THE

CANADIAN RECORD OF SCIENCE.

MONTREAL.

VOLUME I. ... ... NUMBER 3

I. THE CLASSIFICATION OF NATURAL SILICATES.*

(Abstract.)

BY T. STERRY HUNT.

The author in this paper reviewed the history of mineralogy, and noticed the method of classification of mineral species based solely on physical characters, which makes mineralogy a division of natural history. He then proceeded to consider the method of those who have arranged mineral species in accordance with the results of chemical analysis, while disregarding or giving a subordinate place to physical characters. A true philosophy, it was contended, should keep in view both of these methods: the chemical cannot be separated from the physical study of species, and a thorough knowledge of the chemical constitution of these will show that their physical characters are intimately related thereto, and will lead to a natural system in mineralogy.

The author in attempting the elaboration of such a system, the importance of which is evident, begins by showing in the present paper its application to natural silicates. These he regards as polysilicates of high equivalent weight, in accordance with the view

* The paper of which this is an abstract was presented to the National Academy of Sciences at Washington, April 23, and to the Royal Society of Canada at Ottawa, May 27, 1885. It will be published at length in the Transactions of the last named Society for 1885.

put forward by him in papers published in 1853 and 1854, when wollastonite was referred to a polysilicic acid with $11SiO_2$, and pyroxene to one with $14SiO_2$, or perhaps some simple multiple of these numbers, with an equivalent volume, probably not less than 460. In such compounds the degree of complexity of the molecule is shown by the relation to space of the chemical equivalent, or, in other words, by its volume. To arrive at a term of comparison for this relation in species of various and unknown degrees of complexity, the author deduces for each silicate the mean equivalent weight of its atomic unit, corresponding to an atom of NaCl; for which purpose H_2O and CaO are divided by two; SiO_2 by four, and Al_2O_3 by six. The mean unit-weight thus deduced from any arbitrary chemical formula, when divided by the specific gravity of the species gives the volume of the unit, which serves to show for different species the relative condensation of the molecule. The hardness and the chemical relations of species will be found to vary with the unit-volume, as is shown in the tables given below.

The various relations just described may be illustrated by an example. The simplest atomic formula representing the chemical elements of meionite and zoisite (which have the same centesimal composition) is $(ca.al_2 si_3)\ o_6$; the small letters representing atoms and $o = 8$. This gives an equivalent weight of 107, which, divided by six, shows the mean weight (P) of the unit or oxyd-atom in these species to be 17.83. Dividing this latter number by 2.7, the specific gravity of meionite (water=1.0), we have for the volume of the oxyd-atom in this species, V=6.60. Dividing by 3.4. the specific gravity of zoisite, we find that V=5.24. The true formulas and equivalent weights of these two complex silicates must be deduced from a comparison of their specific gravities with those of other species whose equivalent weights are otherwise determined. Meanwhile it will be seen that the species zoisite, having the lower value of V, or the more condensed molecule, differs from the less dense meionite in its greater hardness and its superior resistance to acids. Mineralogy affords many examples of the principles here illustrated.

From the complex constitution thus assigned to silicates it follows that the comparatively simple ratios generally deduced for the silica and the various bases are, in many cases, but approximations to the more complex ratios really existing. These, from the frequent impurities of natural silicates, can seldom be fixed with exactness, although with sufficient precision to give very nearly the values of P and V, which latter serves to determine the place of the species in the natural system of classification. Water being an element universally distributed in nature, its presence or absence in a silicate becomes of subordinate importance in determining alike the genesis and the natural affinities of species. Hence the water-ratios are omitted in the tables of classification, wherein the various natural silicates are from the chemical side, considered with regard to the atomic ratios of the fixed bases to each other and to silica.

There are genetic reasons (which were explained at length) for separating silicates of sesquioxyd-bases, like alumina, from protoxyd-silicates. The former of these constitute the Persilicates, and the latter the Protosilicates, those containing both protoxyds and sesquioxyds being designated Protopersilicates. Ferric oxyd and zirconia are classed with alumina, while titanic and boric oxyds in silicates are counted with the silica in determining the atomic ratios.

In the table of the Protosilicates, and in that of the Persilicates, both hydrous and anhydrous, the generally accepted atomic ratios of the fixed bases to the silica are noted, but in the table of the Protopersilicates regard is had to the more important ratios of the sesquioxyd and fixed protoxyd bases to each other, inasmuch as the ratio of the silica to both of these is found to vary greatly in closely related species, as may be seen in zeolites, feldspars, scapolites and micas. In these tables the three groups of silicates are arranged with primary reference to physical characters. Thus for Protosilicates we have in parallel vertical columns Pectolitoid, Spathoid, Adamantoid, Phylloid and Ophitoid, for each of which the range of values for V is given, while in an adjacent column are inscribed the approximate atomic ratios of fixed protoxyds to silica. Among pectolitoids are included with pectolite, apophyllite and datolite, hydrorhodonite, dioptase, pyrosmalite, calamine, cerite and thorite. The spathoids embrace tephroite, willemite, gadolinite, helvite, leucophanite, tscheffkinite and wollastonite; the adamantoids, chondrodite, chrysolite, phenacite, bertrandite, hornblende, pyroxene, titanite,

Order SILICATE.

SUB-ORDER A.—PROTOSILICATE.

r : si.	PECTOLITOID. V = 7·0—5·3	SPATHOID. V = 6·7—6·0	ADAMANTOID. V = 6·0—4·6	OPHITOID. V = 7·3—5·5
1 : ¾	- - - - - - - - - - -	- - - - - - - - - - -	Chondrodite.	
1 : 1	Calamine. Thorite. Cerite. -	Willemite. Batrachite. Tephroite. Gadolinite. Helvite.	Monticellite. Chrysolite. Phenacite. Bertrandite.	Villarsite. Matricite.
1 : 1⅓	- - - - - - - - - - -	Leucophanite. - - - - - - -	- - - - - - - - - - -	Serpentine. Retinalite.
1 : 1½	Gyrolite. Pyrosmalite.	- - - - - - - - - - -	- - - - - - - - - - -	Deweylite. Genthite.
1 : 2	Xonaltite. Plombierite. Hydrorhodonite. Dioptase.	Wollastonite. Tscheffkinite. -	Hornblende. PYROXENIDES.	Picrosmine. Aphrodite. Cerolite. Chrysocolla.
1 : 2⅔	Pectolite. - - - - - - -	- - - - - - - - - - -	Hornblende. - - - - -	Spadaite.
1 : 2½	- - - - - - - - - - -	- - - - - - - - - - -	- - - - - - - - - - -	Talc. Rensselaerite.
1 : 3	- - - - - - - - - - -	- - - - - - - - - - -	- - - - - - - - - - -	Talc. Sepiolite. Glauconite.
1 : 3½	Datolite.			
1 : 4	Apophyllite. Okenite. - - -	- - - - - - - - - - -	Guarinite. Titanite.	
1 : 7	- - - - - - - - - - -	- - - - - - - - - - -	Danburite.	

and danburite; while the phylloids embrace thermophyllite and talc, and the ophitoids, the various hydrous silicates, of which villarsite, serpentine and deweylite are representatives.

Order SILICATE.

SUB-ORDER B.—PROTOPERSILICATE.

r : r : Si.	ZEOLITOID. V = 7·2 — 6·3	SPATHOID. V = 7·2 — 6·0	ADAMANTOID. V = 5·8 — 4·7		PHYLLOID. V = 6·2 — 5·1	
1 : ½ : n	- - - - - -	Melilite. Eudialyte. -	Keilhauite. - - - - - - - - - -		MICAS. Phlogopite. -	CHLORITES. A large group of hydrous magnesian species.
1 : ⅔ : n	- - - - -	- - - - - - - - -	Idocrase. Ilvaite. Schorlomite (1 : ¾).		Phlogopite. -	
1 : 1 : n	Xanthorthite. -	Gehlenite. Sarcolite. Milarite. Wöhlerite.	Garnet. Allanite. Beryl. - - - - -		Biotite. - -	
1 : 1½ : n	Prehnite. - -	Barylite. - - - - -	Euclase. Ardennite. - - - - - -		Seybertite.	PINITOID.
1 : 2 : n	Hamelite. Catapleiite.	SCAPOLITES. - - - -	Axinite. Epidote. Zoisite. Jadeite. -		Biotite. - -	Jollyte. Palagonite.
1 : 3 : n	ZEOLITES. - - -	FELDSPATHIDES. - -	- - - - - - - - -	TOURMALINES. Coronite.	Chloritoid. -	Fahlunite. Bravaisite
1 : 4 : n	- - - - - -	Petalite. - - - - -	Spodumene. Staurolite. Sapphirine.	Schorlite.	Lepidolite. -	Hygrophilite (1 : 5).
1 : 6 : n	Forestite. - -	- - - - - - - - -	- - - - - - - - -	- - -	Margarite. Muscovite.	
1 : 8 : n	- - - - - -	- - - - - - - - -	- - - - - - - - -	Aphrizite.	Euphyllite. -	Pinite.
1 : 9 : n	- - - - - -	- - - - - - - - -	- - - - - - - - -	Indicolite.	Damourite Muscovite.	Cossaite.
1 : 12 : n	- - - - - -	- - - - - - - - -	- - - - - - - - - -	Rubellite.	Muscovite. - (With other species).	Gümbellite.

The Protopersilicates are grouped under the heads of Zeolitoid, Spathoid, Adamantoid, Phylloid and Pinitoid; while in a column to the left are given the atomic ratios of fixed protoxyds and sesquioxyds, the silica being variable. The zeolitoids include, besides the zeolites proper, forestite, prehnite, catapleiite, xanthorthite, etc. Under the spathoids of this class are placed petalite, all feldspars and feldspathides, including sodalite, iolite and leucite; the scapolites, including meionite; barylite, milarite, gehlenite, sarcolite, melilite, wöhlerite and eudialyte. The adamantoids comprise pargasite, keilhauite, schorlomite, ilvaite, idocrase, garnet, allanite, beryl, euclase, ardennite, axinite, epidote, zoisite, jadeite, spodumene, staurolite, sapphirine, and the various tourmalines. In the phylloids are included the micas proper, from phlogopite and biotite, through seybertite and chloritoid, lepidolite, margarite and euphyllite to the muscovites and damourite. With the magnesian micas are placed, under the head of phylloids, the whole family of chloritic species, while parallel with the non-magnesian or muscovitic micas, are ranged the pinitoids, including besides pinite or gieseckite, jollyte, fahlunite, bravaisite, cossaite and gümbellite.

Order SILICATE.

Sub-Order C.—PERSILICATE.

r : Si.	Kaolinoid. V = 6·8 — 5·3	Adamantoid. V = 5·3 — 4·4
1 : ¼	Schrötterite.	
1 : ⅓	Collyrite. - - - - - -	Dumortierite.
1 : ⅔	Allophane. - - - - -	Topaz. Andalusite. Fibrolite. Cyanite.
1 : 1	Pholerite. Samoite. - -	Bucholzite. Zircon. Malacone.
1 : 1⅓	Kaolinite. Halloysite.	
1 : 1½	- - - - - - - - - - -	Auerbachite.
1 : 2	Pyrophyllite. Steargillite. Chloropal.	
1 : 2½	Pyrophyllite.	
1 : 3	Cimolite. - - - - -	Anthosiderite.
1 : 4	Smectite.	

The Persilicates are arranged in like manner in five groups, the received ratios of silica and the fixed bases being given, as before, in a column to the left. The adamantoid persilicates include dumorticrite, andalusite, fibrolite, topaz, cyanite, bucholzite; the zircons and anthosiderite. The phylloids include pholerite, kaolinite and pyrophyllite; and the argilloids, the various amorphous hydrous silicates of alumina from the highly basic schrötterite, through halloysite, to the more silicious cimolite and smectite.

The relations of fluorine in silicates like topaz and chondrodite, of chlorine in pyrosmalite, sodalite and scapolites, and of sulphur in helvite, lapis-lazuli and danalite are considered at length by the author. Tables showing the values of P and V, together with the simplest atomic formulas deduced from chemical analysis are given for most well-known silicates. The discussion of the equivalent weights of these species, and of their definite place in a chemical classification of polysilicates is noticed, but is left for future consideration.

If we regard the silicates as constituting a natural order, the three groups already noticed may be called sub-orders; A. Protosilicates; B. Protopersilicates; C. Persilicates. The divisions of these will constitute tribes, and the tribal characters being repeated in the sub-orders, we distinguish the spathoids, adamantoids and phylloids, by prefixing the distinctive syllables of the sub-orders; as protospathoid, peradamantoid and protoperphylloid. The sub-divisions of these tribes into families, genera and species cannot here be discussed. The genus feldspar, including anorthite, albite and perhaps iolite, with other genera, some of which are represented respectively by orthoclase, by leucite, and by sodalite, will constitute the family of the feldspathides. The families of the micas and the pyroxenides in like manner will each include several genera, having different values for V.

The application of the principles above defined to carbonates, and the reference of the various carbon-spars to different polycarbonates, were long ago shown by the author in his papers already noticed. The extension of like views to all liquid and solid inorganic species, both natural and artificial, is but a matter of detail and labor, and when fully carried out will be the basis of a new chemistry.

II. Recent Discoveries in the St. John Group.†

By G. F. Matthew.

For some years the St. John group has been known as a formation containing the fullest representation of the oldest Cambrian fauna yet discovered in America.

In Europe this very old fauna is well known, but in America the Cambrian rocks which are best known and have been most carefully studied, do not contain it. These Cambrian rocks of America are known as the Potsdam sandstone; they cover extensive areas along the valley of the St. Lawrence and in the Middle and Western States, and are thus the oldest Cambrian group recognized by its fauna in the central region of North America, but they do not contain any of the species of the St. John group.

On the shores of Lake Champlain and along Hudson River another group of Cambrian rocks is found, older than the Potsdam sandstone, but even this, so far as we know, contains none of the St. John species. In short, nowhere west of the Appalachian Mountains have Cambrian strata been met with containing remains of animals of the ancient type of those of the Acadian provinces.

The crustacean genus *Paradoxides* is one of the most characteristic forms of this early fauna, and it has thus far been found in America only to the east of the Appalachian chain. One species is known to occur in Massachusetts, and three in Newfoundland, but the genus is represented by a greater variety of forms at St. John, N. B., than elsewhere on this continent. This genus is considered to be characteristic of the Lower Cambrian rocks. The late Professor C. F. Hartt, by a study of the fossils of the St. John group, was able to declare that they were of the same type as those of the Primordial zone in Bohemia, which Joachim Barrande had shown to contain the oldest of all known organic remains.* But, since Prof. Hartt made this determination, the fauna of the Primordial zone has been further elaborated, and Paradoxides is now found to mark the lower part of the Primordial or Cambrian system. This fact was ascertained for central

† From the Bulletin of the Natural History Society of St John, New Brunswick, read December 2, 1884.

* That is, the oldest known at that time.

Europe by the illustrious Barrande, and for Great Britain by Mr. J. W. Salter and Dr. Henry Hicks. These students discovered that while Paradoxides characterized the Lower Cambrian rocks, the Upper Cambrian could be recognized by the presence in it, among other fossils, of the crustacean genus *Olenus.* Dr. Hicks went further, and was able to divide the Lower Cambrian formation of Wales into three groups, by means of the different assemblages of animals which it contains. He thus established the succession of the groups known as Cærfai, Solva, and Menevian.

Prof. Hartt fixed the age of the St. John group as nearly as was possible in his time, as Primordial, or, as we now call it, Cambrian; but these latter discoveries in Europe have enabled the writer to point out more exactly the Cambrian group in Wales holding a fauna to which the beds containing the St. John fauna described by Prof. Hartt correspond.* This has been shown in a memoir in the Transactions of the Royal Society of Canada (1884) and elsewhere, and we now know that Hartt's species more nearly represent those of the Solva group than those of the Menevian. In other words, it is the fauna of the older part of the Lower Cambrian.

When we look for a source from which our Lower Cambrian fauna may have been derived we are met with the difficulty that no other large assemblage of animals of greater antiquity is known. The oldest creature known, *Eozoon canadense*, so far preceded in time the advent of the Cambrian forms of life that its influence on them is almost beside the question. It is true that a species resembling *Eozoon canadense* has been found in the pre-Cambrian rocks of Bavaria, but the genus *Eozoon* is not known to have left any successors or nearly related forms in the Cambrian limestones, and may therefore be considered as practically extinct at the opening of the Cambrian period.

Coming to more recent times than that represented by Eozoon, there is a Geological stage in Newfoundland indicated by the Intermediate series of Mr. Alex. Murray, in which a single organism has been found. This Intermediate series is regarded by Mr. Murray and others as equivalent to the Huronian system of Canada, and therefore intermediate between the Laurentian

*The two groups, one in Wales and the other in Acadia, are not necessarily on that account exactly cotemporaneous.

(the system containing Eozoon) and the Cambrian. The organic form which occurs in this Intermediate system was described by the late Mr. E. Billings of the Canadian Geological Survey, who appears to have thought it a representative of the Gasteropods (Sea-snails, etc.) and gave it the name of *Aspidella terranovica*. It is a curious patelliform object, which Mr. Billings was unable to refer to any known genus or family, so that its bearing on the question of the origin of the Lower Cambrian or Acadian fauna of the St. John group is somewhat problematical.

In the Acadian fauna of the St. John group, notwithstanding its antiquity, we do not have the ultimate source of organic life, but, on the contrary, an assemblage of animals already greatly differentiated and adapted to the conditions under which they existed. At the time when the Acadian fauna flourished, there may also have been other areas on the globe occupied by living beings, for when we consider the place and mode of occurrence of the species of the St. John basin, belonging to Division or Series 1, both described and undescribed, it is clear that there were three successive irruptions of living forms into this area, all of Lower Cambrian types, and all strictly within the limit upward of the Paradoxidean zone. Each of the three sets of organisms in these beds contains a large proportion of distinct species, with a smaller number of identical species. The latter serve as connecting links to bind these several sub-faunas together as one connected whole.

Before describing the three assemblages of organic forms that are found in the lower part of the St. John group it may be well to give a brief statement of the nature and order of the beds in which they occur. The St. John group has been divided in six principal masses of strata, designated as Divisions (=Series) 0, 1, 2, 3, 4 and 5. Of Division 0, it may be said that no organic remains have been found in it; but in Division 1 is found the fauna described by Professor Hartt and others. This fauna is not found at the base of Division 1, but in one of its middle members. Division 1 at St. John has been described as consisting of four bands of strata, differing in the nature of the sediments, and designated respectively, in ascending order, as *a*, *b*, *c*, and *d*. The band *a* is barren, and *c* contains the species already described; but both *b* and *d* are now found to have each their own peculiar assemblage of species.

The oldest fauna is found in the band *b*. It is littoral, and its deep-sea equivalent is not known, but its crustaceans differ from those of the next band. The connecting link between the fauna of this band and that of the band *c* above it, is found chiefly in the brachiopods and pteropods. In the fauna of *b* are two new types of bivalve crustaceans. The solitary trilobite known, Agraulos (?), is notable for the great development of the axial lobe of the cephalic shield and thorax, and of the close approximation of the eyes to the glabella. In this feature it resembles *Conocoryphe lyellii* of the Welsh Cambrian strata. Two species of the pteropods display the remarkable feature, in this class, of a camerated shell, and were apparently adapted to resist the accidents of life on a sandy sea-shore. As for the brachiopods, we find among them only the most primitive types—Linnarssonia, Lingulella, Acrothele and Acrotreta.

On passing to the beds of band *c* a host of new forms present themselves, among which are two types of sponges, Protospongia (?) and an undescribed genus. The cystidian, Eocystites, also appears at this horizon. To the genera of brachiopods referred to as found in band *b* are now added three species of the genus *Orthis*, and another Lingulella takes the place of that found in band *b*. Among the gasteropods are several genera: *Stenotheca*, *Scenella*, *Harttia*, etc. The pteropods are well represented in hyalithoid species of three different types. The bivalve crustaceans have a fair representation; those of the underlying band are not found but new species appear, including those of the genera *Primitia*, *Leperditia*, etc. The trilobites are represented by the most ancient, genera:—*Agnostus* has four species, *Microdiscus* two, *Ptychoparia* five or more, *Conocoryphe* three, an ancient type of *Ctenocephalus* one, and *Paradoxides* four; all four of this last genus have continuous eyelobes.

Passing to the beds of the new band, viz., *d*, a change in the fauna is at once apparent, though a connection with the preceding fauna is maintained by the presence of the undescribed sponge, all of the pteropods, and two familiar forms of brachiopods—Linnarssonia and Acrothele; there are also varieties of the Agnosti, the Ptychopariæ, and of Protospongia (?) of band *c*. On the other hand, quite a number of new species appear at this horizon, among which may be named a Dendrograpsus (?), another Lingulella, and two new species of Stenotheca. Two worm-casts and new species of bivalve crustaceans also come in at this horizon. Among the trilobites also there are new species; the Agnosti have four; Microdiscus exhibits a new form closely allied to *M. punctatus*, Salter. Among the Ptychopariæ some species now appear for the first time, and Solenopleura has a representative. A Paradoxides with shortened eyelobes has left abundant fragments in these measures; it is a species which, by its pleural spines, pygidium and hypostome, is allied to *P. tesseni* of Europe.

This new fauna consists largely of forms similar to those of the Menevian group, and is chiefly remarkable for the great abundance of Pteropods, Microdisci and Agnosti, and for the presence of a Paradoxides with shortened eyelobes. So far as they are at present known, each of the successive sub-faunas has an individuality of its own; that in band *b* contains forms the most remarkable for novelty; band *c* is notable for the variety of species it contains, and band *d* for the abundance of individuals of many of the species. The beds of the band *b* may be said to have been deposited on a sandy shore, those of *c* on a muddy shore, and those of *d* in deeper and more tranquil waters. Volcanic action in the vicinity of the St. John basin seems to have been dormant during the time when the beds of band *a* were laid down, but awoke into activity during the period when the strata of *b* were deposited, and gradually died away while the olive-grey mud beds of *c* were formed. The time when these successive faunas were making their way into the St. John basin was a period of decreasing volcanic action and of gradual subsidence in that area.

In concluding this article, I quote a letter of Prof. Alpheus Hyatt of Boston, well known for his researches among the Cephalopods and Sponges, which relates to one of the new forms noticed in the preceding paper. Prof. Hyatt had very kindly offered to advise me in reference to difficult points connected with the fossils of the St. John group, and I therefore availed myself of this opportunity to place before him the various specimens of pteropodous shells bearing upon the possible early connection of the pteropods with the cephalopods. Unfortunately, the letter giving the details of his examination of these fossils has been lost in transmission, but the general results of the investigation are given in the summary quoted below from a later letter. By way of preface to Prof. Hyatt's letter I may say that more than one of the early pteropods of the St. John group are remarkable for the presence of several distinct septa at the base of the tube. There are two such species in the band *b*; another, but a longer and narrower kind, is found in the band *c*, and this or a similar camerated shell occurs in the band *d*. Of these species (referring, however, chiefly to the latest) Prof. Hyatt says (February 3, 1885):

"I kept no notes of the details I had observed; my results, however, were quite definite in respect to the main points. These were: (1) The fossil is a Hyolithes allied to *H. undulatus*, Barr. (Syst. Silur. pl. 11, f. 29.) (2) The aspect of a siphon is due to the compression of the sharper against the flatter side, and the form of the sutures, which favors this impression. Barrande figures, as I found after arriving at this decision, a similar case, (pl. 15, figs. 35, 35*a*) of a closely allied species, *H. elegans*. (3) The sutures are similar to those of *H. elegans* in curvature, but wider apart. These fossils with their distinct septa are startlingly similar to certain forms of Nautiloidea, but there is no siphon. They, however confirm Von Jhernig's and my opinion that the Orthoceratites and Pteropods have had a common, but as yet undiscovered, ancestor in ancient times."

III. The Mesozoic Floras of the Rocky Mountain Region of Canada*

By Sir William Dawson.

In a previous memoir, published in the Transactions of the Royal Society of Canada, Vol. I, the author had noticed a lower Cretaceous flora consisting wholly of pines and cycads occurring in the Queen Charlotte Islands, and had described a dicotyledonous flora of middle Cretaceous age from the country adjacent to the Peace River, and also the rich upper Cretaceous flora of the coal formation of Vancouver Island—comparing these with the flora of the Laramie series of the Northwest Territory, which he believed to constitute a transition group connecting the upper Cretaceous with the Eocene tertiary.

*Abstract of a paper read before the Royal Society of Canada, May, 1885.

The present paper referred more particular by to a remarkable Jurasso-cretaceous flora, recently discovered by Dr. G. M. Dawson in the Rocky Mountains, and to intermediate groups of plants, between this and the middle Cretaceous, serving to extend greatly our knowledge of the lower Cretaceous flora, and to render more complete the series of plants between this and the Laramie.

The oldest of these floras is found in beds which it is proposed to call the Kootanie group, from a tribe of Indians of that name who hunted over that part of the Rocky Mountains between the 49th and 52nd parallels. Plants of this age have been found on the branches of the Old Man River, on the Martin Creek, at Coal Creek, and at one locality far to the northwest on the Suskwa River. The containing rocks are sandstones, shales and conglomerates, with seams of coal, in some places anthracitic. They may be traced for 140 miles in the north and south direction, and form troughs included in the Palæozoic formation of the mountains. The plants found are conifers, cycads and ferns, the cycads being especially abundant and belonging to the genera *Dioonites*, *Zamites*, *Podozamites* and *Anomozamites*. Some of these cycadaceous plants as well as of the conifers, are identical with species described by Heer from the Jurassic of Siberia, while others occur in the lower Cretaceous of Greenland. The almost world-wide *Podozamites lanceolatus* is very characteristic, and there are leaves of *Salisburya sibirica*, a Siberian mesozoic species, and branches of *Sequoia smittiana*, a species characteristic of the lower Cretaceous of Greenland. No dicotyledonous leaves have been found in these beds, whose plants connect in a remarkable way the extinct floras of Asia and America and those of the Jurassic and Cretaceous periods.

Above these are beds which, with some of the previous species, contain a few dicotyledonous leaves, which may be provisionally referred to the genera, *Sterculia* and *Laurus*; and still higher the formation abounds in remains of dicotyledonous plants of which additional collections have been made by Mr. T. C. Weston. The beds containing these, though probably divisible into two, groups, may be named the Mill Creek series, and are approximately on the horizon of the Dakota group of the United States geologists, as illustrated by Lesquereux and others. The species are described in the paper, and differ for the most part from those of the Peace River series, which is probably of the age of the Niobrara group, and, of course, still more from the overlying Laramie group. With regard to the latter, the author adduced some new facts confirmatory of his previously expressed view as to the position of the Laramie at the top of the Cretaceous and base of the Eocene, and also tending to show that some of the plants still held by some palæo-botanists to be of Miocene age are really, in Canada at least, fossils of the Laramie group, and consequently considerably older than is currently supposed. These facts also confirm the views previously expressed of the author as to the Eocene or Laramie age of the fossil plants of Mackenzie River and of Greenland, hitherto usually regarded as Miocene. The collections of plants studied by the author had for the most part been placed at his disposal by the Director of the Geological Survey.

IV. Some Points in the Composition of Soils; with Results Illustrating the Sources of Fertility of Manitoba Prairie Soils.

By Sir J. B. Lawes, Bart., and J. H. Gilbert.

This paper is a continuation of one given by the authors at the meeting of the American Association, held at Montreal in the autumn of 1882, entitled " Determinations of nitrogen in the soils of some of the experimental fields at Rothamsted and the bearing of the results on the question of the sources of the nitrogen of our crops."

The first part of the present paper consists of a résumé of the previous one. It was there shown that when crops are grown year after year on the same land without nitrogenous manure, the produce and the yield of nitrogen decline in a very marked degree. This is the case even when a full mineral manure has been applied; and it is the case not only with cereals and with root crops, but also with Leguminosæ. Further, with this great decline in the annual yield of nitrogen of these very various descriptions of plant, when grown without artificial nitrogenous supply, there is also a marked decline in the stock of nitrogen in the soil. Thus a soil-source of, at any rate, some of the nitrogen of the crops was indicated. Other evidence was also adduced clearly pointing to the same conclusion.

Next, that determinations of the amounts of nitrogen as nitrate in soils of known history as to manuring and cropping, and to a considerable depth, show that the amount of nitrogen in the soil in that form is much less after the growth of a crop than under corresponding conditions without a crop. It was hence concluded that nitrogen had been taken up by the plant as nitrate. In the case of gramineous crops and some others, the evidence points to the conclusion that most, if not the whole, of the nitrogen is taken up from the soil. It is also clear that some, at any rate, of the nitrogen of Leguminosæ has the same source and the results are in favour of the supposition that in some of the cases the whole of it might be so accounted for. Still it is admitted that, in other cases, this seems doubtful.

The conditions and the results of a large number of new experiments are next described. It is found that there is very much more nitrogen as nitrate, in the soils and subsoils down to the depth of 108 inches, where leguminous than where gramineous plants have grown. The results point to the conclusion that under the influence of leguminous growth and crop residue, especially in the case of strong and deep-rooted plants, the conditions are more favourable for the development and distribution of the nitrifying organism; and if this view be confirmed, an important step would be gained towards the more complete explanation of the sources of the nitrogen of the Leguminosæ, which assimilate a very large quantity of nitrogen, including, as above supposed, the nitrification of the nitrogen of the subsoil, which may thus become the source of the nitrogen of such crops. An alternative obviously is that the plants might still take up nitrogen from the subsoil, but as organic nitrogen and not as nitrate. There is however no direct experimental evidence in favour of such a view, whilst some physiological considerations, which are discussed, seem to be against it. Again, results show that the soil and subsoil contain less nitrogen as nitrate after the growth of good crops of *Vicia sativa* than where the more shallow-rooted *Trifolium repens* fails to grow. This is further evidence that the Leguminosæ take up nitrogen as nitrate; and in the experiments in question the deficiency of nitric nitrogen in the soil and subsoil of the *Vicia sativa* plots, compared with the amount of those of the *Trifolium repens* plot to the depth examined, is sufficient to account for a large proportion of the nitrogen estimated to be contained in the Vicia crops.

Other experiments were quoted, which bear less directly on the point, the results of which are, however, accordant; and they at the same time afford illustrations of the loss of nitrogen that the land may sustain by fallow in a wet season, and therefore of the benefits arising from the ground being covered with a crop which takes up the nitrate as it is produced. To conclude on this part of the subject, it may be considered as established that much, at any rate, of the nitrogen of the crops is derived from the stores within the soil, and that much, and in some cases the whole, of the nitrogen so derived is taken up as nitrates.

This leads the authors to the consideration of the second part of their subject, namely, the sources of the fertility of some Manitoba prairie soils.

Soils from Portage la Prairie, from the Saskatchewan district, and from near Fort Ellice, were first examined. They proved to be about twice as rich in nitrogen as the average of arable soils n Great Britain, and perhaps about as rich as the average of the surface soil of permanent pasture land.

Four other Manitoba soils were examined in greater detail, one was from Niverville, forty-four miles west of Winnipeg, the second from Brandon, the third from Selkirk, and the fourth from Winnipeg itself. These soils show a very high percentage of nitrogen; that from Niverville nearly twice as high a percentage as in the first six or nine inches of ordinary arable land, and about as high as in the surface soil of pasture land in Great Britain. The soil from Brandon is not so rich as that from Niverville, still the first twelve inches of depth are as rich as the first six or nine inches of good arable lands. The soil from Selkirk shows an extremely high percentage of nitrogen in the first twelve inches, and in the second twelve inches as high a percentage as in ordinary pasture surface soil. Lastly, both the first and second twelve inches of the soil from Winnipeg are shown to be very rich in nitrogen—richer than the average of old pasture surface soil.

The question arises, how far the nitrogen in these soils is susceptible of nitrification and so of becoming easily available for vegetation? The soils and subsoils are placed in shallow dishes, covered with plates of glass, kept under proper conditions of temperature and moisture for specified periods, extracted from time to time, and the nitric nitrogen determined in the extracts.

The periods were never less than twenty-eight days, and sometimes more. The rate of nitrification declined after the third and fourth periods. There was a very marked increase in the rate of nitrification in the subsoils during the eighth period compared with the seventh, there having been added only as much as the tenth of a gram of garden soil containing nitrifying organism.

This result is of much interest, affording confirmation of the view that the nitrogen of subsoils is subject to nitrification, if only under suitable conditions, and that the growth of deep-rooted plants may favour nitrification in the lower layers.

Records show that the rich prairie soils of the Northwest are competent to yield large crops; but, under existing conditions, they certainly do not on the average yield amounts at all commensurate with their richness compared with the soils of Great Britain, which have been under arable cultivation for centuries. That the rich prairie soils do not yield more produce than they do, is due partly to climate but largely to scarcity of labour, and consequent imperfect cultivation, and to luxuriant growth of weeds; and until mixed agriculture, with stock feeding, can be had recourse to, and local demand arises, the burning of the straw, and deficiency or waste of manure, are more or less inevitable, but still exhausting practices. So long as land is cheap and labour dear some sacrifice of fertility is unavoidable in the process of bringing these virgin soils under profitable cultivation; and the only remedy is to be found in the increase of population. Still the fact should not be lost sight of, that such practices of early settlement, however unavoidable, do involve serious loss of fertility.

A table has been prepared showing the comparative characters, as to percentage of nitrogen and carbon, of exhausted arable soils, of newly laid down pasture and of old pasture soils, at Rothamsted, also of some other old arable soils in Great Britain; of some Illinois and Manitoba prairie soils; and, lastly, of some very rich Russian soils. A comparison of the figures leaves no doubt that a rich virgin soil, or a permanent pasture surface soil, is characterised by a relatively high percentage of nitrogen and carbon. On the other hand, soils which have long been under arable culture are much poorer in these respects; while arable soils under conditions of known agricultural exhaustion show a very low percentage of nitrogen and carbon, and a low relation of carbon to nitrogen.

In conclusion, the authors said that it had been maintained by some authorities that a soil was a laboratory and not a mine; but not only the facts adduced by them in this and former papers, but the history of agriculture throughout the world, so far as it was known, clearly show that a fertile soil is one which had accumulated within it the residue of ages of previous vegetation; and that it had become infertile as this residue was exhausted.

V. The Geognosy of Crystalline Rocks.*

By T. Sterry Hunt.

The author discussed at length the relations of the great masses of crystalline rocks usually divided into stratified and unstratified, and considered the intrusion of the latter, both in a plastic state among harder rocks, and in the form of resisting solids among softer and yielding materials. He then proceeded to notice the view held by many of the older geologists, and still entertained by some, that the laminated structure in crystalline schists is no evidence of aqueous deposition, but is developed by movements of translation in a plastic igneous mass. While maintaining for most stratiform rocks an origin by aqueous deposition, he showed that such a structure is also developed in many cases by movements during the extrusion of exotic rocks, and sought to define its conditions.

As regards the source of such rocks, it is argued that granites and some related aggregates are (in accordance with the crenitic hypothesis elsewhere advocated by the author) of secondary origin, and previous to their displacement had been formed from a primary plutonic mass, mediately, through the action of water solvents. A larger portion of exotic rocks, however, comes immedately from this primary mass, which was itself from an early

* Abstract of a paper read before the Royal Society of Canada at Ottawa, May 28, 1885.

time penetrated by water, and has furnished directly the chief part of the basic eruptive rocks of various geological ages. This primary plutonic stratum was considered as modified from without by additions and subtractions through permeating waters, and also interiorly by differentiations, through a process of segregation, which has probably been at work from a remote period. This was illustrated by the slow crystallization from fused silicated mixtures of species such as chrysolite and magnetite, which are heavier and less fusible than the parent mass. From such partially crystallized mixtures, a separation by eliquation may take place ; and thus unlike, and more or less basic, portions may be derived from a once-homogeneous plutonic mass. Evidences of some such process are afforded in the variations to be seen in undoubtedly exotic basic rocks, which often present mineralogical differences in contiguous portions, having a stratiform arrangement due to movements of flow in extravasation. Phenomena of this kind, which the author had formerly ascribed to the partial intermingling by fusion of masses originally distinct, he now conceives to be due to partial separation by the above-described process, the importance of which, in the history of igneous rocks, was long since recognized by Durocher.

The limitations of such a process of differentiation by crystallization and eliquation, and the distinction to be drawn between exotic masses, occasionally stratiform in their internal arrangement and aggregates—whether in veins or in beds—of direct crenitic origin, was insisted upon. The great extent and the importance of certain crenitic masses deposited in fissures as veinstones, and often distinctly stratified, was noted, and it was maintained that a neglect to distinguish between these and exotic rocks has been the source of much error and confusion among observers, who, by confounding two kinds of mineral masses of unlike origin, have obscured instead of elucidating important geological problems. The study of such masses belongs primarily to the chemist and the mineralogist.

VI. A New Genus of Cambrian Pteropods.

By G. F. Matthew.

The hyolithoid pteropods of the St. John group present several different types of structure, of which, perhaps, the most interesting and instructive, as regards genetic relationship, is the one I propose herein to describe.

In the investigation of some points of structure in these species of pteropods, the writer has been favoured with the assistance and advice of Prof. Alpheus Hyatt, of Boston, a gentleman who has given much time to the investigation of the structure and affinities of the Cephalopoda, and is, therefore, well qualified to define the relationship of that class of animals to the pteropods in question. Professor Hyatt's conclusions, after an examination of these fossils, is that they are not Orthocerata, but are pteropods allied to Hyolithes, though with the unusual feature of transverse septa shutting off chambers at the bottom of the tube. Since they were submitted to Professor Hyatt, other individuals of some of the species have been obtained, which exhibit an earlier or larval condition, represented by a narrow tube, which is analogous to the embryonic or larval tube or prosiphon of the Cephalopods, as described by several authors. The simple camerated species I propose to describe, under the name of

Camerotheca.

Slender oval or transversely oval cones with attenuated apices. In the lower (smaller) part of the tube, or cone, there are septa that divide off segments of the tube from the body cavity (chamber of habitation). In most species, this septate portion of the cone is prolonged towards the apex into a narrow attenuated tubule formed during the earliest stage of growth; the tubule is divided by transverse diaphragms (?) at regular intervals, and is more or less flexible.

In these shells there is added to the ordinary body cavity of Hyolithes, two spaces or regions showing antecedent conditions differing from that manifested by the ordinary thecoid pteropod of the Cambrian and Silurian systems. The first may be designed as the larval region, and is, perhaps, most instructively exhibited in a species (*Diplotheca hyattiana*, n. gen. et sp.,) which from its subsequent development falls in another genus. The tubule in this species is in the condition of a flexible whip or tail, and as preserved in the shale it is not unfrequently twisted from the plane in which the principal part of the shell is flattened, and it is also frequently bent away from the axial line of the cone to the right or left. In some cases, the larval region of *D. hyattiana* is preserved in the shale as a flattened cylinder; in others, as a very slender, slowly-expanding tubule; but in all cases it is crossed by distinct annulations about as far apart as the tube is wide, and of a firmer texture than the interspaces. Whether the projection of these nodes is due to a thickening of the tube, or to transverse diaphragms within, does not clearly appear, but the latter alternative seems the more probable one.

The mucronate point in which the apex of most species of Hyolithes terminates, may be seen to have been formed in the upper part of the larval region in some specimens of *D. hyattiana;* but others have not got it. This variation of the presence or absence of the mucronate point at the top of the larval tubule, shows how and where the thickening or calcification of the shell began, and renders it probable that all of the Hyalithoid shells began in a similar larval tube, but that in most of them the tube became deciduous, or was absorbed.

The possession of a septate region is perhaps the feature by which this genus of pteropods can most readily be recognised, or at least separated fron the ordinary Hyolithes. This region is well shown in two species of this genus, *C. gracilis* (n. sp.), and *C. daniana* (*Hyolithes danianus*, Bulletin No. 10, U. S. Geological Survey). It is marked by a more or less rapid expansion of the cone, by added firmness of texture in the shell, and by the presence of several transverse septa, crossing the cavity of the shell. The chambers thus produced are not known to be connected by a siphon. This part of the shell, as preserved in the shale, is always more terete than the rest; owing either to its firmer outer shell, or to the support given by the septa, or to a more perfectly rounded contour during the life of the occupant.

In the species of this genus, the conical shell expands less rapidly above the septate space than in it. *C. gracilis* (n. sp.) may be taken as the type.

The modern genus *Cuvieria* possesses a septate shell which has some features in common with Camerotheca, but the lower part of the body-cavity is more ventricose, and the lower chambers formed by the septa at the ap x are broken away, or from other causes are wanting. *Phragmotheca* of Barrande comes nearer the St. John genus in time, being of Upper Silurian age, but as it is classed by some authors as a sub-genus of *Pterotheca* it is evidently widely different from the slender cones of the genus *Camerotheca*.*

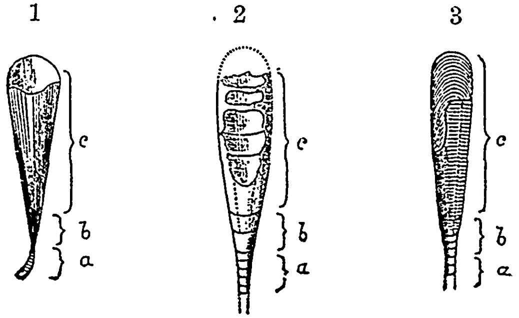
In the three phases of growth through which these pteropods passed some interesting affinities are suggested. Professor Hyatt in his article on the Fossil Cephalopoda read at the Minneapolis meeting of the American Association, 1883, concludes from his study of this group of animals that the prototype of the mollusca must have had a "globose embryo attached to the apex, the apex composed of a living-chamber opening into the protoconch, or globose shell of the embryo, without septa, though possibly divided more or less by diaphragms. Diaphragms precede the formation of the septa in the embryo Ammonoid. This confirms Von Jhermig's opinion that Tentaculites was the prototype of the Cephalopoda, since it has similar embryo and diaphragms. The prototype of the sub-classes *Tetrabranchiata* and *Dibranchiata* must have been a form of the same type, with, however, only a single septum or series of septa, having closed cœca in place of a siphon."

In these words we have almost an exact description of the larval and septate regions of the shell of *Camerotheca*, a genus which, originating earlier than *Tentaculites*, is more likely to have been connected with the ancestors of the Orthoceratidæ.

Finally, I may remark that the form of the apex of the Gasteropods of the St John group belonging to Division 1 (the portion of the formation containing the Acadian fauna) is a straight tubule similar to those we have described, though much shorter in proportion to their size, and apparently devoid of diaphragms.

* At the time of writing the above description of Camerotheca, I had access only to the generic description of Hyolithes, in which no reference is made to the occurrence of septa in the tube. Since then, however, I have seen the specific description of Eichwald's typical species *H. acutus*, from which it appears that this species had one of the important characters of Camerotheca, viz., septa near the apex of the tube. It will therefore be necessary to place Camerotheca as a sub-genus of Hyolithes, characterised by its elongated form and attenuated and flexible apex.

The accompanying figures represent the three species referred to in this article:—



No. 1. *Diplotheca hyattiana* var. *caudata*, $\frac{3}{1}$, with larval tube or prosiphon.

No. 2. *Camerotheca daniana* with larval tube and septa above.

No. 3. *Camerotheca gracilis* (immature).

a. is the larval region or space, having a thin flexible tube with diaphragms.

b. is the septate region, with thicker shell and septa sometimes calcified.

c. is the body-cavity or chamber of habitation.

VII. Meteorological Observations for 1884.

By C. H. McLeod.

The table on the succeeding page is an abstract of the meteorological observations made in 1884 at the McGill College Observatory, Montreal. The Observatory is situated at the height of 187 feet above the level of the sea.

The greatest heat was 91.0 on August 21st; greatest cold was 23.5 below zero on Dec. 20th; extreme range of temperature was therefore 114°.5. Greatest range of the thermometer on one day was 37.6 on May 2nd; least range was 4.0 on Nov. 28th. The warmest day was Aug. 21st, the mean temperature being 81.15. The coldest day was Dec. 20th, mean temperature 17.3 below zero. The highest barometer reading was 30.964 on January 27th, the lowest 28.960 on January 9th, giving a range of 2.004 in. for the month and year. The lowest relative humidity was

TABULAR SUMMARY.

Month.	Thermometer.				*Barometer.				†Mean pressure of vapour.	‡Mean relative humidity.
	Mean	Max.	Min.	Mean daily range	Mean.	Max.	Min.	Mean daily range		
January	8 73	40.5	—16.5	16.38	30.0409	30.964	28.960	.3353	.0634	81.12
February	18.11	44.0	—11.0	17.52	30.0027	30.686	29.175	.3649	.0956	85.59
March	25.65	47.1	— 9.4	14.02	29.9941	30 395	29.518	.2350	.1212	79.69
April	40.55	69.0	24.5	14.17	29.8369	30.317	29.233	.1635	.1791	71.68
May	51.95	75.9	33.5	17.92	29.8829	30.266	29.438	.1721	.2751	68.55
June	66.91	86.0	44.0	21.00	30.0187	30 565	29.584	.1544	.4478	67.00
July	65.84	86.7	51.0	16.48	29.7783	30.073	29.445	.1326	.4826	75.98
August	68.79	91.0	43.8	17.84	29.9733	30.348	29.569	.1227	.5006	71.05
September	61.76	87.7	36.5	16 07	29.9859	30.530	29.487	.2163	.4160	73.09
October	44.96	70.6	23 9	13.28	30.0393	30.623	29.573	.2557	.2427	76.41
November	30.34	49 8	13.2	13 45	29.9683	30.451	29.311	.2878	.1383	79.96
December	16.51	49.0	—23 5	13.57	30.1140	30.836	29.204	.2932	.1007	85.99
Means for 1884	41.675	......	....	15.975	29.9695	....	....	.2278	.25537	76.312
Totals	......	......	....	......	....	....	....	......	......	....
Means for 10 years ending Dec. 31, 1884.	42.113	......	...	......	29 9746	....	....	......	.25275	74.225

Month.	Wind.		Sky clouded p. ct.	Percentage of possible sunshine.	Inches of rain.	Number of days on which rain fell.	Inches snow.	Number of days on which snow fell.	Inches rain and snow melted.	Number of days on which rain and snow fell.	Number of days on which rain or snow fell.
	Mean direction.	Mean velocity in miles p. h.									
January	S.W.	12 23	66.4	27.6	0.22	3	44.2	21	4.38	2	22
February	W.S.W.	9.98	75 8	22.4	2 18	9	29.3	20	4.95	6	23
March	W.S.W.	11.41	56 2	47.0	1.32	7	20.9	14	3.39	2	19
April	N.W.	9.33	68.2	33.7	2.09	10	3.9	6	2.48	1	15
May	W.S.W.	9.84	70.3	43.8	3·51	19	0.0	0	3.51	0	19
June	S.W.	8.99	45.7	68.8	3·38	9	0 0	0	3.38	0	9
July	W.S.W.	9.61	59.5	46.4	4 73	19	0.0	0	4.73	0	19
August	W.S.W.	8.35	39.9	67 1	1·75	7	0.0	0	1.75	0	7
September	W.S.W.	9.87	41.7	58.9	3 37	11	0.0	0	3.37	0	11
October	W. by S.	9.72	73.6	33.2	2·62	17	0.5	5	2.67	3	19
November	S.W. by W.	11.15	72.9	27.6	2 13	12	5.0	10	2.62	3	19
December	W.S.W.	11.81	64.3	22.4	1·53	8	35.0	14	4.57	1	21
Means for 1884	W.S.W.	10.191	61.46	41. 8	......	......	....	....	......	......	......
Totals	....	......	......	......	28.83	131	138.8	90	41.80	18	203
Means for 10 years ending with Dec. 31st, 1884.	W. by S.	10.935	60.99	§46.92	27.27	136.5	116.6	85 3	38 91	15 9	211.7

* Barometer reading reduced to 32° Fahr., and to sea level. †Inches of Mercury. ‡Relative saturation being 100. § For three years only. The monthly means are derived from observations taken every 4th hour, beginning with 3.08 a.m.

23 on April 26th. The greatest mileage of wind recorded in one hour was 50 on May 2nd, when the velocity in one gust was at the rate of 80 miles per hour. (This is the greatest velocity ever recorded here.)

The sleighing of the winter closed on April 1st. The first appreciable snow of the autumn fell on October 25th, but melted as it fell. The first sleighing of the winter was on Nov. 29th. Upper river navigation opened April 17th. Ferries were running on April 22nd. River open to ocean ships on April 27th. First ocean ship arrived in port on May 2nd.

Auroras were observed on 21 nights. Hoar frost on 23 days. Fogs on 13 days. Lunar halos on 8 nights; Lunar corona on 2 nights. Thunder storms on 12 days, and lightning without thunder on 6 days.

The red sky at sunrise and sunset was very brilliant in January and February. It has decreased in brightness, but has been observable up to the end of the year.

VIII. Notes on the Geology and Fossil Flora of Prince Edward Island.*

By Francis Bain and Sir William Dawson.

[In the Canadian Naturalist, the predecessor of this Journal (Vol. IX, No. 9, New Series), Mr. Bain published some notes on the geology of Prince Edward Island; and the following additional note is intended to be supplementary thereto, and to refer more especially to the evidence of fossil plants in relation to the arrangement of the formations of the Island previously proposed by Mr. Bain.]

The rocks of Prince Edward Island seem to me to be divisible on the evidence of superposition and fossils into three sections, as follows.—

First.—The lower series of grey, brown. and red sandstones and shales, termed by Sir William Dawson Permo-Carboniferous presenting a thickness of about 800 feet. This series contains all the more decidedly Carboniferous plants found on the Island,

---

*Communicated to the Royal Society of Canada at its meeting in Ottawa, May, 1885.

as *Calamites suckovii*, *C. cistii*, *C. cannæformis*, *Dadoxylon acadianum* and *Trigonocarpum*, associated, however, with plants of a Permian character.

Secondly.—A middle series, reposing conformably, or nearly so, on the last, and consisting of 2,000 feet of red sandstones and shales,—the shales, and also calcareous sandstones, predominating in the lower part. This series is distributed over the greater part of the Island. It is of greatly reduced thickness in the western parts. It contains plants of a decidedly Permian character, as Walchia, *Calamites gigas*, *Pecopteris arborescens*, great numbers of stems of Araucarites evidently allied to Walchia, and the impressions of large, thick leaves that look like Noeggerathia, with *Dadoxylon edvardianum* of Triassic affinity. The beds are disturbed slightly by three lines of anticlinal, running parallel with the Cobequid range of mountains. The disintegration of the great shale beds of the lower part of this series has caused the separation of Prince Edward Island from the mainland. At what appears to be the summit of the series is a bed of quartzose conglomerate, which is pretty extensively distributed, being found in the synclinal on the Murray Harbor road, about the head waters of North River, and other localities in the centre of the Island.

Thirdly.—A horizontal series of red sandstones and shales, not distinguishable lithologically from the last, except it be by more regular bedding, and appearing to repose unconformably on the denuded strata of the most northern anticlinal of the Permian. Greatest thickness observed, 150 feet.

So far as yet ascertained, the plants found in this series are mostly specifically distinct from those of the lower rocks. But there is a generic relationship, especially with those of the middle series. This is seen in the few better preserved specimens, and also in the numerous fragments and obscure markings. Adding to the general specific distinctness of its plants the fact, that this series yielded the remains of *Bathygnathus borealis*, we are inclined to consider it the representative of the Triassic. Its beds are best seen on the north shores of the Island, about New London and eastward; but their exact distribution is very difficult to determine, owing to their general conformability to the underlying Permian. A good and typical exposure of this series occurs at Cape Turner on the north shore of the Island.

The rocks at Cape Turner belong to a horizontal series of strata which stretches along the north shore from New London to Tracadie Harbor, lying unconformably on a denuded anticlinal of the Permian, at least they occupy the place where we ought to find indications of the eastward extension of the Tryon anticlinal. The Report of Drs. Dawson and Harrington, 1871, states that at Tryon appears to be " the beginning of a synclinal." At Campbell's Cove I found the centre of the anticlinal, the beds dipping both ways from it. To the west its influence can be traced for a considerable distance on the Irish Town Road, though not seen at Darnley and its vicinity; but eastward it is lost under the horizontal series mentioned.

This Cape Tryon anticlinal is the third of a series parallel to the Cobequids, which disturbs our Island beds. Two have been mapped out in the Report above referred to, and this third and most distant one, though irregular and broken, is of great interest.*

The horizontal beds of Cape Turner, I think, must be called truly Triassic. Their westward extension into New London contained the Bathygnathus, and all the remains that I have found in them are dissimilar from these of the south side of the Island, except, perhaps, one doubtful fucus.

In looking at the little group of plants from Cape Turner it is to be observed, that while the groups from Gallas Point, St. Peter's Island, Miminigash, and localities on the south side of the Island all have a decided relationship among themselves, this Cape Turner group has no relationship to any of them. Even the fucoids of the Cape Turner beds are distinct, with, perhaps, one exception.

Remarks on the above by Sir William Dawson :—

The geology of Prince Edward Island, though somewhat simple, has been the subject from time to time of diverse opinions. It was natural that the earlier observers, influenced merely by mineral character and superposition, should relegate all the sandstone deposits, mostly of red colors, overlying the coal-measures of eastern Nova Scotia and extending across the

*See also Mr. Ells' Report, Geol. Survey of Canada, 1883-4.

Northumberland Strait into Prince Edward Island, to a "new Red Sandstone" formation, including in the geology of that time both the Permian and Triassic. As early, however, as 1842 * the writer was able to announce the existence of Carboniferous fossils in these beds, and in 1845, in two papers published in the Journal of the Geological Society of London, to refer the whole of the Red Sandstone of the south side of Northumberland Strait and a portion of that of Prince Edward Island to the "Newer Coal formation," a name afterwards changed, in so far as the upper beds were concerned, to "Permo-carboniferous."

In 1871, in conjunction with Dr. Harrington, the writer instituted a geological examination of the whole Island, at the instance of the local Government, and published a report of fifty pages, with a map, sections, and figures of fossils. In this report were described and catalogued twenty species of fossil plants, of which sixteen were referred to the Permo-carboniferous and four to the Triassic. In the Report referred to, it was proposed to arrange the strata of the Island in two groups, Permo-carboniferous and Triassic, and to divide the latter into a lower and upper series, and in our map we limited the distribution of the former group to those regions in which it was distinctly characterized by infra-position and by fossils, thus leaving the greater part of the surface to appear as Triassic. Since 1871, Mr. Bain has been able to discover fossil plants of Permo-carboniferous types in several places in which they were not found by us, thus extending the range of that formation. These facts he published in the paper in the CANADIAN NATURALIST above referred to. More recently, he suggests a three-fold division of the beds, and would refer to Permian that part of the Series which we designated Lower Trias. Mr. Ells of the Geological Survey of Canada, who has recently re-examined the rocks of Prince Edward Island (Report of Survey, 1883-4), not only extends the limits of the lower series, but regards the Trias as very limited, and not clearly distinguishable from the Permo-carboniferous; but in this last respect I cannot but think he exaggerates the difficulty occasioned by the low dips of all the beds, and the strong mineral resemblance of the Trias to the underlying Permo carboniferous, from whose disintegration it has undoubtedly been derived.

* Notes on Geology of Prince Edward Island, *Hazard's Gazette*.

The object of these remarks is, however, more especially to consider the testimony of the fossils recently collected by Mr. Bain when added to that previously obtained. On this I would remark:—

1. That the beds at Miminigash, Gallas Point, St. Peter's Island, Governor's Island, Rice Point and other places on the south coast, contain plants which elsewhere characterize the Upper Carboniferous and Lower Permian.

2. At certain points in the interior of the Island and in the bays of the north coast, which represent troughs between the Permo-carboniferous anticlinals, there are found plants indicating a higher horizon. Here the characteristic Carboniferous species are absent, and their place is taken by others, either Permian or Triassic. For example, the abundant coniferous wood of the Carboniferous species, *Dadoxlyon materiarium*, is replaced by an entirely different type more characteristic elsewhere of the Trias, *Dadoxylon edvardianum*. Some of the fossils found in this by Mr. Bain are undoubtedly of Permian aspect, as, for instance, the Walchias and *Calamites gigas*. Others, like the Dadoxylon above referred to and the curious *Cycadoidea abeqidensis* are undoubtedly more Triassic in aspect.

3. In the beds on the north side of the Island in which we found no well-characterised plants, but which afforded the remains of the Dinosaur, *Bathygnathus borealis*, Mr. Bain finds a few plants which he considers distinct from those in the lower beds. These must, I think, from their associations, be regarded as Triassic, though too few and imperfect to afford satisfactory terms of comparison with that formation elsewhere.

1. *Permo-carboniferous.*

The species catalogued from this formation in my Report of 1871, and my paper of 1874 in the Journal of the Geological Society of London, were the following:—

Dadoxylon materiarium, Dn.
Walchia gracilis, Dn.
" robusta, Dn.
Calamites suckovii, *Brongt.*
" cistii, Dn.
" gigas, Dn.
Neuropteris rarinervis, *Bunbury.*

Alethopteris nervosa, *Brongt.*
" massilionis (?), *Lesq.*
Pecopteris oreopteroides, *Brongt.*
" arborescens, "
" rigida, Dn.
Cordaites simplex, Dn.
Trigonocarpum, Sp.

To these Mr. Bain adds *Calamitics cannæformis* or specimens very closely resembling that species, and stems of the genus *Tylodendron*, while he seems to think that Walchia of the type of *W. gracilis*, *Calamites gigas* and certain Noeggerathia-like leaves as well as the conifer, *Dadoxylon edvardianum* are more particularly Permian and characteristic of the second member above referred to.

Tylodendron was found by Weiss to include stems with elongate, prominent leaf-bases of the character of those of Knorria, but bifurcate at top. These stems or branches are very characteristic of the Permian of Russia, Germany and France. They have been found by Weiss to show the character of Dadoxlyon when the structures are preserved, and are therefore Coniferous; and it is now pretty generally believed that they are decorticated branches of Walchia * So far as European evidence extends, they are to be regarded as strictly Permian, and the species drawn by Mr. Bain is not distinguishable from *T. speciosum* of Weiss. In Prince Edward Island, I have figured (Report, Plate III, Fig. 30,) what seems to be the same species, though under the name *Knorria* but my specimen may have been from the Middle Series, then called Lower Trias, but now regarded by Mr. Bain as Permian. In any case it is a strictly Permian form. The ferns of the Permo-carboniferous merit a careful re-examination in the light of recent publications in Europe and America.

2. *Permian and Triassic.*

The Walchia found by Mr. Bain in the second or Permian group is very near to my *W. gracilis*, and probably the same. Weiss has, however, described and figured in Germany,

* Flora der Rothliegenden in Saar-Rhein-Gebeite, 1872.

in a memoir published about the same time with my Report,* a species which he names *Walchia linearifolia*, and which is very near to *W. gracilis*, and especially to the variety of that species figured by Mr. Bain. Knorria-like stems and specimens of Sternbergia, obtained by Mr. Bain in the same beds, may all belong to this species. Large Noeggerathia-like leaves, such as those referred to by Mr. Bain, are not infrequent in the Permian elsewhere, and have been variously referred to ferns, to palms, and to taxine trees of the type of Salisburia. I have not seen Mr. Bain's specimens of these leaves.

Fig. 1. Branch of Walchia? Tr. . .ince Edward Island. From a drawing by Mr. Bain.

The few plants collected by Mr. Bain in the Upper Trias, or Trias proper, are especially interesting in consequence of the paucity of well-preserved fossils in this formation. He finds in these beds a Calamites with very fine ribs of the type of *C. arenaceus*, and which may be an internal cast of that Triassic species, which, when perfect, is really an Equisetum rather than a Calamite; also certain Knorria-like branches different from Tylodendron but probably branches of coniferous trees (Fig. 1), and a species of Walchia apparently distinct from that of the lower beds. It has very stout and straight branches, marked with interrupted furrows. Its branchlets are long, slender and crowded, and at right angles to the branch. The leaves are closely appressed, triangular and scale-like. Detached branchlets have thus the aspect of the Mesozoic genus *Pachyphyllum*, but the

* I may remark here that I have obtained from the Permo-carboniferous of Cape John, on the Nova Scotia coast, a leafy branch with long parallel-sided obtuse leaves, and which may indicate a species of Ulmannia or Voltzia, but is not sufficiently perfect for precise description.

habit of growth is that of Walchia. The species is near to *W. imbricata* of the European Permian, but sufficiently distinct to deserve a name, and I have therefore called it *W. imbricatula* (Fig. 2).

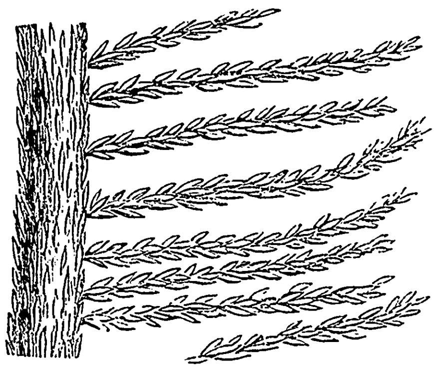


Fig. 2. *Walchia imbricatula*, S.N., Trias, Prince Edward Island. From a drawing by Mr. Bain.

It is to be observed that, in the red sandstones of Prince Edward Island, all the more delicate plants, and even twigs of coniferous trees, have completely lost their organic matter and are represented by mere impressions, stains, or casts in clay or sand, so that it is very difficult to ascertain their minute characters.

The general result, in so far as the subdivision of the beds is concerned, would seem to be that the lower series is distinctly Permo-carboniferous, that its extent is considerably greater than we supposed in 1871, that there is a well-characterised overlying Trias, and that the intermediate series, whether Permian or Lower Triassic, is of somewhat difficult local definition; but that its fossils, so far as they go, lean to the Permian side. The further researches of local observers like Mr. Bain may be expected to throw new light on these points, and to enable a more exact separation to be made of the several deposits.

IX. The Relation of Annual Rings of Exogens to Age.

By D. P. Penhallow.

That there is a certain relation existing between the well-known phenomenon of the development of rings of growth in exogenous trees and the age of the trees themselves, has been a matter of common observation and speculation for a very long time. Latterly, a few scattered observations have been made to determine this relation more exactly, but there appears to be nothing on record of a sufficiently systematic and exhaustive character to permit the deduction of a general law. The difficulties in the way of obtaining such data are considerable, one of the greatest being that of getting together a sufficiently large number of woods of different species, of which the exact ages are known. During the past year, somewhat unusual opportunities have been presented in this direction, and it has therefore been deemed desirable to collect all the data possible, and see how far they are in accord with the statements already made and the views generally held by botanists. The question may be considered as presenting itself under two aspects, viz:—

1st. Upon what does the distinction of rings depend?

2nd. Does every ring indicate one year of growth?

These primary considerations necessarily involve several others which it will be desirable to consider; but we will first pass in review the general opinions held at the present time, as also some of the more recent observations recorded.

It has been commonly accepted by botanists that each ring in the stem is generally determined by the annual cessation and renewal of activity, and that it thus corresponds to one full season of growth, and thus an estimate of the age of the tree may be obtained by counting the full number of rings. Schleiden gave expression to this view several years since.* More recently Gray † says: "Each layer being the product of a single year's growth, the age of an exogenous tree may, in general, be correctly ascertained by counting the rings in a cross section of the trunk." Bessey ‡ is a little more explicit when he says that,

* Principles of Scientific Botany, 1849, p. 238.

† Text Book of Botany, p. 79.

‡ Text Book of Botany, p. 447.

"In cold climates they enable us to determine with accuracy the age of trees and shrubs." Again, Sachs* informs us that: "In woody plants, . . . that grow in a climate in which the periods of growth are interrupted by a cold or wet season, . . . the annual additions to the wood may be recognized as sharply concentric layers, known as *annual rings*."

These expressions, then, in which all agree in the main, may be taken as representing the prevailing view at the present time, and in confirmation of them we have certain facts cited from time to time by various writers and observers.† Mr. P. C. Smith ‡ cites cases in his own experience as a lawyer, where important legal decisions, involving large property rights, have been based upon a recognition of this relation; and he also calls attention to the exact correspondence found to exist between the subsequently developed rings of wood, and the time which has elapsed since surveyor's blazes were made on trees during the closing years of the last century. Similar testimony is also offered by Mr. J. A. Ferrer,§ as the result of his own observation.

On the other hand, however, Dr. A. L. Childs || brings forward important evidence to the contrary. He cites one instance where a shrub had developed as many rings as it was months old, and also states that, having planted seeds of *Acer rubrum* for the purpose of making an accurate test, at the age of twelve years he found the trees had developed from thirty-five to forty rings, or about three for every year's growth. Unfortunately, one very important item in this statement is omitted, since the locality is not given. Of the same nature, also, is the statement made by Dr. Warring¶ concerning *Chenopodium album*, in which he found that the plant had developed eight well-defined rings at the end of four months' growth.

The question also frequently arises as to how far the law of correspondence of rings to age will apply to trees of both temperate and tropical growth. With reference to this, Dr.

* Text Book of Botany, p. 132.

† Pop. Science Monthly, Vol. III, p. 321.

‡ *Ibid.*, Vol. XXIII, p. 552.

§ *Ibid.*, Vol. XXIV, p. 53. Vol. XII, p. 382.

|| *Ibid.*, Vol. XXII, p. 204.

¶ Amer. Jour. of Science, Vol. XIV, 1877, p. 305.

Warring* remarks that: "Trees in the tropics do form rings regularly, even when the conditions of growth are absolutely uniform, *e.g.*, mangroves growing on muddy margins of tropical rivers." He also endeavors to strengthen this view by citing the development of rings in the orange and lemon when grown in greenhouses, where the conditions are supposed to be subject to but slight variation all the year round. Sachs † remarks that "In tropical, woody plants, when several years old, the additions to the wood formed in each successive year are not generally distinguishable on a transverse or longitudinal section; the entire mass of the wood is homogeneous." And he very properly makes a distinction between such growth in warm climates and that where the alteration of seasons, and so of growth, is sharply defined. Dr. A. S. Baldwin‡ cites the case of a tree on his own ground in Florida, which was less than thirty years old when cut, but which exhibited very nearly forty rings of growth, and he infers from this and similar cases that the rings are determined by meteorological conditions, and represent periods of physiological rest and activity, which may be repeated whenever the external conditions are favorable.

STRUCTURAL CONSIDERATIONS.

An examination into the immediate cause of the distinction between contiguous rings of growth shows it to be of a two-fold nature and due (*a*) to localized deposition of coloring matter; (*b*) to structural peculiarities. In the cases of those trees which develop a large amount of resinous matter or of well-defined pigment this is often deposited in such a manner as greatly to facilitate distinct definition of the rings. In certain cases the color may be uniformly distributed throughout the entire structure; in other instances, as *Pinus* and to a certain extent lignum-vitæ, the deposition of the coloring matter is more strictly localized, and generally in that part of the structure formed at the close of the season's growth. The particular depth of color may arise from an actual deposition of pigment associated with resinous matter, as in *Pinus*, or from structural peculiarities which tend to in-

* Amer. Jour. of Science, 1877, p. 395. Acad. Nat. Science, 1878.
† Text Book of Botany, p. 132.
‡ Pop. Science Monthly, Vol. XXIV. p. 554.

tensify whatever color may be peculiar to the tissue as a whole; or it may arise from both these causes combined. This means of definition, however, is by far the least important, and may very properly be considered as subordinate to and serving only to augment those distinctions which arise from purely structural peculiarities.

In certain exogens it is to be observed that, in the growth of each year, the ducts and vessels are not uniformly distributed among the wood cells, but that there is often a very strong tendency for them to become localized, preponderating in that inner portion of the rings which represents the earliest growth of the season, thus forming a layer of more open and porous tissue, while the wood cells preponderate in the outer portions of the rings formed at the close of the growing season, and thus produce a much denser layer. This alternation of more or less dense structure, therefore, offers at once the means of clear and sharp distinction between contiguous rings, since the inner porous portion of each is directly opposed to the dense tissue last produced in the preceding ring. Moreover, this variation in density is not due alone to distribution of the ducts, but to variations in the size and aggregation of the wood-cells themselves, as will be seen in the next paragraph. Examples of this kind are to be found in varying degrees of development, in *Quercus, Corylus, Ulmus, Fraxinus, Castanea, Juglans, Rhus, Acer, Zanthoxylum, Tilia,* etc., of which we may well consider *Fraxinus* the type.

In other instances there is a marked absence of ducts and vessels, or, if present, they are so uniformly distributed that the entire structure becomes homogeneous and the distinction of rings is thus obliterated; and when rings do appear under such circumstances, their distinction must rest upon variations in the wood-cells themselves. Thus we find that those wood-cells which are first produced each season, are in cross-section relatively large, thin-walled, and more loosely aggregated; while those which are produced towards the close of the season are relatively small, thick-walled, closely aggregated, and often flattened in a radial direction. This variation often proceeds at a uniform rate towards the end of growth, or, as in *Alnus*, the transition from less dense to more dense structure is not unfrequently very abrupt. In any case, there is thus produced an apposition of more and less dense tissue, which at once defines the rings, particularly if this denser aggregation involves a deepening of the color peculiar to the tissue as a whole. Examples of this we find very generally in the *Coniferæ*, *Populus*, *Alnus*, *Betula*, *Carpinus*, *Ostrya*, largely in *Fagus*, *Pirus*, *Amelanchier*, *Prunus*, etc.

In these respects, whenever rings are developed, tropical woods show the same characteristics as do those of temperate climates. Thus, from an examination of woods from Brazil, we gather the following data :—

Rings conspicuous	7
Rings imperfectly defined	4
Rings very obscure or none	10
Rings slightly defined structurally	4
Rings strongly defined by alternation of more and less dense tissues (ducts)	3
Rings defined by excess of color in first or last formed cells.	6
No structural distinctions, ducts uniformly distributed	11
Rings due to alternating growth and rest, ducts none, no obvious structural difference	5
Tissue dense throughout, rings numerous and variable	2
Outer rings broadest	2
Whole number of species	23

CAUSE OF VARIATION IN DENSITY OF STRUCTURE.

With regard to the immediate causes operating to produce variation in density of structure, the views of the earlier botanists have been very largely retained up to the present time. This variation was believed to be due primarily to alternating periods of activity and repose, as defined by the seasons ; that the sharpness of definition and regularity of occurrence must be dependent upon the sharpness with which variable climatic conditions were separated and the regularity of their occurrence; and that whatever operated to interrupt a given period of activity, or introduce a new period of growth into one of rest, would strongly tend to modify the number of resulting rings. So that, while one ring might be the product of one season, it might, on the other hand, be the product of only a portion of the entire season's activity. Thus it naturally came to be considered that while in northern latitudes rings were an approximately exact index of age, they could not be so considered in more southern and tropical latitudes. These views, as generally held, are well expressed by Sachs*, who also regards the alternation of density of structure as largely resulting from external pressure† exerted by the more resisting cortical structure, holding that the bark being relatively loose or of minimum tension in spring, the wood-cells first developed will therefore be larger and looser in structure, and the form least modified; but that as the tension constantly increases with continued development of new structure within, the cells must show a constantly increasing density and modification of form until, in the last of the season, the difference is very pronounced. In support of this view he also cites the experiments of H. de Vries ‡ by which the influence of external pressure in producing such modification is directly demonstrated. It would appear very doubtful, however, whether we are justified in assuming this tension of the cortical tissues to be the chief determining factor. If it were, then as the tension steadily increases towards the close of the growing season, there should be a correspondingly gradual change from the less dense to the more dense structure. But this does not always occur. Frequently the duct tissue ends abruptly, or, as we have seen, the ducts are uniformly distributed; there is an absence of ducts with uniform density in the distribution of the wood-cells, or, as in *Alnus*, the transition from larger thin-walled cells to those which are smaller and thick-walled may occur very abruptly at or near the close of growth for the season. Thus in the case of the tropical woods examined, sixteen out of the twenty-three appear to show that pressure of the bark is an unimportant factor, especially as eleven out of the sixteen show a regularity in distribution of the ducts through an otherwise uniformly dense woody tissue. In these woods, also, when rings are developed their distinction often rests—in five cases out of twenty-three—upon mere superposition of rings successively upon one another, without other structural difference, the lines of union or contract between successive layers thus becoming the means of distinction.

The general evidence here brought forward, therefore, seems to indicate, in many instances at least, a more or less close correspondence between the number of rings and the periods of

* Text Book of Botany, p. 652.

† *Ibid.*, p. 813.

‡ Flora, No. 16, 1872.

alternate repose and activity. Plants, like animals, seem to be incapable of continuous activity, but require periods of physiological rest and recuperation. Strict alternation of seasons secures and defines these periods, but where the climate is of a comparatively uniform character they must be secured by other conditions, as alternation of wet and dry periods, or possibly, also, by certain properties of the plant which are intrinsic; and this appears to be the explanation of the cases cited by Dr. Warring* of trees growing under uniform conditions and yet developing rings. We may thus state it as a general principle, that whatever tends to periodicity in growth, either from external or internal causes operates as a strong factor in the development of rings.

FACTS COLLECTED.

During the past year my friend, Mr. C. Gibb, removed the chief difficulty in the way of determining this question by placing at my disposal several trees, the ages of which were exactly known. Such an opportunity rarely occurring, it was at once taken advantage of, and the general results showing relation, of rings to age were found to be as follows :—

SUBJECTS.	Age.	Rings clearly defined	Rings obscure.	Total Rings.
Salix regalis	7	5	2	7
European Silver Poplar.	6	6	....	6
Early Strawberry Crab.	11	10	....	10
Large Striped Crab	11	10	....	10
Quaker Beauty Crab	11	10	....	10
Re-exam. of stump lower down.	11	10	3	13
Golden Sweet Crab	11	10	....	10
Re-exam. of stump lower down	11	10	2	12
Pirus Coronaria	12	12	1	13
Gen. Grant Crab No. 1	11	7	5	12
Re-exam. of Stump lower down.	11	11	....	11
Gen. Grant Crab No. 3, close to ground	11	11	....	11
Gen. Grant Crab. No. 4, close to ground	12	12	....	12
Totals	136	124	13	137

Again, an examination of a large ash (*F. americana*), for correspondence between annual rings and the annual increase in length, gave the following results :—

* Amer. Jour. of Science, Vol. XIV, 1877, p. 395.

BRANCHES.	(In length) Years Growth.	Rings wel defined.	Rings poorly defined.	Total Rings.
No. 1	28	24	....	24
No. 2	16	16	...	16
No. 3	15	15	....	15
No. 4	18	18	....	18
No. 5	29	....	....	....
No. 6	31	....	....	....
No. 7	18	18	....	18
Totals	155	91	....	91

Of these, three showed a fairly close correspondence between thickness of rings and length of shoot for the same year. The figures of the first table show that of the thirteen examinations made, the following is the general summary of results:—

Whole number of examinations	13	....
Rings equal to age	5	38.4%
Rings exceed the age	4	30.8%
Rings less than age	4	30.8%
Totals	13	100.00

And, if we combine the results of the two, then we obtain as follows:—

Whole number of examinations	20	....
Rings equal to age	9	45.%
Rings exceed the age	4	20.%
Rings less than age	7	35.%
Totals	20	100.00

In most, if not all, of the cases in which the number of rings was found to exceed the age, this appeared to arise from the development of secondary rings, in which, while structurally defined, the definition was generally much less distinct than in the *primary rings*. Indeed they usually have the appearance of being strangers, and of having been produced by unusual causes.

The results show, however, that the probabilities are strongest in favor of correspondence between age and the rings of growth, and that while these latter may, and often do, exceed the former, there is greater probability of their being less, through want of *structural definition.*

We have next to consider the relation between rings and the meteorology for the corresponding year. It is first of all observable that. in many cases. the growth of the stem is not uniform upon all sides; or, in other words, a cross-section would show axes of unequal length and an elliptical section. In such cases, the major axis will be found in general to have the same compass bearings in all trees within a certain area where they are similarly influenced, thus indicating a common and prevailing force as operating upon them. This inequality of growth, as determined by my own observations, is often very considerable, in twelve cases ranging from 0.1 c.m. to 0.95 c.m. in stems not exceeding 9.5 c. m. in their greatest diameter, thus making the maximum inequality equal to $\frac{1}{10}$ of the diameter itself. A very good case of this kind has been cited by Mr. T. S. Gold,* as occurring under his immediate observation. This irregularity of growth is well known to be due, as Sachs has shown,† to the action of the wind, which, swaying the tree back and forth, causes an alternating release of tension in the tissue of opposite sides of the stem. This release of tension necessarily tends to accelerated growth in the subjacent tissues, and thus unequal growth results, the major axis of which will coincide with the direction of the prevailing winds. Assuming the longitudina growth of the axis to bear the same relation to meteorological conditions as the growth in diameter, the following comparison for twelve years' growth of *Fraxinus americana* will be of interest:—

RELATION OF GROWTH IN LENGTH TO METEOROLOGY.

YEARS.	1	2	3	4	5	6	7
1883............	3.90	11.50	6.40	13.10	2.50	3.70	9.60
1882............	3.50	5.70	4.15	7.15	2.60	3.70	6.00
1881............	5.30	7.25	5 35	7.50	3.00	4.60	9.90
1880............	3.00	4.18	4.45	5.70	2.35	3.10	9.35
1879............	3.00	5.40	6.35	4.10	2.60	2.55	11.50
1878............	1.50	3.50	3 00	2.30	1.75	2.00	4.60
1877............	1.90	3.35	4.00	2.10	2.30	1.90	4.00
1876............	2.25	7.85	7.35	4.10	3.75	2.90	10.10
1875............	2.35	6.95	9 65	6.90	3.70	4.00	19.30
1874............	3.25	7.70	14 70	11.20	3.90	4.60	16.50
1873............	1.95	13.10	13.30	12.50	3.15	3.20	27.50
1872............	4.15	8.80	11.10	7.35	4.20	3.00	25.40

* Pop. Science Monthly, Vol. X, p. 379.
† Text Book of Botany, p. 813.

RELATION OF GROWTH.—*Continued.*

Years.	Sums.	Means.	Rain.	R. H.	Temp. O°F
1883............	50.7	7.24	20.38	71.6	61.1
1882............	32.8	4.68	18.40	69.1	61.2
1881............	42.9	6.15	11.95	69.9	64.2
1880............	32.7	4.65	15.85	68.1	64.3
1879............	35.5	5.07	14.95	69.9	62.0
1878............	18.7	2.66	16.40	69.1	64.6
1877............	19.6	2.79	11.62	68.2	64.5
1876............	38.3	5.47	18.51	73.0	63.0
1875............	52.3	7.47	19.77	73.9	61.8
1874............	61.8	8.83	14.35	70.2	61.5
1873............	74.7	10.66	14.19		67.0
1872............	60.0	8.57	14.00		65.0

In the table on the following page comparison is made with the thickness of rings for each year. The thickness of each ring as given is the mean of the thickness measured in cross diameters, and thus of four measurements in each case; and the mean of several rings for the same year, from different trees, should enable us to trace whatever connection there may be between growth and meteorological conditions. There is one element here, however, which tends to impair the accuracy of such a comparison, and makes it only indicative. In bringing the same years of growth together, it necessitates comparing the rings of a younger generation of growth with those of an older generation, *e. g.*, the Gen. Grant Crab No. 1 was eleven years old when cut in 1883; the European Silver Poplar was six years old at the same date, and therefore, in comparing the growth in the two for 1883, the sixth generation of the latter is necessarily brought into comparison with the eleventh generation of the former, and this tends to inaccuracy, since each generation or each ring, does not involve variations dependent upon meteorological conditions alone, but upon cycles of physiological change, as will be seen shortly. In our comparisons, therefore, this must be kept clearly in mind and due allowance made.

* Measurements in centimeters. Meteorological means for five months, May to Sept., inclusive.

COMPARATIVE TABLE OF METEOROLOGY AND ANNUAL GROWTH BY RINGS.

SUBJECTS.	1883	1882	1881	1880	1879	1878	1877	1876	1875	1874	Means.
Relative Humidity	71.60	69.10	69.90	68.10	69.90	69.10	68.20	73.00	73.90	70.20	73.30
Precipitation	20.38	18.40	11.95	15.85	11.95	16.40	11.62	18.51	19.77	14.35	16.24
Mean Temperature	61.10	61.20	64.20	64.30	62.00	61.60	64.50	63.00	61.80	61.50	62.80
Salix regalis	1.300	0.650	0.075	0.225	0.250	0.100	0.175	......	......	......	0.396
Gen. Grant Crab No. 1	0.665	0.010	0.425	0.050	0.550	0.050	0.050	0.075	0.075	0.300	0.225
" " " No. 2	0.350	0.250	0.650	0.350	0.250	0.250	0.050	0.750	0.425	0.125	0.345
" " " No. 3	0.975	0.725	0.750	0.800	0.850	0.700	0.425	0.325	0.020	0.115	0.568
" " " No. 4	0.850	0.450	0.750	0.400	0.400	0.400	0.500	0.150	0.550	0.400	0.485
European Silver Poplar	1.450	0.800	0.500	0.300	5.250	0.400	......	......	......	......	0.620
Early Strawberry Crab	0.300	0.400	0.800	0.750	0.450	0.700	0.300	0.100	0.400	0.400	0.460
Large Striped Crab	0.400	0.500	0.400	0.400	0.225	0.150	0.175	0.200	0.350	0.200	0.300
Aiken Stripe Winter Crab No. 6	0.800	0.400	0.300	0.390	0.100	0.600	0.275	0.250	0.275	......	0.366
Quaker Beauty Crab No. 1	0.450	0.250	0.300	0.300	0.350	0.350	0.200	0.200	0.500	0.300	0.320
" " " No. 2	0.900	0.850	0.450	0.450	0.400	0.450	0.275	0.225	0.466	0.333	0.480
Golden Sweet Crab No. 1	0.600	0.460	0.400	0.250	0.350	0.250	0.150	0.150	0.350	0.250	0.315
" " " No. 2	0.600	0.500	0.300	0.275	0.350	0.300	0.275	0.150	0.400	0.250	0.340
Pirus coronaria	0.550	0.550	0.400	0.450	0.550	0.500	0.450	0.125	0.325	0.250	0.415
	0.728	0.481	0.464	0.378	0.380	0.371	0.254	0.225	0.344	0.266	0.403

Met. for 5 months, May to Sep., inclusive. Rain in inches. Temp. 0°F. L.M. = C.M.

TABLE COMPARING RINGS AND METEOROLOGY.

The most exact results, such as I hope to obtain as soon as another opportunity offers, would be secured by the use of a planimeter to determine the area of each separate ring of growth, and from that its mean thickness. The circumstances of the case, however, necessitated less exact methods.

In the course of these examinations, it has been observed incidentally that the rings of growth show a regularity of increase or decrease in thickness which is quite independent of those variations previously referred to. In other words, the first formed layers are thinnest or thickest, and those subsequently formed either steadily increase or diminish in thickness with each succeeding year, and thus there is produced what may be termed the curve of accelerating or diminishing growth, which is quite independent of the waves representing annual variations from other causes.

Examining our specimens in this direction it was found that of the eleven tropical woods forming distinct rings, the innermost rings were broadest in two cases, while in the remaining nine there appeared to be uniformity of thickness throughout. An examination of thirty-five native Canadian woods gave the following:—

1. Central rings broadest	10
2. Outer rings broadest	11
3. Cycles of increase and diminution	3
4. Rings uniform throughout	11
	35

The first case, in which the rings steadily decrease in thickness from the centre outward, is illustrated in *Tsuga canadensis*, *Betula nigra*, *Ulmus fulva*, *Fraxinus sambucifolia*, *Amelanchier canadensis*, *Prunus americana*, *Rhus typhina*, *Acer dasycarpum*, *Zanthoxylum americanum*, and *Tilia americana*. The second case, in which the rings continually increase in thickness with each year of growth, is illustrated in *Picea nigra* and *alba*, *Pinus resinosa* and *strobus*, *Thuya occidentalis*, *Abies balsamea*, *Quercus rubra*, *Corylus rostrata*, *Fagus ferruginea*, and *Pirus americana*. From what has been observed in other cases, it seems highly probable that, had the specimens been of sufficient age, this continued increase in thickness would have been succeeded by as regular a diminution, thus bringing these eleven cases in reality in the next division. The third case, in which the rings first increase continually in thickness, and, later, as regularly decrease, is illustrated in *Betula alba*, *Ostrya virginica*, and *Fraxinus americana*. The fourth and last case, in which the rings are all of more uniform thickness, is illustrated in *Populus tremuloides* and *grandidentata*, *Alnus serrulata*, *Betula lutea*, *Carpinus caroliniana*, *Juglans cinerea*, *Ulmus americana*, *Fraxinus viridis*, *Prunus serotina*, *Acer rubrum* and *saccharinum*.

CONCLUSION.

I hardly feel justified in drawing decisive conclusions from evidence of so limited a character, but the facts here stated furnish certain indications which it may be well to state as a guide to future and confirmatory observations. They are as follow :—

(1) The formation of rings of growth is chiefly determined by whatever operates to produce alternating periods of physiological rest and activity. In temperate climates, where the seasons are sharply defined, these periods are determined by the seasons themselves, but in tropical and sub-tropical latitudes other influences, recurring at less regular periods, operate to determine them, therefore—

(2) In cold climates, rings of growth are an approximately correct index of age, but in warm climates they are of little or no value in this respect.

(3) Even in cold climates there is not an absolute correspondence between number of rings formed and years of growth.

(4) In warm climates the tendency is to obliteration of rings and homogeneity of structure.

(5) The distinction of rings is essentially due to structural modifications, sometimes aided by local deposit of pigment or resin, and this modification of structure is due in part to pressure of the external structure upon the forming tissues, and, in part, to physiological peculiarities of the plant itself as independent of such presence.

These indications are thus seen to be essentially in accord with the views generally held at the present time, as already stated.

(6) The influence of meteorological conditions in determining the growth of each season is most important, particularly with reference to rainfall.

(7) Periodicity in rainfall corresponds with periodicity in growth.

These general relations are very manifest in the chart,* both in the formation of rings and elongation of the axis. In the first case it will be seen that the period of accelerating growth extends over the first eleven years, and at the end of that time does not appear to be fully completed. In the second case, the period of diminishing growth is found to occur during the earlier years of development and reaches its minimum in six years, when it is followed by the period of accelerating growth during the remaining five years out of the eleven over which observations extended.

X. Montreal Botanic Garden.

We are in receipt of a circular from the Board of Management of the Botanic Garden, setting forth in brief terms the object to be accomplished and the amount of money required, for which an appeal is made to the generosity of the citizens as follows:—

"The Act obtained, Quebec, Vict. 48, Chap. 63 provides: Sec. 1, that the Corporation shall consist of seven persons elected from the Horticultural Society, and such other persons as shall donate sums of money not less than $100 each. Also, Sec. 5, that all donors shall be entitled to one vote at all meetings of the Corporation, but the latter may have the power to give additional votes for each additional $100 subscribed. It further provides, Sec. 7, that the affairs of the Corporation shall be managed by a Board of Management, composed of five members elected from the Corporation, one of the said Board to be the Director of the Garden. Also that there shall be a Secretary and Treasurer or Secretary-Treasurer.

"Through the generous assistance which the friends of the project have given, a grant of $1,000 for preliminary work has been obtained from Quebec, and it is hoped that an annual grant may be secured from the same source. It is also believed that a work of such eminent public utility, appealing, as it does, to wide and important national interests, will also commend itself so fully to

---

* The chart showing these relations in curves was unavoidably omitted. [Ed.]

public consideration that we may secure a grant from the Dominion Government at Ottawa.

"From the city of Montreal we have the promise of such land as will answer the needs of the Garden. The boundary lines have already been located, and only await ratification by the Council.

"The tract of land selected embraces about seventy-five acres, extending from Park Avenue to the base of the mountain, and from the land of Mr. J. H. R. Molson to the Park boundary on the west. The location is the most favorable that could have been selected within easy distance of the centre of population. It will be easy of access, and it is central to all the educational interests of the city, while a fine garden in such a place, will tend to draw a good class of citizens in that direction, and thus cause the erection of dwellings along now unoccupied streets.

"In its natural advantages of soil and resources the location is a very favorable one. The soil is rich and the surface diversified, permitting ample scope for the development of fine landscaping effects. There are several buildings already on the ground which will be made the best use of. There are also, within the limits of the tract, three natural springs, which will afford an unfailing supply of pure water.

"It is designed to devote a certain portion of the land to the purpose of an arboretum, in which may be grown hardy trees and shrubs from all parts of the world, our own included. A smaller portion of the tract will constitute the garden proper, in which will be collected all the herbaceous plants, arranged in their natural order and properly labelled, which can be grown here. These will be collected from all parts of the world. As an important feature of the Garden, there will be glass-houses for the growth of tender exotics, and buildings to contain the offices, library, and museum of economic vegetable products. As resources and opportunity permit, investigations will be instituted concerning the care and treatment of forests, the prevention of disease and other important questions affecting the commercial prosperity of the Dominion through its forests and orchard industries.

"In its relations to educational interests, it is designed that all the institutions of the city shall receive equal and impartial privileges to the full extent consistent with the highest public interests.

"To execute the plans in view it is designed to complete a fund and secure special donations for buildings, which will enable the Board to have an assured income of from $8,000 to $10,000 per year.

" The Board desire to assure the public that they will spare no effort to realize, in a high degree, the ideal of a Garden which may become a matter of justifiable pride to the citizens of Montreal; but, at the same time, would ask that, since all such important works are necessarily matters of somewhat slow growth, due forbearance be had in the expectation of immediate and striking results."

The circular is signed by the Rev. R. W. Norman, Chairman of the Board; Dr. T. Sterry Hunt; Prof. D. P. Penhallow, Director; Hon. L. Beaubien; Mr. R. Holland, Chairman of the Park Commissioners; and Henry S. Evans, Secretary and Treasurer.

Of the many objects which have claimed generous consideration from the citizens of Montreal, we can recall none which has appealed more forcibly than this, or which has been of a more deserving character. The aim appears to be, primarily, to advance the interests of higher education in this branch of Natural Science; and, secondarily, to develop special research in questions affecting important national interests. On the Continent of Europe, particularly in Germany, no University course is regarded as complete unless it can include the practical instruction to be derived from botanic gardens, while these latter are considered as hardly less important as centres for the promotion of original research and the distribution of information of great practical value and wide application.

The movement is one which has so many substantial arguments in its favor that it cannot fail to meet with the success and support it deserves; and that all the varied interests concerned will be well secured, both with reference to the public and to Science, is well assured in the members who compose the Board of Management. We commend it as worthy of all consideration.

XI. Proceedings of the Natural History Society.

(*Continued from page* 128.)

The Society held their *Annual Field-day* on June 16, 1884, when an excursion took place to Montarville Mountain. The weather was favorable, and a large party left Montreal from Bonaventure Station. From St. Bruno the excursion party drove to their destination.

After lunch, Messrs. Hunt, Penhallow, McConnell and Caulfield acting as judges, the following prizes were assigned:—

Entomology.—1st Prize, Master G. Sumner (26 specimens).
2nd Prize, Master W. Adams (6 specimens).

Miscellaneous Collection.—1st Prize, Miss Jane Lovell.
2nd Prize, Master G. Tiffin.

Named Plants.—Miss Bayliss (35 specimens).

Unnamed Plants.—Miss Martin (36 specimens).

Addresses followed from Messrs. G. L. Marler, Penhallow and Hunt, after which the Society took their way back to St. Bruno.

The *First Meeting* of the Session was held on October 27, 1884, Dr. Hunt taking the chair. The minutes of Council Meetings of September 25 and October 21 were read. On the previous occasion a resolution of condolence was carried to the family of the late G. L. Marler, formerly an active member of this Society.

Messrs. E. L. Trenholm and W. D. Shaw were elected ordinary members of the Society.

The President, Dr. Hunt, then delivered an address upon the meeting of the British Association for the Advancement of Science, held in Montreal during September.

The *Second Meeting* of the Session was held on December 1, 1884.

In the absence of Dr. Hunt, Sir William Dawson occupied the chair.

The following gentlemen were then elected as ordinary members of the Society:—Messrs. J. B. McConnell, C. C. Snowdon, F. W. Radford, H. T. Bovey and A. H. Mason.

Mr. E. Murphy having been called to the chair, Sir Wm.

Dawson addressed the meeting upon the Geology of a portion of the Nile Valley, and described various specimens collected by him during his visit to Egypt.

The *Third Meeting* of the Session was held on February 2, 1885, the President being in the chair.

The minutes of Council, held December 23, were then read, at which the Chairman reported that the Provincial Treasurer would visit the Museum and take into consideration the resumption of the grant to the Society. The meeting agreed to leave the matter in the hands of the President and Sir Wm. Dawson.

The President reported that the Marquis of Lansdowne had consented to become Patron of the Society.

Dr. O. C. Edwards of Winnipeg delivered an address on the habits of the Northwest Gopher, the Turkey Buzzard, the Badger and the White Pelican of Qu'Appelle Valley.

Dr. Baker Edwards then read a paper upon the Sanitary Disposal of Sewage, which was followed by a full and interesting discussion.

The *Fourth Meeting* of the Session was held on Feb. 23, 1885. In the absence of the President, Sir Wm. Dawson was Chairman.

The minutes of the Council meetings of January 20 and February 17 were read to the Society. At the former it was arranged that a Committee should proceed to Quebec and press upon Government the continuance of the grant to the Society.

Messrs. J. Johnston and W. Sutherland were elected as ordinary members and Mr. L. Sutherland as life member of the Society.

Prof. Penhallow then read a paper upon "The Growth Rings of Exogens and their Relation to Age," which was followed by some remarks by Sir Wm. Dawson upon the work of the late Dr. J. G. Jeffreys of England.

The *Fifth Meeting* of the Session was held on March 30, 1885, the President taking the chair, and reporting upon his visit to Quebec.

Mr. Caulfield then read a paper upon "Canadian Diptera."

Prof. Donald then read a paper communicated from Mr.

MacKay upon "Organic Remains in Fresh-water Lakes in Nova Scotia."

Mr. Alex. Mackenzie followed with some Notes on Infusorial Deposits in Nova Scotia and New Brunswick and some of the uses to which the mineral is adapted.

The *Sixth Meeting* of the Session was held on April 27, 1885, Sir William Dawson being in the chair.

The minutes of the Council meeting (April 21) were read, at which a communication was received from the Royal Society of Canada inviting this Society to send a delegate to the Annual Meeting to be held at Ottawa on May 19. A delegate was appointed, the honor being conferred eventually upon Dr. J. B. Edwards.

Mr. C. Gibb renewed his offer to receive the Society at Abbottsford on the occasion of their Annual Field-day.

The portrait of Sir W. E. Logan was then presented to the Society, with an address by Dr. J. Baker Edwards, to which was appended a list of the gentlemen by whose subscriptions the picture had been purchased.

Dr. Blackader was elected an ordinary member of the Society.

Mr. W. Ferrier read to the Society a paper by Mr. G. F. Matthew on "Recent Discoveries in the Cambrian of St. John."

Sir W. Dawson then called the attention of the Society to the work that was being carried on in Egypt by the Egypt Exploration Fund, announcing that Mr. H. R. Ives, a member of the Society, would receive subscriptions from those desiring to become members.

Prof. J. T. Donald then read two papers of "Chemical Notes on Adulteration."

The *Annual Meeting* was held on May 18, 1885, the President taking the chair.

The minutes of the Council meeting of May 12 were read to the Society, in which it was recommended that Dr. Wolfred Nelson and Mr. G. Nelson should be made corresponding members, as a recognition of their kindness in communicating numerous specimens from Panama.

The President then gave a long Address referring to the work of the Society during the past year, and stating that the second number of the RECORD of the Society should be issued shortly.

Mr. J. S. Shearer, Chairman of Council, then presented his Report for the past year.

The Financial Report was next submitted by the Treasurer, Mr. P. S. Ross, showing receipts to the amount of $1,059.60 and disbursements to the amount of $1,430.75. The discontinuance of the Government Grant was lamented, and it was recommended to convert the revenue from Life Membership into a permanent Endowment Fund. Attention was also drawn to the falling off of revenue from visitors to the Museum. Various means of increasing the revenue were suggested. The necessity of regularity in the publication of the RECORD was emphasized, as well as the advisability of securing a paid editor.

The Curator of the Museum, Mr. William Muir, announced the following donations as having been made to the Museum during the year 1884–85:—

PRESENTED BY

Wm. Muir:

Turkey Buzzard (*Cathartis aura*).
White Pelican (*Pelicanus erythrorhynchus*).
American Badger (*Taxidia americanus*).
Richardson's sphermophile (*Spermophilus richardsonii.*)
Grasshoppers (*Udupsylla nigra*).
Oil Beetle (*Meloe Sp.*).

Capt. Shepherd:

Night Heron (*Nyctiarda grisea*).
2 Red Squirrels (*Sciurus hudsonius*).

H. A. Whitehead:

Specimen of boulder from East Stanbridge.
3 Species of marine mollusca.
1 Series of Zoological specimens.
1 Specimen of fossil fish.

Dr. Wolfred Nelson:

Borings from Panama Canal.
Fossil wood.
Collection of Indian stone implements.

1 Indian rattle.
1 " whistle.
1 " image.

The several Reports having been adopted, it was carried that they should be printed in the RECORD OF SCIENCE.

Dr. Wolfred Nelson of Panama was then elected a corresponding member of the Society:

Dr. T. S. Hunt exhibited a curious harpoon, the property of Mrs. Guilbault, used by Capt. Brush in 1822.

A ballot having been held, the following members were declared elected as officers for the ensuing year:—

President.—Sir William Dawson.

Vice-Presidents.—Dr. T. Sterry Hunt, Dr. B. J. Harrington, J. H. R. Molson, Edw. Murphy, J. H. Joseph, L. A. H. Latour, Dr. Hingston, Dr. J. Baker Edwards, Rev. R. Campbell.

Corresponding Secretary.—Prof: D. P. Penhallow.

Recording Secretary.—W. T. Costigan.

Treasurer.—P. S. Ross.

Curator of Museum.—Wm. Muir.

Members of Council.—G. Summer, J. T. Donald, J. S. Shearer, Dr. J. B. McConnell, R. W. McLachlan, M. H. Brissette, Alf. H. Mason, J. M. Kirk.

Library Committee.—J. A. U. Beaudry, J. Bemrose, F. B. Caulfield, T. Macfarlane, E. T. Chambers.

A vote of thanks having been moved to the retiring officers, the meeting adjourned.

At a subsequent *Meeting of Council*, held June 1, 1885, Mr. J. S. Shearer was elected Chairman of Council, and the following Committees were appointed:—

Editing Committee.—Messrs. D. P. Penhallow, T. S. Hunt, A. H. Mason and the Recording Secretary.

Lecture Committee.—Messrs. J. B. Harrington, J. Baker Edwards, J. B. McConnell, P. S. Ross and M. H. Brissette.

House Committee.—Messrs. G. Sumner, J. S. Shearer, W. Muir and Major Latour.

Membership Committee.—Messrs. G. Sumner, P. S. Ross, J. S. Shearer, J. M. Kirk, M. H. Brissette, J. Stevenson Brown and the Recording Secretary.

Committee on Exchanges.—The duties of this Committee were left in the hands of the Editing Committee.

The *Annual Field-day* of the Society was held at Abbottsford, on June 4, 1885. The village is situated at the foot of Yamaska Mountain, which gives rich scope for the work of practical students of Natural History. The excursionists were organised into three parties, under the guidance, respectively, of Sir Wm. Dawson, Messrs. Penhallow and McConnell, of Messrs. Caulfield and H. Lyman, and of Mr. Gibb.

Upon the return of the exploring parties the following prizes were awarded by the judges :—

Unnamed Section.—1st Prize, Miss M. Van Horne.
2nd Prize, Miss Oct. Ritchie.

Named Section.—1st Prize, Mr. E. H. P. Blackader (48 specimens).
2nd Prize, Miss F. M. Girdwood (45 specimens).

Entomological.—1st Prize, Mr. R. C. Holden.
2nd Prize, Miss Rose Edwards.

The proceedings terminated with addresses by Sir Wm. Dawson and Dr. T. Sterry Hunt. The thanks of the Society were due to Mr. Charles Gibb for the hospitable way in which he discharged his functions as host and entertainer. This excursion, which will long be remembered as one of the most successful of the Society's outings, was attended by about 120 members and guests.

During the Session the usual course of *Sommerville Lectures* was delivered. The following is the list of the subjects :—

Feb. 12*th.* " The British Association at Montreal," by Dr. T. Sterry Hunt, F.R.S.

Feb. 19*th.* " Reminiscences of the late Sir W. E. Logan," by Dr. Robert Bell, F.G.S.

Feb. 26*th.* " Certain Features of our Climate," by Dr. W. H. Hingston, L.R.C.S.E.

March 5*th.* " Phenomena of Plant Growth," by Prof. D. P. Penhallow, B. Sc.

March 12*th.* " On Cholera," by Dr. J. B. McConnell.

March 19th. "Time Observing and Time Keeping," by PROF. C. H. MCLEOD, Ma.E.

March 26th. "The Valley of the Nile," by SIR WILLIAM DAWSON, F.R.S.

XII. ANNUAL STATEMENT OF CASH TRANSACTIONS OF THE NATURAL HISTORY SOCIETY OF MONTREAL, MAY 19TH, 1885.

RECEIPTS.

Balance on hand, May 18th, 1884		$638 56
Rents received during the year	440 50	
Entrance Fees to Museum	1 10	
Life Membership, L. Sutherland	50 00	
Subscriptions from Members	543 00	
Donations (Dr. T. Sterry Hunt)	25 00	1,059 60
Total Receipts		$1,698 16

DISBURSEMENTS.

Salaries and Commissions Collecting	$270 25	
Sundry Services of Taxidermist	48 70	
Loss by Extension, June, 1884	67 48	
Repairs to Property, Painters, Carpenters, &c.	36 50	
Carpet for Library, &c.	60 97	
Taxes for two years, including special assessment	289 45	
Insurance, part for three years	91 00	
Printing, Advertising, &c.	207 29	
Fuel and light	252 64	
Petty Expenses, &c.	106 47	
	$1,430 75	
Balance carried forward to next year	$ 267 41	$1,698 16

PHILIP S. ROSS,
Treasurer.

Audited and Certified by

JOHN S. SHEARER,
W. T. COSTIGAN.

XIII. List of the Members of the Natural History Society of Montreal.

LIFE MEMBERS.

Burland, J. H.
Chapman, Henry
Claxton, F. J.
Claxton, T. J.
Dawson, Sir J. W.
Drummond, G. A.
Ferrier, Hon. J.
Ferrier, Jas., jun.
Hingston, W. H., M.D.
Hobbs, Wm., jun.
Joseph, J. H.
Kay, W. F.
Latour, Major L. A. H.
Lunn, Wm.
Lyman, Henry
Macfarlane, Thos.
McCulloch, F.
McGibbon, Alex.
Mitchell, James
Molson, John
Molson, J. H. R.
Molson, John Thomas
Molson, John W.
Nivin, Wm.
Redpath, Peter
Robertson, Duncan
Savage, Alfred
Sumner, George
Sutherland, Louis
Watt, D. A. P.
Winn, J. H.
Workman, Thomas

ORDINARY MEMBERS.

Aikman, David
Adams, Robt. C.
Alexander, Charles
Allan, Andrew
Angus, Wm.
Ascher, J. J.
Bagg, R. S. C.
Baker, J. C.
Baker, M. C.
Beaudry, J. A. U.
Beattie, John
Bemrose, J.
Bentley, D.
Bethune, Strachan
Blackader, Dr. A. D.
Bovey, Prof. H. T.
Bowles, G. J.
Brissette, M. H.
Brown, J. Stevenson
Buchanan, W. J.
Campbell, Kenneth
Campbell, Rev. Robt.
Carsley, S.
Cassils, A. M.
Cassils, Chas.
Caulfield, F. B.
Chambers, T. J.
Cheney, Gilman
Costigan, Wm. T.
Craik, Dr. R.
De Lamotte, A. W.
Devine, Thomas
Donald, Prof. J. T.
Drummond, A. T.
Drysdale, Wm.
Duncan, A. E.
Edwards, Dr. J. Baker
Evans, W. N.
Ewan, Alex.
Ewing, A. S.
Ewing, S. H.
Fair, John
Ferrier, W. F.
Fortier, Joseph

Fraser, D. Torrance
Gardner, James
Garth, Charles
Gault, M. H.
Gibb, Charles
Girdwood, Dr. G. P.
Godfrey, Dr. R. T.
Goode, J. B.
Graham, Hugh
Greene, E. K.
Greene, G. A.
Greenshields, E. B.
Greenshields, S.
Harrington, Prof. B. J.
Henshaw, F. W.
Hickson, Jos.
Hodgson, Jonathan
Holden, Albert
Holden, J. C.
Hope, John
Howard, Dr. R. J. B.
Howard, Dr. R. P.
Hutton, James
Ives, H. R.
Jack, Andrew
Jamieson, R. C.
Johnson, James, jun.
Kennedy, W.
Kerry, John
King, R. S.
King, Warden
Kirk, J. M.
Kuetzing, Paul
Lewis, John
Lightbound, George
Linton, Robert
Little, William
Lockerby, A. L.
Lyman, Henry
Martin, P. J.
Mason, Alfred H.
Mathews, F. B.
Mathewson, J. A.
McArthur, Colin
McCallum, Dr.
McConnell, Dr. J. B.
McEachran, Dr.
McGown, A. M.
McKenna, A.
McKenzie, Hector
McLachlan, J. S.
McLachlan, R. W.
McLaren, J. C.
McLennan, Hugh
McPherson, Alex.
Miller, Robert
Mills, Dr. J. W.
Mitchell, Robert
Montgomery, Henry
Morton, G.
Montgomery, Thomas
Mooney, J. H.
Morrice, David
Murphy, Edward
Mussen, Thomas
Norman, Rev. Canon
Ogilvie, John
Ostell, John
Penhallow, Prof. D. P.
Phillips, Henry
Porter, J. A.
Prowse, G. R.
Radford, F. McL.
Richardson, Henry
Riddell, A. F.
Rintoul, W. H.
Robb, Charles
Robert, E. A.
Robert, J. A.
Robertson, Andrew
Robertson, J.A.
Ross, Dr. G.
Ross, P. S.
Scott, Gilbert
Shaw, Henry
Shaw, W. D.
Shearer, James
Shearer, John S.
Shelton, E. E.
Shorey, H.

Silverman, J.
Simpson, W.
Smith, Hon. D. A.
Smithers, C. F.
Snowdon, C. C.
Sutherland, J. B.
Sutherland, Dr. W.
Tees, William, jun.
Thomas, F. W.
Trenholme, E. H.
Trimble, Thomas
Walbank, W. McL.
Wanless, Dr. W.
White, Richard
White, Thomas, M. P.
Wilson, James
Williamson, James
Wood, Dr. C. A.
Wulff, R.
Young, C. J.
Yuille, D.

CORRESPONDING MEMBERS.

Alexander, Sir J. E., 35 *Bedford Place, Russell Sq., London, W. C.*
Allan, E. A. H., *Troy, N.Y.*
Angas, G. F., 48 *Norland Sq., Holland Park, London.*
Ashton, Rev. Michael, *Adelaide, Australia.*
Baird, Prof. S. F., *Washington, D.C.*
Bethune, N. W., *Ottawa, P. O.*
Bois, Rev Ed., *Maskinongé, P.Q.*
Boucherville, G. P. de, *St. Hyacinthe, P.Q.*
Bowen, Dr. Ed., *Brantford, P.Q.*
Brithoner, Rev. W., *Ormstown, P.Q.*
Brodie, M. C., *Beauharnois, P.Q.*
Brown, John, *Hamilton, P. O.*
Brunel, A., *Toronto, P. O.*
Buckland, Prof. W., *Toronto, P. O.*
Bulger, Br.-Major G. E., 156 *Leadenhall St., London, E.C.*
Cameron, Archibald, *Pointe de Chene P.Q.*
Campbell, Col. C. B., *St. Hilaire, P. Q.*
Dessaulles, Cassimer, *St. Hyacinthe, P.Q.*
Fleming, Sanford, *Ottawa, P.O.*
Fortin, P. G., *Laprairie, P.Q.*
Gongrais, J. F. *Quebec, P. Q.*
Guidlack Dr. J., *Ingenio Fermina Bemba, Cuba.*
Hamilton, Dr. J., *Prescott, P.O.*
Hind, Prof. H., *Windsor, N.S.*
Honeyman, Rev. D., *Halifax, N.S.*
Hubbard, Prof. O. P., *Hanover, N.H.*
Laberge, Chas., *St. Johns, P.Q.*
Langevin, J., *Rimouski, P.Q.*
Latour, Dr. C. H., *Boucherville, P.Q.*
Lavalle, Rev. M., *St. Vincent de Paul, P.Q.*
Leaycroft, J. W., *Quebec, P.Q.*

Lee, Dr. J. C., *London, P.O.*
Macoun, J., *Ottawa, P.O.*
Marsh, Prof. J. W., *Forest Grove, Oregon.*
Matthew, G. F., *St. John, N.B.*
McDougall, P. L., *Toronto, P.O.*
McFarlane, Thomas, *Actonville, P.Q.*
Newcomb, Dr. W., *Troy, New York.*
Niles, B. F., *Washington, D.C.*
Osler, Dr., *Univ. of Pennsylvania, Philadelphia, Pa.*
Packard, A. S., *Providence, R.I.*
Pilote, Rev. F., *St. Anne de la Pocatière, P.Q.*
Robinson, Rev. P., *Abbotsford, P.Q.*
Rose, H., *Granby, P.Q.*
Salisbury, Dr. J. W., 9 *West 29th St., New York City.*
Saunders, W., *London, P.O.*
Sicotte, Judge, *St. Hyacinthe, P.Q.*
Spence, J., *Pointe Claire, P.Q.*
Taché, J. C., *Quebec, P.Q.*
Thieleke, H., *Quebec, P.Q.*
Turcot, Dr. M., *St. Hyacinthe, P.Q.*
Westwood, Prof. J. O., *Oxford, Eng.*
Wilson, Prof. D., *Toronto, P.O.*
Wurtele, Rev. L., *Actonville, P.Q.*

HONORARY MEMBERS.

Baldwin, Right Rev. M.S., Bishop of Huron, *P.O.*
Beaubien, Hon. Louis, *Montreal, P.Q.*
Hall, Prof. James, *Albany, N.Y.*
Hunt, Dr. T. Sterry, *Montreal, P.Q.*
Lefroy, General J. H., 82 *Queen's Gate, London, Eng.*
Montgomery, James, *Toronto, P.O.*
Rae, Dr.
Rogers, Charles, *London, Eng.*
Selwyn, A. R. C., *Geological Survey, Ottawa, P.O.*
Whiteaves, J. F., *Geological Survey, Ottawa, P.O.*

XIV. List of Exchanges, etc.

CANADA.

McGill College	Montreal	Que.
Meteorological Office, McGill College	do.	do.
Canada Medical and Surgical Journal	do.	do.
Laval University	Quebec	do.
Literary and Historical Society	do.	do.
Bishop's College	Lennoxville	do.
Canadian Institute	Toronto	Ont.
Knox, College	do.	do.
Meteorological Office	*do.*	*do.*
Journal of the Board of Arts	do.	do.
Trinity College	do.	do.
University College	do.	do.
Geological and Natural History Survey	Ottawa	do.
Ottawa Field Naturalists' Club	do.	do.
Royal Society of Canada	do.	do.
Botanical Society	Kingston	do.
Queen's College	do.	do.
Entomological Society of Ontario	London	do.
Hamilton Association, *Alexandrian Arcade*	Hamilton	do.
Natural History Society	St. John	N.B.
Department of Agriculture, Statistics and Health.	Winnipeg	Man.

UNITED STATES.

Smithsonian Institute	Washington,	D.C.
U. S. Geological Survey	do.	do.
U. S. Fish Commission	do.	do.
State Library, State House	Boston	Mass.
Natural History Society	do.	do.
American Academy of Sciences	do.	do.
Harvard College Library	Cambridge	do.
Office of "Science"	do.	do.
Amherst College Library	Amherst	do.
Essex Institute	Salem	do.
Academy of Sciences, 12 *W.* 31 *St.*	New York	N.Y.
Astor Library	do.	do.
N.Y. State Library	Albany	do.
Vassar College	Poughkeepsie	do.
Academy of Natural Sciences	Philadelphia	Pa.
Franklin Institute	do.	do.
American Phil. Society	do.	do.
Silliman's Journal	New Haven,	Conn.

Yale College Library	New Haven,	Conn.
Academy of Sciences	St. Louis	Mo.
University of the South	Nashville	Tenn.
Cincinnati Society of Natural History	Cincinnati	Ohio.
Academy of Sciences	New Orleans	La.

GREAT BRITAIN.

Geological Society	London	Eng.
Royal Society	do.	do.
Entomological Society	do.	do.
Zoological Society	do.	do.
Society of Arts	do.	do.
Chemical Society	do.	do.
Geological Survey of Great Britain	do.	do.
British Museum	do.	do.
Museum of Practical Geology, *Jermyn St.*	do.	do.
Linnean Society, *Burlington House*	do.	do.
Annals and Magazine of Natural History	do.	do.
The Geologist	do.	do.
The Phytologist	do.	do.
The Zoologist	do.	do.
The Ibis	do.	do.
The Technologist	do.	do.
London, Edin. and Dublin Phil. Magazine	do.	do.
Natural History Review	do.	do.
Journal Royal Mic. Society	do.	do.
Chemical News	do.	do.
The Builder	do.	do.
The Engineer	do.	do.
The Gardener's Chronicle	do.	do.
Bodleian Library	Oxford	do.
University Library	Cambridge	do.
Literary and Philosophical Society	Manchester	do.
Natural History Society	Newcastle on Tyne	do.
Botanical Society	Edinburgh	Scot.
Royal Physical Society	do.	do.
Royal Society	do.	do.
Royal Scottish Society of Arts	do.	do.
Edin. Geological Society	do.	do.
Edin. New Phil. Journal	do.	do.
Glasgow University Librar	Glasgow	do.
Royal Irish Academy	Dublin	Ire.
Royal Geological Society of Ireland	do.	do.
Royal Dublin Society	do.	do.

CONTINENT OF EUROPE.

Annales des Sciences Naturelles................	Paris	France.
Archives de Musée...........................	do.	do.
Académie des Sciences.......................	do.	do.
Société Géologique de France..................	do.	do.
Société de Géographie 184 *Boulevard St. Germain*	do.	do.
Académie des Sciences, Arts, &c.	Dijon	do.
Académie Royale des Sciences..................	Lyons	do.
Archive fur Naturgeschichte...................	Berlin	Prussia.
Deutsches Geolog. Gesellschaft.................	do.	do.
Koniglichen Akademie der Wissenchaften	do.	do
Academy Car. Leop.	Jena	do.
Konigl. Gesellschaft der Wissen................	Gottingen	do.
Konigl-Sachs. Gesellsch. der Wissench	Leipsig	do.
Tanhard und Brohn Jahrbucher................	Stuttgart	do.
Allgemeine Deutsches Natur. Zeitung]..........	Dresden	Saxony.
Flora......................................	Ratisbon	Bavaria.
Konigl. Bayerichen Akademie der Wiss.........	Munich	do.
Kaiserlichen Akademie.	Vienna	Austria.
Imperial Geological Institute..................	do.	do.
Koninlshipke Akademie de Wet................	Amsterdam	Hol'nd.
Société Hollandaise des Sciences...............	Haarlem	do.
Société Impériale de Naturalistes	Moscow	Russia.
Jardin Impériale Botanique...	St. Petersb'rg,	do.
Academie Royale	Brussels	Belgium.
British and American Archæological Society, 17 *Via Prefette*...........................	Rome	Italy.

ELSEWHERE.

Royal Society of New South Wales..............	Sydney	Australia.

[NOTE.—The attention of Subscribers is requested to the above list of names and addresses. The editors of the CANADIAN RECORD OF SCIENCE will be obliged for information concerning the present residence or death of any of those mentioned in the lists, as well as for other corrections, and will add any names accidentally omitted.

They also regret the unavoidable irregularity with which previous numbers have appeared. The issues will hereafter be quarterly, the next number appearing in the first week of October. Subscribers, or those exchanging, who do not receive regularly, should at once call the attention of the editors to the fact; and if the first two numbers of this volume have not been received, they will be forwarded upon request.]