and crystals from $\frac{1}{500}$ to $\frac{1}{50}$ inch in diameter, of nearly tin-white colour, and specific gravity 10.602. The following analysis by Prof. Wells show that it is an Arsenide of Platinum and that its composition may be represented by the formula $PtAs_2$:—

	I.	II.	Mean.
As....................	40.91	41.05	40.98
Sb....................	0.42	0.59	0.50
Pt....................	52.53	52.60	52.57
Rh....................	0.75	0.68	0.72
Pd....................	trace	trace	trace
Fe....................	0.08	0.07	0.07
SnO_2....................	4.69	4.54	4.62
	99.38	99.53	99.46

The mineral decrepitates slightly when heated. In the closed tube it remains unchanged at the fusing point of glass. In the open tube it gives very readily a sublimate of arsenic trioxide and does not fuse if slowly roasted, but if rapidly heated it melts very easily after losing a part of the arsenic. According to the investigations of Professor Penfield, the crystals of Sperrylite show the combination of cube, octahedron, pyritohedron and very rarely dodecahedron. The hardness of the mineral is between 6 and 7.

The above details are taken from the papers of Professors Wells and Penfield in the American Journal of Science for January, 1889.

B. J. H.

ABSTRACT FOR THE MONTH OF JANUARY, 1889.

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

DAY.	THERMOMETER.				BAROMETER.				† Mean pressure of vapour.	‡ 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	28.83	31.0	26.7	4 3	29.8358	29.885	29.771	.114	.1302	82.0	24.2	S.W.	18.6	10.0	10	10	00	....	0.2	0.02	1
2	24 78	30.7	18.4	12.3	29.9133	30.046	29.791	.255	.1148	83.7	20.7	S.	10.2	10.0	10	10	00	....	0.9	0.09	2
3	17.98	24.1	15.0	9.1	29.9955	30.063	29.937	.126	.0933	95.0	16.7	S.	9 7	7.0	10	0	21	0.02	Inapp.	0 02	3
4	26.20	·0.7	18.4	12.3	30.1632	30.262	30.059	.203	.1245	87.5	23.0	W.	8.3	10.0	10	10	00	....	....	....	4
5	27.13	30 0(?)	25.0(?)	5.0	30.3025	30.372	30.211	.161	.1275	86.3	23.5	N.	20.7	7.3	10	1	12	....	....	....	5
SUNDAY........ 6	.....	30.1	21.7	8.4	....	......	......	....	....	....	....	N.	14.3	....	..	..	00	0.15	....	0.15	6 ....SUNDAY
7	31.32	33.1	29 7	3.4	29.5900	29.684	29.534	.150	.1640	93.5	29.7	N.	13.1	10.0	10	10	00	0 46	3.3	0.78	7
8	31.62	34.0	29.7	4.3	29.8435	29.946	29.659	.287	.1605	91.5	29.0	S.W.	17.9	6.8	10	0	53	....	0 3	0.03	8
9	32.68	39 5	28.7	10.8	29.4490	29.810	29.064	.746	.1702	91.2	30.7	S.E.	16.7	10.0	10	2	00	0.99	Inapp.	0.99	9
10	29 73	34.5	22.0	12.5	29.3807	29.790	29.115	.675	.1488	88.5	27.0	S.W.	37.7	8.0	10	0	00	....	1.6	0.16	10
11	23.98	27.0	20.8	6.2	29.9467	30 038	29.853	.185	.1057	82.0	19.3	W.	23.2	7.8	10	0	00	....	0.2	0.02	11
12	19.17	23.3	16 0	7.3	30 2653	30.364	30.113	.251	.0730	70.3	11.2	W.	21.1	2.2	10	0	66	....	....	....	12
SUNDAY........13	.....	19.0	10.8	8.2	... .	......	......	....	....	....	....	W.	4.8	....	.	..	51	....	....	...	13 ....SUNDAY
14	11.92	16.7	7.0	9.7	30 4423	30.481	30.408	.073	.0625	84.2	8.0	S.W.	8.3	2.7	10	0	50	....	Inapp.	0.00	14
15	17.18	22.2	9.6	12.6	30.3902	30.447	30.322	.125	.0775	81.2	12.3	S.W.	20.6	4.7	10	0	88	. ..	.. .	....	15
16	25 80	37.0	18 0	19.0	30.0513	30.293	29.678	.615	.1182	82.8	21.3	S.E.	13.5	9.5	10	7	00	....	....	0.01	16
17	38.68	44.0	34.6	9 4	29 4798	29.627	29 347	.280	.1935	80.7	33.0	S.W.	32.7	8.7	10	2	51	0.01	....	0.22	17
18	29.53	35.2	20.3	14.9	29 8403	30.040	29 688	.352	.1212	73.7	22.2	S.W.	24.6	10.0	10	10	13	0.22	Inapp.	0.00	18
19	3.13	21.0	-2.4	23 4	30 5333	30.685	30.253	.432	.0337	66.3	-5.8	W.	17.8	2.0	10	0	95	..	0 2	0.02	19
SUNDAY........20	....	12.0	-3.0	15.0	.... ..	......	......	...	....	....	....	N.E.	15.0	...	.		54	....	2.0	0.13	20 ....SUNDAY
21	13.45	17.9	9.4	8 5	29.6650	29 836	29.493	.343	.0718	89.7	10.8	N.E.	19.0	10.0	10	10	00	....	18.3	0.92	21
22	9.98	15.1	4.0	11.1	30.2880	30.471	30.024	.447	.0503	73.5	3.2	W.	26 0	1.2	7	0	100	....	Inapp.	0.00	22
23	8.83	15 5	4.8	10.7	30.4482	30 513	30.353	.160	.0545	84.3	4.8	S.	14.9	1.5	6	0	67	....	....	..	23
24	26.85	36.3	7.6	28 7	30.1128	30.268	29.991	.277	.1273	85.2	22.7	S.	22.7	7.8	10	0	00	0 03	0.2	0.05	24
25	31.05	37.0	25.8	11.2	30.0572	30.130	29.988	.142	.1302	74.8	24.0	S W	26 0	4.2	9	0	60	. ..	....	....	25
26	23.35	32.1	14.8	17.3	30.0185	30.046	29.995	.051	.1042	82.3	18.8	N.W.	23 3	8.3	10	0	00	....	...	...	26
SUNDAY........27	. .	16 0	11.1	4.9	....	......	... .	....	....	....	....	N.E.	27.1	....	..	..	00	....	4.1	0.41	27 ....SUNDAY
28	16 72	20.7	12.7	8.0	29.2380	29.326	29.120	.206	.0793	86.0	13.2	N.W.	17.3	10.0	10	10	00	....	5.0	0.36	28
29	11.17	17.1	6.0	11.1	29.5748	29 858	29.347	.511	.0567	77.2	5.3	W.	21.8	1.8	10	0	67	....	1.8	0.13	29
30	0.13	6.5	-4.3	10.8	30.1172	30.252	29 943	.309	.0275	64.2	-10.0	N.	10.6	0.3	1	0	96	....	....	....	30
31	11.97	33.3	-6.5	39.8	29 8685	30.171	29.613	.558	.0805	90.2	9.3	N.E.	17.2	10.0	10	10	00	....	2.4	0.16	31
............Means	21.23	26.54	14.59	11.94	29.9560	......	......	.298	.1038	82.5	16.6	......	18.5	6.73	.		30.5	1.88	40.5	4.67	Sums ....
15 yrs. means for & including this mo.	11.59	20.20	3.34	16.85	30.0610	......	......	.339	.0717	80.7	....	....	....	6.34	..	..	¶33.5	0.79	30.3	3 64	15 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...........	1839	1801	239	527	1219	4913	2941	318	
Duration in hrs..	106	104	14	40	62	207	154	23	34
Mean velocity...	17.3	17.3	17.1	13.2	19.7	23.7	19.1	13.8	

Greatest mileage in one hour was 52 on the 10th
Greatest velocity in gusts 60 miles per hour on the 10th.

Resultant mileage, 5063
Resultant direction, S 70° W.
Total mileage, 13,797.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ Eight years only.

The greatest heat was 44.0 on the 17th; the greatest cold -6.5 on the 31st, giving a range of temperature of 40.5 degrees. Warmest day was the 17th. Coldest day was the 30th. Highest barometer reading was 30.708 on the 20th; lowest barometer was 29.064 on the 9th, giving a range of 1.644 inches. Maximum relative humidity was 100 on the 3rd and 31st. Minimum relative humidity was 48 on the 30th.

The mean temperature is the highest for January in 15 years, except that for 1880, which was 22.45 degrees. The average minimum is 5 degrees in excess of the highest, and the average range of temperature is the least for January in 15 years.

Rain fell on 7 days.

Snow fell on 19 days.

Rain or snow fell on 22 days.

Hoar frost on two days.

Lunar halo on the 15th and 16th.

Fog on six days.

Solar halo on the 27th.

ABSTRACT FOR THE MONTH OF FEBRUARY, 1889.

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 vapour.	‡ 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	9.35	30.5	-1.1	31 6	29.8675	29.995	29.618	.377	.0598	79.2	4.0	W.	32.5	4.5	10	0	82	....	....	....	1
2	6.55	16.9	-4.6	21.5	29.7192	29.964	29.561	.403	.0498	82.5	2.2	N.W.	19.8	5.5	10	0	33	....	0.4	0.02	2
SUNDAY. 3	......	11.5	-10.4	21.9	....	......	......	....	....	....	....	N.	10.8	....		..	63	....	0.1	0.01	3 ....SUNDAY
4	-9 33	0.4	-22.6	23.0	29.9747	30.057	29.877	.180	.0250	89.2	-12.0	...	10.7	8.2	10	4	27	....	....	....	4
5	13.40	22 1	0.4	21.7	29.5753	29 768	29.439	.329	.0757	89.7	10.7	N.E.	17 7	10.0	10	10	00	....	11.2	1.06	5
6	-0 12	23.0	-8.0	31 0	29.5065	29.539	29.488	.051	.0418	86.2	-3.7	S.W.	45 1	9.7	10	8	00	....	4 8	0.48	6
7	-0.78	4.4	-7.9	12.3	29.7347	29.963	29 570	.393	.0327	79.0	-6.5	W.	33.3	6.7	10	0	00	....	1.3	0.13	7
8	11.55	19.1	2.0	17.1	29.9952	30.037	29.948	.089	.0642	83.5	6.7	S.W.	14.0	6.8	10	0	19	....	1.2	0.12	8
9	16 03	19 9	8.4	11.5	9437	29.982	29.893	.089	.0822	91.0	14.0	N.	7.7	10.0	10	10	00	....	0.6	0.05	9
SUNDAY.. 10	.....	17.8	10.9	6.9	....	......	.....	....	....	....	....	S.W.	10.3	...	..		86	....	0.2	0.02	10 ....SUNDAY
11	21.65	20 5	13.0	13.5	29.8540	29.993	29.719	.274	.0957	81.2	16.7	S.E.	14.0	8.8	10	3	51	....	0.1	0.01	11
12	18.87	25.5	9.0	16.5	29.6560	29.683	29.613	.070	.0822	76.8	13.0	S.W.	13.6	8.5	10	1	28	....	5.0	0.40	12
13	4.53	10.0	2 0	8 0	29.5505	29.601	29.507	.094	.0450	84.5	0.8	S.W.	34.5	9.2	10	5	00	....	1.6	0.16	13
14	9.03	16 6	2.0	14 6	29 8760	30.117	29.666	.451	.0497	75.3	2.7	W.	30.2	8.0	10	0	45	....	....	....	14
15	11.45	17.3	4 7	12.6	30.3523	30 424	30.227	.197	.0550	75.7	4.8	S.W.	13.5	0.0	0	0	100	....	....	...	15
16	15.38	33.6	2 2	31.4	30.1633	30 422	29.810	.612	.0817	83.5	11.3	S.E.	14.8	5.3	10	0	53	0.12	....	0.12	16
SUNDAY.......17	.....	39.5	32.7	6.8	....	......	......	...	....	....	....	S.W.	22.1 ?	....	.	..	00	0.18	....	0.18	17 ....SUNDAY
18	23.77	33 7	20 7	13.0	29.6227	29 903	29.222	.683	.1070	83.8	19.5	N.E.	20.1	10.0	10	10	00	....	3.3	0.33	18
19	15.40	28.0	11.6	16.4	29.6877	30.033	29.261	.772	.0715	81.3	10.8	W.	30.9	6 7	10	1	55	....	0.6	0.06	19
20	10.23	16.5(?)	3 5	13.0	30.3162	30.426	30.172	.254	.0517	74.0	3.5	W.	19.5	0 5	1	0	79	....	Inapp.	0.00	20
21	15.63	23.0	7.0	16.0	30.4488	30.556	30.229	.327	.0643	71.5	8.3	S W.	19.1	4.8	10	0	75	....	....	....	21
22	15.75	34.0	-7.4	41.4	30.0848	30.329	29.903	.426	.0792	76.3	9.7	S.W.	24.9	8.7	10	2	00	....	1.4	0.14	22
23	-10.73	-6.8	-16 9	10 1	30.4585	30.614	30.399	.215	.0202	78.5	-16.0	W.	21.9	1.7	9	0	93	....	....	...	23
SUNDAY.... ...24	. ...	6.6	-13.0	19 6	......	......	......	....	....	....	....	S.W.	17.1	...	..	..	98	....	.. .	....	24 ....SUNDAY
25	6.57	11.0	0 8	10.2	30.7022	30.807	30.605	.202	.0385	67.2	-2.8	S.W.	11.7	2.7	10	0	87	....	....	....	25
26	5.60	13.1	-7.0	20.1	30.7842	30.885	30.663	.222	.0422	75.0	-1.0	E.	8.2	4.8	10	0	83	....	....	....	26
27	16 73	24.1	5.9	18 2	30.5728	30 636	30.525	.111	.0882	91.0	14.5	E.	7.7	10.0	10	10	00	....	0.4	0.04	27
28	27.68	33.7	23.3	10 4	30.4378	30.581	30.525	056	.1283	85.3	23.7	.....	4.5	3 8	10	0	65	....	....	...	28
....Means	10.59	19.70	2.19	17.51	30.0410	......	.....	.287	.0638	80.9	5.62	......	....	6.45	.		43.6	0.30	32.2	3 33	Sums ....
15 yrs. means for & including this mo.	15.24	23.79	6.62	17.17	30.0430	......	......	.318	.0807	78.4	....	....	....	5.81	..	..	¶41.3	0.76	22.3	2.98	15 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..	360	1046	200	725	975	4679	3551	1190	
Duration in hrs..	40	71	24	53	63	216	158	43	4
Mean velocity...	9.0	14 7	8.3	13.7	15.5	21.7	22.5	27.7	

Greatest mileage in one hour was 56 on the 6th.
Greatest velocity in gusts 56 miles per hour on the 6th.
Resultant mileage, 6,875.

Resultant direction, S 65° W.
Total mileage, 12,726.
*Barometer readings reduced to sea-level and temperature of 32° Fahr.

§ Observed.
† Pressure of vapour in inches of mercury.
‡ Humidity relative, saturation being 100.
¶ Eight years only.

The greatest heat was 39.5 on the 17th; the greatest cold was 22.6 below zero on the 4th, giving a range of temperature of 62.1 degrees. Warmest day was the 17th. Coldest day was the 23rd. Highest barometer reading was 30.885 on the 26th; lowest barometer was 29.222 on the 18th, giving a range of 1.663 inches. Maximum relative humidity was 100 on the two days. Minimum relative humidity was 51 on the 3rd.

Rain fell on 2 days.
Snow fell on 16 days.

Rain or snow fell on 18 days.
Auroras were observed on two nights.
Hoar frost on two days.
Lunar halo on two nights.
Lunar corona on one night.
Fog on four days.
Solar halo on one day.
Small portion of a contact arc. was visible on the 21st.

ABSTRACT FOR THE MONTH OF MARCH, 1889.

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 vapour.	‡ 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	28.75	34.0	22.5	11.5	30.4200	30.503	30.315	.188	.1358	86.2	25.0	S.W.	12.6	0.0	0	0	94	....	....	....	1
2	28.32	34.5	16.9	17.6	30.2053	30.295	30.122	.173	.1342	85.8	24.5	S.E.	3.4	9.2	10	5	00	....	....	.	2
SUNDAY. 3	......	39.6	26.9	12.7	....	......	......	....	....	....	....	S.W.	1.1	....	..	..	90	....	....	....	3 ....SUNDAY
4	32.10	38.9	21.3	17.6	29.8930	30.000	29.779	.221	.1418	78.8	26.0	E.	4.2	2.0	10	0	85	....	....	....	4
5	35.45	38.9	31.7	7.2	29.6623	29.749	29.540	.209	.1623	78.3	29.2	N.	2.8	10.0	10	10	00	Inapp.	....	....	5
6	34.93	38.5	32.7	5.8	29.2978	29.451	29.107	.344	.1800	88.8	31.7	N.W.	12.2	10.0	10	10	00	0.20	3.3	0.53	6
7	30.90	35.9	25.0	10.9	29.0348	29.122	28.982	.140	.1667	96.2	29.8	W.	21.7	10.0	10	10	00	0.14	5.4	0.68	7
8	22.17	25.8	19.9	5.9	29.2843	29.327	29.220	.107	.1052	88.3	19.2	W.	38.1	10.0	10	10	00	....	1.6	0 16	8
9	20.78	22.8	17.9	4.9	29.4317	29.578	29.291	.287	.0953	86.0	17.2	W.	36.2	10.0	10	10	00	....	0.1	0 01	9
SUNDAY........10	.....	25.0	18.3	6.7	......	......	......	....	....	....	....	W.	27.0	....	..		00	....	0.3	0.03	10 ....SUNDAY
11	21.93	27.0	16.8	10.2	29.9402	29.960	29.907	.053	.0803	68.2	13.5	W.	18.8	5.3	10	0	56	....	0.4	0.00	11
12	26.80	32.9	17.9	15.0	29.9125	29.959	29.874	.085	.1227	83.7	22.7	S.W.	12.7	9.3	10	0	00	....	0.3	0.03	12
13	31.58	41.3	22.8	18.5	29.8095	30.023	29.612	.411	.1230	68.0	22.0	S.W.	28.7	8.0	10	0	24	Inapp.	Inapp.	0.00	13
14	16.92	24.5	11.5	13.0	30.3260	30.383	30.200	.183	.0552	58.7	5.0	W.	14.5	2.2	10	0	99	....	.. .	....	14
15	25.70	32.3	17.8	14.5	30.1990	30.295	30.121	.174	.1035	73.3	18.5	N.E.	11.1	4.7	10	0	75	....	....	....	15
16	30.43	39.0	20.8	18.2	30.0972	30.137	30.066	.071	.1245	74.7	23.0	N.E.	18.4	2.5	8	0	94	....	....	....	16
SUNDAY........17	.....	37.2	27.6	9.6	....	......	......	....	....	...	....	N.E.	25.3	....	..	..	08	0.08	0.9	0.17	17 ....SUNDAY
18	32.45	35.6	30.7	4.9	29.9307	29.957	29.908	.049	.1592	86.7	29.0	N.E.	13.4	10.0	10	10	13	Inapp.	1.9	0.19	18
19	33.58	37.3	29.8	7.5	29.9093	29.946	29.875	.071	.1518	79.5	27.5	N.	5.5	10.0	10	10	06	....	....	...	19
20	34.27	39.3	30.4	8.9	30.0033	30.039	29.962	.077	.1557	79.2	28.3	N.E.	23.7	9.5	10	2	12	....	....	....	20
21	31.43	37.4	25.8	11.6	30.0748	30.146	30.032	.114	.1102	63.2	20.3	N.E.	29.5	4.7	10	0	80	....	....	....	21
22	35.40	43.9	25.8	18.1	30.1947	30.258	30.128	.130	.1107	54.3	20.5	N.E.	13.5	3.7	10	0	93	....	....	....	22
23	38.25	42.6	32.8	9.8	29.9353	30.070	29.773	.297	.1518	65.5	27.7	S.W.	29.5	2.8	8	0	92	....	....	....	23
SUNDAY.. 24	.....	39.0	29.7	9.3	......	......	......	....	....	....	....	S.W.	24.5	....	..	..	07	0.07	Inapp.	0.07	24 ....SUNDAY
25	22.12	31.1	15.9	15.2	29.8647	29.997	29.735	.262	.0703	59.0	10.3	N. E.	13.7	0 2	1	0	98	....	....	....	25
26	18.80	25.9	7.8	18.1	30.0223	30.074	29.964	.110	.0687	64.7	8.8	E.	9.4	7.5	10	0	36	...	....	....	26
27	33.53	40.0	20.8	19.2	29.8005	29.961	29.682	.279	.1472	75.0	26.5	S. E	15.6	6.7	10	0	21	0.10	....	0.10	27
28	32.62	39.2	29.0	10.2	29.7447	29.840	29.696	.144	.1453	78.2	26.5	S.W.	21.6	6.3	10	0	15	0.03	....	0.03	28
29	28.78	36.2	19.7	16.5	29.8383	29.999	29.742	.257	.1207	75.3	22.2	S.W.	19.2	8.2	10	0	27	....	1.1	0.11	29
30	18.13	23.0	9.7	13.3	30.2697	30.345	30.149	.196	.0615	62.7	7.7	S.W.	17.3	1.5	7	0	96	....	....	....	30
SUNDAY 31	......	32.3	15.9	16.4	....	......	......	....	....	....	....	S.	12.8	....	..	..	19	....	...	....	31 ....SUNDAY
....Means	28.70	34.55	22.32	12.22	29.8885	......	......	.178	.1224	75.3	21.6	......	17.36	6.32	..	..	40.0	0.62	15.3	2.11	Sums ....
15 yrs. means for & including this mo.	23.69	31.06	16.00	15.06	29.9573	......	......	.266	.1062	75.9	....	....	....	6.17	..	..	¶45.5	0.88	26.5	3.53	15 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..	750	3007	138	256	702	3991	3408	658	
Duration in hrs..	66	165	22	30	56	176	140	52	37
Mean velocity...	11.4	18.2	6.3	8.5	12.5	22.7	24.3	12.7	

Greatest mileage in one hour was 45 on the 8th.

Greatest velocity in gusts 52 miles per hour on the 8th.

Resultant mileage, 4,265.

Resultant direction, S 85° W.

Total mileage, 12,910.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ Eight years only.

The greatest heat was 43.9 on the 22nd; the greatest cold was 7.8 on the 26th, giving a range of temperature of 36.1 degrees. Warmest day was the 23rd. Coldest day was the 14th. Highest barometer reading was 30.503 on the 1st; lowest barometer was 28.982 on the 7th, giving a range of 1.521 inches. Maximum relative humidity was 100 on the 7th. Minimum relative humidity was 41 on the 22nd.

Rain fell on 9 days.

Snow fell on 12 days.

Rain or snow fell on 14 days.

Auroras were observed on three nights.

Hoar frost on five days.

Solar halo on two day.

Lunar halo on two nights.

Lunar corona on one night.

Fog on three days.