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THE

CANADIAN RECORD

OF SCIENCE.

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Cretaceous Floras of the Northwest.

By Sir William Dawson.

The following is a summary of the general conclusions of a paper on this subject, now in the press in the "Transactions of the Royal Society of Canada," and in which a number of new species recently collected by Dr. G. M. Dawson, Mr. Weston, and Mr. Tyrrell, of the Geological Survey, are described and figured.

GEOLOGICAL RELATIONS OF THE FLORAS.

In a memoir by the writer in the first volume of the Transactions of the Society will be found a table of the Cretaceous formations of the western Northwest Territories of Canada, prepared by Dr. G. M. Dawson, and giving the geological position of the plants at that time described. The new facts detailed in the paper mentioned require us to intercalate in this table three distinct plant-horizons not previously recognized in the western territories of Canada.

One of these, the Kootanie series, should probably be placed at the base of the table as a representative of the Urgonian or Neocomian; or, at the very least, should be held as not newer than the Shasta group of the United States geologists, and the lower sandstones and shales of the Queen Charlotte Islands. It would seem to correspond in the character of its fossil plants with the oldest Cretaceous floras recognized in Europe and Asia, and with that of the Komé formation in Greenland, as described by Heer. No similar flora seems yet to have been distinctly recognized in the United States, except, perhaps, that of the beds in Maryland, holding cycads, and which were referred many years ago by Tyson to the Wealden.

The second of these plant-horizons, separated according to Dr. G. M. Dawson, by a considerable thickness of strata, is that which he has called the Mill Creek beds, and which corresponds very closely with that of the Dakota group, as described by Lesquereux, and that of the Atané and Patoot formations in Greenland, as described by Heer. This fills a gap, indicated only conjecturally in the table of 1883. Along with the plants from the Dunvegan group of Peace River, described in 1883, it would seem to represent the flora of the Cenomanian and Turonian divisions of the Cretaceous in Europe.

Above this we have also to intercalate a third sub-flora, that of the Belly River series at the base of the Fort Pierre group. This, though separated from the Laramie proper by the marine beds of the Pierre and Fox Hill groups, more than 1,700 feet in thickness, introduces the Laramie or Danian flora, which continues to the top of the Cretaceous, and probably into the Eocene, and includes several species still surviving on the American continent, or represented by forms so close that they may be varietal merely.

Lastly, the subdivision of the Laramie group, in the last report of Dr. G. M. Dawson, into the three members known respectively as the Lower or St. Mary River series, the Middle or Willow Creek series, and the Upper or Porcupine Hill series, in connection with the fact that the fossil plants occur chiefly in the lower and upper members, enables us now to divide the Laramie flora proper into two sub-floras,—an older, closely allied to that of the Belly River series below; and a newer, identical with that of Souris River, described as Lignite Tertiary in Dr. G. M. Dawson's Report on the 49th Parallel, 1875, and which appears to agree with that known in the United States as the Fort Union group, and in part at least with the so-called Miocene of Heer from Greenland.

From the animal fossils and the character of the plants, it would seem probable that the rich flora of the Cretaceous coal fields of Vancouver Island is nearly synchronous with that of the coal-bearing Belly River series of the western plains.

It will thus be seen that the explorations already made in Canadian territory have revealed a very complete series of Cretaceous plants, admitting, no doubt, of large additions to the number of species by future discoveries, and also of the establishment of connecting links between the different members; but giving a satisfactory basis for the knowledge of the succession of plants, and for the determination of the ages of formations by their vegetable fossils.

In connection with the subjoined table it should be understood that Tertiary floras, probably Miocene in age, are known in the interior of British Columbia, though they have not yet been recognized in the territories east of the Rocky Mountains.

Before leaving this part of the subject, I would deprecate the remark which I see occasionally made, that fossil plants are of little value in determining geological horizons in the Cretaceous and Tertiary. I admit that in these periods some allowance must be made for local differences of station, and also that there is a generic sameness in the flora of the Northern Hemisphere, from the Cenomanian to the modern; yet these local differences and general similarity are not of a nature to invalidate inferences as to age. No doubt so long as palæobotanists seemed obliged, in deference to anthority, and to the results of investigations limited to a few European localities, to group together, without distinction, all the floras of the later Cretaceous and earlier Tertiary, irrespective of stratigraphical considerations, the subject lost its geological importance. But when a good series has been obtained in any one region of some extent, the case becomes different. Though there is still much imperfection in our knowledge of the Cretaceous and Tertiary floras of Canada, I think the work already done is sufficient to enable any competent observer to distinguish by their fossil plants the Lower, Middle, and Upper Cretaceous, and the latter from the Tertiary; and, with the aid of the work already done by Lesquereux and Newberry in the United States, to refer approximately to its true geological position any group of plants from beds of unknown age in the west.

The successive series may be tabulated as on the opposite page, with references for details to the fuller table in my memoir of 1883.

Though the flora of the Belly River series very closely resembles that of the Lower Laramie, showing that similar plants existed throughout the Senonian and Danian periods in North America, yet it is to be anticipated that specific differences will develop themselves in the progress of discovery. In the meantime, it scarcely seems possible to distinguish by fossil plants alone the Lower Laramie beds from those of Belly River; and, if these are really separated by 1,700 feet of marine strata, as is now believed on stratigraphical grounds, the flora must have been remarkably persistent. The Dunvegan series of Peace River probably corresponds in time with the marine Niobrara and Benton groups farther south and the Mill Creek with the Dakota group.

PHYSICAL CONDITIONS AND CLIMATE INDICATED BY THE CRETACEOUS FLORAS.

In the Jurassic and earliest Cretaceous periods the prevalence, over the whole of the Northern Hemisphere and for a long time, of a monotonous assemblage of Gymnospermous and Acrogenous plants, implies a uniform and mild climate and facility for intercommunication in the

SUCCESSIVE FLORAS AND SUB-FLORAS OF THE CRETACEOUS IN CANADA.
(In Descending Order.)

Periods.	Floras and Sub-Floras.	References.
Transition Eocene to Cretaceous.	Upper Laramie or Porcupine Hill	Platanus beds of Souris River and Calgary. Report Geol. Survey of Canada for 1879, and Memoir of 1885.
Upper Cretaceous (Danian and Senonian.)	Middle Laramie or Willow Creek beds.	
	Lower Laramie or St. Mary River	Lemna and Pistia beds of bad lands of 49th Parallel, Red Deer River, etc., with Lignites. Report 49th Parallel and Memoir of 1885.
	Fox Hill Series	Marine.
	Fort Pierre Series	Marine.
	Belly River	Sequoia and Brasenia beds of S. Saskatchewan, Belly River, etc., with Lignites. Memoir of 1885.
	Coal Measures of Nanaimo, B.C., probably here.	Memoir of 1883. Many Dicotyledons, Palms, etc.
Middle Cretaceous (Turonian and Cenomanian.)	Dunvegan Series of Peace River	Memoir of 1883. Many Dicotyledons, Cycads, etc.
	Mill Creek beds of Rocky Mountains	Dicotyledonous leaves, similar to Dakota Group of the U.S. Memoir of 1885.
Lower Cretaceous (Neocomian, etc.)	Suskwa River beds and Queen Charlotte Island Coal Series. Intermediate beds of Rocky Mts.	Cycads, Pines, a few Dicotyledons. Report Geol. Survey. Memoir of 1885.
	Kootanie Series of Rocky Mountains	Cycads, Pines, and Ferns. Memoir of 1885.

north. Toward the end of the Jurassic and beginning of the Cretaceous, the land of the Northern Hemisphere was assuming greater dimensions, and the climate probably becoming a little less uniform. Before the close of the Lower Cretaceous period the dicotyledonous flora seems to have been introduced, under geographical conditions which permitted a warm-temperate climate to extend as far north as Greenland.

In the Cenomanian, we find the Northern Hemisphere tenanted with dicotyledonous trees closely allied to those of modern times, though still indicating a climate much warmer than that which at present prevails. In this age, extensive but gradual submergence of land is indicated by the prevalence of chalk and marine limestones over the surface of both continents; but a circumpolar belt of land seems to have been maintained, protecting the Atlantic and Pacific basins from floating ice, and permitting a temperate flora of great richness to prevail far to the north, and especially along the southern margins and extensions of the circumpolar land. These seem to have been the physical conditions which terminated the existence of the old Mesozoic flora and introduced that of the Middle Cretaceous.

As time advanced, the quantity of land gradually increased, and the extension of new plains along the older ridges of land was coincident with the deposition of the great Laramie series, and with the origination of its peculiar flora, which indicates a mild climate and considerable variety of station in mountain, plain and swamp, as well as in great sheets of shallow and weedy fresh water.

In the Eocene and Miocene periods, the continent gradually assumed its present form, and the vegetation became still more modern in aspect. In that period of the Eocene, however, in which the great nummulitic limestones were deposited, a submergence of land occurred on the Eastern Continent which must have assimilated its physical conditions to those of the Middle Cretaceous. This great change, affecting materially the flora of Europe, was not equally great in America, which also by the north and south extension of its mountain chains permitted movements of migration not possible in the Old World. From the Eocene downward, the remains of land animals and plants are found only in lake basins occupying the existing depressions of the land, though more extensive than those now remaining. It must also be borne in mind, that the great foldings and fractures of the crust of the earth which occurred at the close of the Eocene, and to which the final elevation of such ranges as the Alps and the Rocky Mountains belongs, permanently modified and moulded the forms of the continents.

These statements raise, however, questions as to the precise equivalence in time of similar floras found in different latitudes. However equable the climate, there must have been some appreciable difference in proceeding from north to south. If, therefore, as seems in every way probable, the new species of plants originated on the Arctic land and spread themselves southward, this latter process would occur most naturally in times of gradual refrigeration or of the access of a more extreme climate, that is, in times of the elevation of land in the temperate latitudes, or conversely, of local depression of land in the Arctic, leading to invasions of northern ice. Hence, the times of the prevalence of particular types of plants in the far north would precede those of their extension to the south, and a flora found fossil in Greenland might be supposed to be somewhat older than a similar flora when found farther south. It would seem, however, that the time required for the extension of a new flora to its extreme geographical limit, is so small in comparison with the duration of an entire geological period, that, practically, this difference is of little moment; or at least does not amount to antedating the Arctic flora of a particular type by a whole period, but only by a fraction of such period.

It does not appear that, during the whole of the Cretaceous and Eocene periods, there is any evidence of such refrigeration as seriously to interfere with the flora, but perhaps the times of most considerable warmth are those of the Dunvegan group in the Middle Cretaceous and those of the later Laramie and oldest Eocene.

It would appear, that no cause for the mild temperature of the Cretaceous needs to be invoked, other than those mutations of land and water which the geological deposits themselves indicate. A condition for example of the Atlantic basin in which the high land of Greenland should be reduced in elevation and at the same time the northern inlets of the Atlantic closed against the invasion of Arctic ice, would at once restore climatic conditions allowing of the growth of a temperate flora in Greenland. As Dr. Brown has shown,[1] and as I have elsewhere argued, the absence of light in the Arctic winter is no disadvantage, since, during the winter, the growth of deciduous trees is in any case suspended; while the constant continuance of light in the summer is, on the contrary, a very great stimulus and advantage.

It is a remarkable phenomenon in the history of genera of plants in the later Mesozoic and Tertiary, that the older genera appear at once in a great number of specific types, which become reduced as well as limited in range down to the modern. This is no doubt connected with the greater differentiation of local conditions in the modern; but it indicates also a law of rapid multiplication of species in the early life of genera. The distribution of the species of *Salisburia*, *Sequoia*, *Platanus*, *Sassafras*, *Liriodendron*, *Magnolia*, and many other genera, affords remarkable proofs of this.

Gray, Saporta, Heer, Newberry, Lesquereux, and Starkie Gardner, have all ably discussed these points; but the continual increase of our knowledge of the several floras, and the removal of error as to the dates of their appearance must greatly conduce to clearer and more definite ideas. In particular, the prevailing opinion that the Miocene was the period of the greatest extension of warmth and of a temperate flora into the Arctic, must be abandoned in favour of the later Cretaceous and Eocene; and, if I mistake not, this will be found to accord better with the evidence of general geology and of animal fossils.

While the Memoir, of which the above are the conclu-

[1] Florula Discoana.

sions, was passing through the press, the report of Mr. Whiteaves, F.G.S., Palæontologist to the Canadian Survey, on the invertebrate fossils of the Laramie and Cretaceous of the Bow and Belly River districts appeared ("Contributions to Canadian Palæontology," Vol. I. Part i, 89 pages and 11 plates). This valuable Report constitutes an independent testimony, based on animal fossils, to the age of the beds in question, and accords in the main very closely with the conclusions above derived from fossil plants. Unfortunately, however, no animal remains have yet been found in the Kootanie series, and the only fossil recorded from the Mill Creek beds is a species of *Inoceramus*, characteristic in the United States of the Niobrara and Benton groups, but which is found in beds which may be somewhat higher than those holding the plants.

THE STRUCTURAL FEATURES OF "DISCINA ACADICA" (HARTT), OF THE ST. JOHN GROUP.

BY G. F. MATTHEW.

This rather common species of the Cambrian at St. John Basin was first figured and described in the second edition of Sir J. Wm. Dawson's "Acadian Geology;" but as, owing to the imperfect material in his hands, the original describer, Prof. C. F. Hartt, did not clearly apprehend the nature of this species, a few words relative to the structural features of this, one of the earliest of the gasteropods, may be of interest.

Mr. R. P. Whitfield first drew attention to the calcareous nature of the test of this species, and suggested that it was a gasteropod allied to *Palæacmea* or *Metoptoma*. Mr. C. D. Walcott afterwards referred it to the former genus, after a study of the type-specimens preserved in Prof. Hartt's collection at Cornell University; but he subsequently referred it to Dr. H. Hicks' genus, *Stenotheca*. This is where the late Mr. E. Billings placed a similar shell found in the Cambrian limestone of S.E. Newfoundland, and to this genus they are undoubtedly closely allied; but an examination of a series of small shells of the St. John group, which have a closer affinity for the shell from the Menevian group of Wales, which was the type of Dr. Hicks' genus *Stenotheca*, leads the writer to infer that Hartt's species *acadica* is not so close to Hicks' *S. cornucopia* as is the group of small shells above referred to. Hence it should be distinguished as a sub-genus, characterized by its subcircular aperture and patelloid form. Probably its nearest relatives now living are not the true limpets, but are among the Fissurellidæ, and especially in the genus *Parmophorus*, which it resembles in many important particulars. The dimensions of the adult of *S. acadica* are: height about 7 mm., width and length of the aperture equal, and about 12 mm. In the young shells, however, the form is quite different, being proportionately higher and much narrower at the aperture; in both of these respects resembling the small Stenothecæ above referred to.

The internal markings of the shell leave no doubt as to its affinities being with the Gasteropods; in the young individual herewith figured they are well displayed, the course and extent of the muscular impression being clearly defined: the apex is directed backward and the muscular scar is of an elongated horse-shoe form.

Except for the absence of an involute apex this species is not unlike *Carinaropsis carinata* (Hall) of the Trenton formation; it is compressed near the apex, and expands rapidly toward the aperture in a manner similar to that species, but in the way in which the concentric ridges are added it is comparable with *Metoptoma (?) rugosa* (Hall).

It lived in shallow seas along the coast, if one may judge from the species associated with it, and probably was a bottom-crawler. The true Stenothecæ appear to have been more varied in habitat, as some are found in company with Hartt's species, and others in finer shales, where they are buried with remains of seaweeds (?), sponges, hydrozoa, etc. A fact in relation to the variation of resembling forms like these is related by Dr. Woodward in his "Manual of the Mollusca," where he speaks of several wide limpets which assume a narrow compressed form when growing on the stems of seaweeds. Similar differences of habitat may have led to the characteristic form of the aperture and other features which distinguish *S. acadica* from the more typical Stenothecæ.

The vertical range of this species is not great, for it is not known either above or below Div. 1c, but it is rather common where it does occur, and its associate species are those that have been found to abound in comparatively shallow water near the shore line. At an horizon corresponding to that in which our species is found, occurs the European *Metoptoma barrandei* (Linnarsson.)

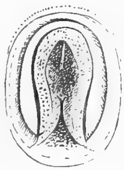


FIG.—*Stenotheca* (sub-gen.?) *acadica*, Hartt, sp., magnified $\frac{6}{1}$, young individual exhibiting the internal characters of the shell. The horse-shoe shaped muscular impression open in front, the visceral cavity with a sharp ridge thickening and stiffening the apex. The inner area of the visceral cavity is lozenge-shaped opposite the more rigid part of the dorsal ridge.

ORIGIN OF THE AINOS AND THEIR FINAL SETTLEMENT AND DISTRIBUTION IN JAPAN.

BY D. P. PENHALLOW.

The Ainos probably displaced an earlier race of people in Japan, or at all events found remains of such a people there. Considering, then, that they are not truly autocthonous, we are led to inquire into their origin, as well as their first appearance in the country. Naturally, we first of all seek evidence from the people themselves, concerning their ancestors and their first appearance in the country ; but in so doing we are furnished with traditional lore, which, however interesting, often proves of little value in arriving at the true facts. Yet it is proper for us to give these traditions due consideration, as being the only historical records of the people.

The principal tradition of their origin is that already related,[1] according to which Jinmu Tenno, the founder of the Japanese, became displeased with his daughter and set her adrift in an open boat. After floating about for some days, she landed on the distant shores of an island now called Yezo, and there formed an attachment for a dog, the result of the union being the first of the Aino people.

Such a tradition possesses no value, and in all probability it did not originate with the Ainos themselves, but with the Japanese who sought to degrade them as much as possible. Moreover, the Japanese origin of this tradition seems the more probable, when we consider that they have endeavored to give the story a certain plausibility by tracing an immediate connection between it and the word, *Aino.* Thus, in Japanese, the word *inu* means a dog, and certain scholars maintain that the word, *Aino*, is but a corruption of this, it being originally applied in allusion to the supposed origin of the people. Yet again, other scholars endeavor to make the word a derivation of *ai-no-ko*, "an offspring of the middle," as signifying a cross between a woman and a dog.

The entire tradition loses whatever of value it may have possessed, when we bear in mind that the Japanese occupation occurred about B.C. 600, and the history of this latter people, points most unmistakably to the occupation of the country at that time by the Ainos. Moreover, if hard pressed for a reason for holding such a tradition, the Ainos usually reply with primative simplicity, "because the Japan ese tell us so." The reluctance which the Ainos exhibit in making this statement, is but a further evidence of the lingering awe with which they regard their conquerors.

That they owe their existence to a god, is also one of the leading traditions of the Ainos; but where they first appear ed, they cannot say.

Mr. Griffis speaks of the word, *Aino*, as of rather modern

[1] See Canadian Record of Science, i. 228–236.

origin; but this there is good reason to doubt. At all events, in their own language, the word means "man" and appears to be the only equivalent of this word in use; and every attempt to trace it back to *inu* or *ai-no-ko* would but strengthen our belief in attempts to degrade the Aino as much as possible. This, moreover, is in accord with the line of policy which has been pursued by the conquering people from the first up to very recent date, for we find that with their advent the Ainos were looked upon with contempt as very inferior beings; and, as they did not give way to the new-comers quite rapidly enough, were pursued into the northern wilds by a war of extermination. From that time on, the Japanese have considered it degrading to have any relations with the Ainos, other than those which would naturally exist between a conquering and conquered people; and, in carrying this policy to an extreme, there might and doubtless would arise many stories greatly to the disadvantage of the Aino, which, repeated through several centuries, would come to be looked upon by many as true, and finally accepted to a certain extent by the Ainos themselves because of their realizing the gulf which separated them from the Japanese, as well as faith in the superior knowledge of the latter.

We must, therefore, look elsewhere for the origin of this interesting people; and we naturally turn at once to an examination of them as they are found at the present day, as well as of localities where they have been, and where they have left undoubted evidence of their presence in words of their language which still linger as first applied to natural objects. Of the Aino movement previous to their occupation of Japan, we can derive no evidence from remains of their manufactures or structures, for none of these have yet been found; and we are thus brought to base our knowledge of their progress upon remnants of their language, which, after all, is the most reliable guide we can probably have, particularly when supplemented by physical characteristics and traditions.

We are well aware that, even at the present time, the Ainos are familiar denizens of eastern Siberia, but it is desirable to determine whence they came for settlement even there.

Throughout the length and breadth of Japan, as we find it to-day, there are many Aino names, clearly recognizable as such, applied to mountains and other prominent natural objects as well as to places, towns and cities; and these are permanent monuments exactly similar to the lasting record of their former greatness, which our North American Indians have left in such names as Connecticut, Winnipesaukee, Niagara, etc., etc. Though the Aino words have undergone much modification at the hands of the Japanese, yet it is difficult so to disguise them that they cannot be recognized. Conspicuous examples of this are to be found in the present name of the town Matsumai from the Aino *Mado-mai*. Likewise in the modern capital town of Sapporo, we have a corruption of the Aino *Satsu-poro*, "a great dry place." And if we apply this test more generally, we may readily discover traces of the Ainos over a much wider area. Thus *Kurile*, applied to the northern chain of islands reaching to Kamschatka, is a distinctively Aino word. When in this manner we get back to the continent, we there discover still further undoubted traces of this people.

Upon this point Latham [1] says:—"I cannot think it is by mere accident that the root, *kor*, appears in the names, *Kor*ia, *Kur*ile and *Kor*iak; nor yet that it is by accident that, when we reach the Baltic, the same syllable appears in *Kar*dia and *Kur*land, also reappearing in the name of the government of *Kur*sa." Pritchard [2] considers the Aino to be closely related to the Samoides and Caucasian tribes, thus leading us to examine western Siberia for evidences of their early home and settlement. Yet again Brace [3], who regards the Japanese as a graft on the Ainos, speaks of the latter in such terms as might lead us to believe that they "belong to the north Turanian family, and though their language does not precisely determine the race, probably the Tungusian." Wood [4] gives great weight to matters of tradition, and is thereby strongly led to the belief in a western origin, for

[1] Descriptive Ethnology.
[2] Nat. Hist. of Man., p. 227.
[3] Races of the Old World.
[4] Trans. Eth. Soc., New Series, iv. 34, etc.

he tells us that, "the chief objection to a northern origin for the Aino is, that they persist in cherishing the tradition that their ancestors came from the west; that is from some place in the direction of the Asiatic continent."

Here and there, along the northern borders of Siberia, are also to be found remnants of a language which show the undoubted presence at some former period of the Aino people, and we may thus retrace their course until, as all the evidence now at our disposal permits, we locate them in the region of the Southern Caucasus, as the centre from which they were dispersed. This view is, as we have seen, consistent also with tradition; and, if we also add the evidence of physical characteristics, then we must grant the probable correctness of this view.

Dr. Scheube, after elaborate studies of this people, distinctly states that there is "no Mongolic type in the Aino," and he further speaks of them as most nearly comparable to the Russian peasantry. Topinard[1] expresses the same view, and speaks of them as comparable to the people of the Moscow district.

The appearance of the Aino is so distinct from that of the Japanese as to determine a wide separation of the two people, even upon the most casual inspection. What these distinctions are, will appear on another occasion; but I may observe in passing, that an unprejudiced observer at once notes the very close resemblance, even in color of skin, which the Ainos bear to Europeans, and all the best accounts of this people speak of this.

After reaching the eastern confines of Siberia, it is a comparatively easy task to trace the Ainos in their subsequent wanderings. They appear first to have spread along the coast from Kamschatka southward, probably as far as Mongolia. Finding the Island of Karafuto—Saghalien—easily reached by boats, and, at certain times when the tides were favorable, even on foot, they were naturally led in time to occupy a territory which afforded, in its streams, an abundance of food in the form of fish. Eventually, the narrow

[1] Anthropology, p. 476. See also *Nature*, xxvi. 524, etc.

strait of La Perouse was easily crossed, and the Island of Yezo was then found to hold out the same temptations to settlement which had previously been discovered in Karafuto. From this point, different considerations operated to tempt them in opposite directions. To the north-east, the long line of the Kuriles offered tempting fishing-grounds from which could be obtained, in the seal and sea otter, an abundance of food and warm clothing; while they would hardly encounter a more rigorous climate, probably less so, than that to which they were accustomed in Siberia. We have also to bear in mind that these islands, as well as the Aleutians, may have been occupied from the north. Again, from Yezo, as a starting point, they found temptations in an opposite direction, not only in an abundance of fish, but in an increasingly warm climate and an abundance of vegetable food which would become of a more enticing character as they constantly progressed southward. The material which they were accustomed to use for clothing in Siberia, they still found abundantly in Yezo and Northern Honshiu. Thus in course of time, the Ainos came to occupy the entire chain of Japanese Islands from the extreme north, probably as far south even as the Riu-Kiu Islands, and it was thus that the Japanese found them at the time of their occupation. As the Japanese came more fully into possession of the country, they preserved and adopted into their own language such names of very prominent natural features as had been bestowed by the Ainos; and these, often with great modification, remain at the present time as evidence of the former presence of this people.

At first gaining a foothold upon their new territory through peaceful overtures, the Japanese, with the consciousness of increasing strength, no longer preserved the measures of precaution dictated by prudence born of a sense of the Ainos' savage superiority; but gradually adopted more boldness, made demands where before treaty was required by good judgment, and finally became openly aggressive. Thus, gradually, they came to occupy the entire southern extremity of Honshiu and the adjacent islands. The Ainos in the meantime, at first susceptible to kindly overtures, gradually became suspicious and uneasy as the strength of the Japanese increased and their demands were more openly made and boldly enforced. Seeing their lands and choicest hunting-grounds fast taken from them, they soon felt that, by a resort to force only, could they hope to preserve their natural rights. Then followed a series of bloody wars in which the Japanese, possessing superior skill and weapons, were in the end victorious, and the poor aborigines were driven further and further towards the northern portion of the country in the direction from which they came. Early Japanese history is filled with accounts of this constant struggle.

The retreat of the Ainos seems to have been slow, however, and stubbornly made, for in A.D. 110, seven hundred years after the first landing of the Japanese, the Ainos were still in possession of the region extending southward from Tokio to the Hakone Mountains, and at this date is chronicled an important campaign of Yamato-Dake against the savages of this district. By the middle of the fourth century, the war, which had been continuously waged against the Ainos for so long a time, had driven them well to the north, so that they were confined principally to the region lying beyond lat. 38° N. The policy which led to constant warfare with the Ainos, continued in full force and was perhaps given fresh strength, when, quite at the end of the twelfth century, the Mikado appointed Yoritomo as his great general, or "barbarian-subjecting great general," the Tei-i-tai Shogun. Driven finally to the limits of Honshiu, their last hold on the main island was lost; and crossing the Straits of Tsugaru (Sangar), they found refuge in the wilds of Yezo. Not even here, however, did they find immunity from persecution, for the Japanese soon discovered the valuable fisheries and compelled the Ainos to yield an unwilling consent to their occupation of the island. Thoroughly subdued at last, with broken spirits, they calmly bowed to the inevitable and became quietly submissive, and thus it is that we find them to-day.

It will thus readily be seen that the relations of the Aino to the Japanese were and are precisely those of the American Indian to the European, and in this history is truly repeated. It is the same story of pacific intentions, bold demands, aggressive acts, and continual wars, resulting in the final subjugation and extermination of a weaker race. During the first centuries of conquest, the Ainos were called *Ebisu*, literally "savages," but later this name gave place to that by which they are now known.

If we are to examine the present geographical distribution of the Ainos, we find the southern limit in Yezo, where they are most abundant now. According to the most recent and trustworthy statistics, there are in all 16,637, of which 8,316 are men and 8, 321 women.[1] They are distributed in the eleven provinces of Yezo as follows:—

Ishikari,	1,058	Shiribushi,	857
Iburi,	3,726	Hitaka,	5,270
Tokachi,	1,498	Teshiwo,	352
Oshima,	245	Kushiro,	1,449
Nemuro,	473	Chisuma,	460
Kitami,	1,249		

Of these, however, 750 were brought from Karafuto to the province of Ishikari, when in 1876 Saghalien was ceded to Russia in exchange for the Kuriles. In addition to these, Ainos are found in Saghalien, on the opposite Siberian coast and in Kamschatka, as also to a more limited extent in Alaska.

Having progressed so far eastward, it is hard to conceive why these people should not have continued in the same direction as long as there were no great barriers. Spreading as they did from one island to another through Japan and the Kuriles, there is no reason why they should not have visited the various members of the Aleutian chain and

[1] Braun's (*Science*, ii. 134, see also i. 210 and 307,) endeavors to make it appear, from statements of missionaries and from estimates based upon the villages he passed, that there are at least 50,000 Ainos. His grounds, however, are wholly unwarrantable and his conclusions in direct conflict with the most reliable official statistics, for which he professes a profound contempt. The figures given above are essentially the same as those given by Dr. Scheube, who states the Aino population to be 17,000 in round numbers.

thus in time have reached America at a very early period. The difficulties to be met were hardly greater than those they must have encountered in passing to and from many of the islands of Japan. We are thus seriously led to ask, if some of the resemblance between the Ainos and Esquimaux are not indications of affinity rather than mere coincidences?

There thus appear possibilities of an Asiatic influence upon our earliest settlers, which may have been more than passing; but the field for speculation in this direction enlarges so rapidly, that we must await the accumulation of facts, which are now wanting, before correct judgment can be given.

New Fresh-Water Sponges from Nova Scotia and Newfoundland.

By A. H. MacKay.

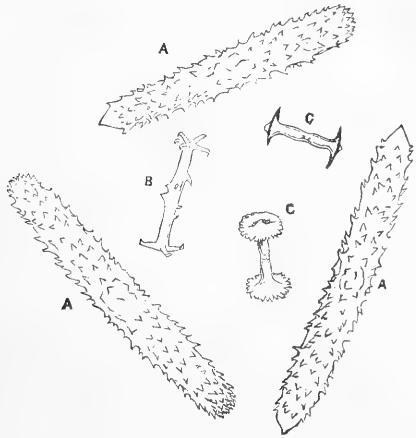
In the article on Organic Siliceous Remains found in the Lake Deposits of Nova Scotia, published in the last number of the Record of Science, Nos. 3 and 8 of the list of sponges were referred to as new. I here quote the original descriptions of the species, to which I append some observations. In the *Annals and Magazine of Natural History* of London, January, 1885, Mr. H. J. Carter, F.R.S., of England, describes a species from a lake in Pictou County, Nova Scotia, as follows:—

"*Spongilla mackayi*, n. sp.—Sessile, spreading, charged with little subglobular bodies like large statoblasts, about 1-12th inch. Skeletal spicule acerate, slightly curved and sharp-pointed, more or less thickly spined, averaging 50 by $2\frac{1}{2}$-6000ths inch in its greatest diameters; [accompanied abundantly by minute birotulate flesh-spicules precisely like that of *Meyenia everetti*—that is 3 to 4-6000ths inch long, with very thin smooth shaft about four times longer than the diameter of the rotule, which is 1-6000ths inch, toothed, with the teeth recurved.] Statoblasts globular, consisting of a thick chitinous coat filled with the usual germinal matter, from which is very slightly prolonged an everted trumpet-shaped aperture; bearing slight traces externally of microcell-structure and the polygonal tissue; making one of twenty such which are arranged so as to form a subglobular body of the size mentioned; situated around a central cavity with their apertures *inward*; the whole supported by statoblast spicules of various sizes, which, intercrossing each other, form a net-like globular capsule, in which the outer parts of the statoblast are fixed and covered; apparently (for the specimen is dry) deficient at one point, which leads to the central cavity. Statoblast spicules acerate, sharp-pointed, like the skeletal spicules, but becoming much shorter and more coarsely spined as they approach the chitinous coats of the statoblasts, where they may be reduced to at least 27-6000ths inch in length, although often increased to 4-6000ths inch in thickness, and their spines, which are very irregular in size and situation, often as long as the spicule is broad."

The words in brackets are mine. Mr. Carter goes on, however, to notice the remarkable fact that this spongilla has flesh spicules identical with those of *M. everetti*; and suggests that possibly they may not belong to *S. mackayi*, but that their presence may be owing to the proximity of *M. everetti*, which grows in the same lake. My subsequent observations go to prove that Mr. Carter's surmise is correct, and that the flesh-spicules in the specimen are adventitious. When in St. John's, Newfoundland, this summer, I was conducted by the well-known historian and scientific observer, Rev. Moses Harvey, to Virginia Lake, a beautiful sheet of water, a few miles from the city, in which the development of *Spongilla mackayi* is very luxuriant on the stones, etc., in depths of from two to four feet of water. I have not observed these flesh-spicules in the specimens from Newfoundland or in other specimens from Nova Scotia.

The second new species was described by Mr. Edward Potts before the Philadelphia Academy of Natural Sciences, at its meeting of Feb. 24th, 1885, as follows:—

"*Heteromeyenia pictovensis,* n. sp.—Sponge light green, even when dry, massive, encrusting; texture very compact; spicules non-fasciculated, persistent; surface mostly smooth. —Gemmules very scarce, spherical crust thick.—Skeleton spicules cylindrical, short, robust, rounded, or abruptly terminated; entirely spined, spines conical at the centre of the spicule, elsewhere generally curving *forward,* or towards each extremity. Rounded terminations of spicules covered with short spines, though frequently a single large spine or acute termination is seen at one or both extremities.—



HETEROMEYENIA PICTOVENSIS.

A.—Skeleton spicule.
B.—Long statoblast spicule.
C.—Short statoblast spicule.

Dermal spicules absent or undiscovered.—Birotulates of the longer class surrounding the gemmules, rather numerous, one half longer than the others; shafts conspicuously fusiform or largest at the centre, where are frequently found one or more long spines; their rotules consist of three to six irregularly placed rays, recurved at the extremities. —Birotulates of the shorter class abundant and compactly placed around the gemmule; shafts mostly smooth, though sometimes bearing a single spine; irregularly cylindrical, but rapidly widening to support the rotules, which are large, umbonate, nearly flat, and finely lacinulate at their margins; occasionally bearing spines. — *Measurements.* Skeleton spicules 0·0075 inch long, by 0·00075 inch thick; length of long birotulates 0·0021 inch; of short birotulates 0·0012; diameter of disc of latter 0·0009 inch."

This is one of the most beautiful of our fresh-water sponges. It is so much more compact and firm than our other sponges, that it can nearly infallibly be recognized at sight or by touch when once seen and handled. Its range in Nova Scotia is quite extensive: it has been found on the Atlantic and Gulf slopes. It is also abundant in Newfoundland. *S. mackayi* is also easily recognized without microscopic examination when once seen. Its encrusting habit, with the conspicuously large compound statoblasts, is very characteristic. Its nearest congener is the variety of *Spongilla fragilis* (Leidy) described by Dr. Geo. M. Dawson as *S. ottawaensis.*

The Sun Dance of the Cree Indians.

By Campbell Lane.

When serving with my brigade in the recent Northwest Rebellion, I had an opportunity of witnessing a traditionary custom of the Indians, which may be of interest from an anthropological point of view. The ceremony was the Sun Dance. It is sometimes known as the "Great Thirst Dance," and not unfrequently as the "Torture Dance." By the former name, however, it is more generally known among the white settlers of the Northwest. The dance I attended began at 7 o'clock p. m. on Thursday, May 28th, and was continued till Saturday, 30th, at the same hour. It was Saturday afternoon when I arrived. Chief Pie-a-Pot's band, together with his visitors from other reserves, were all encamped in tents.

Having passed through the line of deserted *tepees*, forming the circumference of the camp, we approached a high central tent whence issued the beating of drums, the blowing of whistles and a monotonous drone, which told of some ceremony in progress within. Entering this tent under the guidance of two medicine men, who appeared upon our arrival, we found the chief busily engaged in the ceremony of blowing a whistle and jumping in time to the orchestra of *tom-toms* or Indian drums. After the lapse of a period of time sufficient to satisfy his sense of dignity, he came forward and welcomed us.

The tent where the dance was taking place was about forty feet in diameter. Formed like an ordinary tepee, it was decorated in the most fantastic way with colored calicoes, woollens, skins, boughs of trees and other articles. There was a large open space at the top of the tent, through which light and air were admitted. In the centre stood a stout poplar tree, shorn of its branches for some distance upwards, known as the "Medicine Pole." The tent was divided into three portions. One was reserved for spectators, consisting of small children, mothers with babes, old men and women and others who took no official part in the proceedings. The two other divisions of the circle were devoted to the braves and squaws who, after the system followed in the synagogue, were kept apart. Directly opposite the entrance was an orchestra of fifteen *tom-toms.* This musical instrument is formed by stretching a skin over a round wooden hoop, about the size of a side-drum head. Underneath are two transverse bars of wood, which the musician holds in his right hand, while he beats with his left. The time kept is what is known as double time, or the same as that of a jig. Round the interior border of the tent were two rows of stalls, an inner and outer, in which the participants in the Sun Dance were placed. In front of these stalls there was a wooden railing, or fence, breast high.

When the dance began, on an incantation from one of the medicine men—there being two who assumed direction of the ceremony—all those in the stalls jumped and blew whistles, keeping admirable time with the tom-toms. There was also a circle of warriors in full fighting attire, musket in hand, in the centre. Between each dance, which lasted from ten to fifteen minutes, came an interval of from three to five minutes.

When the tom-toms ceased to beat, the medicine man selected from the line of warriors a brave, who immediately fell out of the ring. With an air of great dignity he paraded before the orchestra, reciting his experiences as a public man. These were twofold. He told with accuracy of detail how many Blackfeet or hostile Indians he had killed, and how many horses he had stolen, being rated by the rest of the tribe accordingly. In the course of his narrative he frequently adopted the highly tragic vein, and gesticulated freely. He then fell again into the ring, and in a circle they all jumped to the music which had recommenced, muttering an indescribable, partially suppressed howl. Such are the attendant circumstances to the great event of the festival.

All those engaged in the dance were in war paint, even including the women, but no special pattern was followed, and the result was a curious blending of inharmonious colours and unsymmetrical patterns on the same face.

The object of the Torture Dance is to initiate warriors. The young " bucks" or " squaw-bucks," as they are called, in order to graduate into the class of warriors or " braves," must undergo this ordeal. Before they become initiated they are on a par with the squaw as regards the division of labour, which means that, like the squaw, they have all the menial and heavy work to do, the full-fledged brave merely going on the warpath and stealing horses.

The young " buck" is in full war paint, and, when his turn comes, is called out by the medicine man, before whom he appears perfectly nude but for a breech-clout about his loins. Stepping to the front near the entrance to the tent, he takes up too small flags or bannerettes, one in each hand, and after a few preliminary facings in the way of extending his arms, advancing towards and retiring from the medicine pole, sits down. The medicine men then close in around him, as the rest of the tribe are not allowed to see the incision, and with a sharp knife cut into his breast an inch above the nipple. As our party wore uniforms, we were invited to witness the operation. The knife used on this occasion resembled somewhat a shoemaker's knife, and though sharp, was hardly as pointed as the large blade in a pocket pen-knife. As the incision was made, a noise resembling the tearing of linen, a good deal deadened, was heard. The effect on a white man is not altogether pleasant. The knife came out of the flesh about three or four inches from the spot at which it entered. It was left there until the medicine man stooped to pick up a skewer about as thick as a common lead pencil. It was then withdrawn and the skewer inserted in its place.

During the whole of this operation the young buck never quailed, nor did his eye, which bore a perfectly stolid expression, reveal the slightest trace of suffering. Suspended from the top of the medicine pole were two ropes, to the end of each of which was fastened a leather thong. This latter was attached to each of the skewers (for the incision was made in each breast), and the buck thus firmly tied. This performed, an incantation by the medicine man followed. The music as described, recommenced, and the dance in all its ghastly earnestness began. The young buck was compelled to dance in time, swinging through the circle in which the spectators were found, and keeping the ropes tightened by a centrifugal tension. The flesh and skin of his breasts were thus drawn out in a pointed shape about half a foot from his chest. He had to continue pulling on the ropes in this way until by degrees the wooden pegs were torn out. When he had succeeded in doing this, the medicine men moistened the ends of their fingers with some herb they were chewing, and applied them to the lacerated flesh, completely staunching all effusion of blood. They then turned the exhausted man over on his face and called for the next novice.

Sometimes, instead of breast-pins, shoulder-pins are driven through the upper arm in line with the collar bone. Another mode of torture is the fastening, by a similar process, of a cord between the shoulder blades, to which is appended a buffalo head and horns. The buck is then made to walk about the tent, dragging it on the ground behind him. There are also various other refinements of cruelty practised. They had just released a youth from the shoulder-pin test when I arrived. He stood there fainting and trembling from mingling exhaustion and pain.[1]

For those candidates who are initiated at the opening of the dance, the feeling is simply that of intense physical pain. But those who undergo the test after forty-eight hours of fasting, and after taking part in the ceremony day and night without sleep, frequently faint under the agony, and have to be cut down. This involves their going through the torture *de novo* in order to become braves.

Such is the Sun Dance. The young bucks never shrink from the crucial test of valour, but seem rather to court it. It seems strange, however, that the degree of nerve and indifference to suffering which this dance engenders, should not develop in the Indians a greater courage. Yet the youth who bears with unflinching pluck these terrible agonies, is taught never to fight, when on the warpath, unless he considers himself to be at an advantage.

An Abstract of the Presidents' Addresses.

By R. W. Boodle.

Whether the Presidents of the British and American Associations speak as the representatives of the lay world to the world of science (and this was their chief duty during the earlier years of the British Association), or whether their annual addresses are primarily intended as a means of popularizing the recent progress of science—they are naturally listened to with profound attention. Neither Sir Lyon Playfair's address at Aberdeen, nor Professor J. P. Lesley's at Ann Arbor,[2] however, falls within these categories. The former is of an eminently practical nature, devoted to pointing out the defects of popular education as it exists in Great Britain at the present moment. On the

[1] It sometimes takes an entire day for the pin to make its way through the flesh outwards.

[2] The two addresses bear date: Sir Lyon Playfair's, September 9; Professor Lesley's, August 26.

other hand, Professor Lesley prefers to speak to the inner circle of scientists as one of themselves, and his address might have been called "The True Temper of the Scientist." The result is that the two addresses cover very different grounds and can hardly be compared together, though each is interesting in a different way.

The address of the American President cannot fail to strike the reader as being distinctly conservative in tone. He poses as the representative of older scientists to the rising generation, dwelling on the dangers and folly of empiricism. 'Do not go too fast!' he says, 'Your own character is more important than the construction of new theories. We have too many of these: what we want is solid work and extreme caution.' Character, he insists, should not be sacrificed to science, which is "our means, and not our end. Self-culture is the only real and noble aim of life." There is danger of an over-accumulation of scientific information: "Not only the avarice of facts, but of their explanations also, may end in a wealthy poverty of intellect for which there is no cure. . . . How much we know is not the best question, but how we got at what we know; and what we can do with it; and above all what it has made of us. . . . I beg you to reflect that it is as true of science as of religion, that the mere letter of its code threatens its devotee with intellectual death; and that only by breathing its purest spirit can the man of science keep his better character alive."

The pursuit of science should be made ancillary to the public good. They are indeed closely connected. "Every advancement in science is of its own nature an improvement of the commonwealth. Every successful study of the laws of the world we inhabit inevitably brings about a more intelligent and victorious conflict with the material evils of life, encouraging thoughtfulness, discouraging superstition, exposing the folly of vice, and putting the multitudes of human society on a fairer and friendlier footing with one another. The arts of philanthropy are therefore as direct an outcome of science as is the lighting of the public streets, or the warming of our homes."

Among other questions closely connected with science is the problem of universal education; and while only a few in each community can acquire wealth of knowledge, these few must get it for themselves, and must work hard for it. It is not desirable to make the acquisition of knowledge too easy. "The harder the dinner is to chew, the stronger grows the eater. Canned science, as a steady diet, is as unwholesome for the growing mind as canned fruits and vegetables for the growing body. The wise teacher imitates the method of nature, who has but one answer for all questions: *Find it out for yourself, and you will then know it better than if I were to tell you beforehand.*" The lecturer recognized an evil tendency "in the present popular rage for over-classification, unification, and simplification of science; for ultra-symmetrical formulæ, and excessive uniformity in nomenclature." There is no logical consistency in Nature; nor can the work of the student be over-simplified without danger of its failing to produce genuine men of science.

It is characteristic of science that great discoveries can come only at long intervals, and the claim to special attention made by inexperienced stumblers on forgotten facts should be deprecated. The progress of science the President compared to a procession, in which "two facts arrest attention: first, the eager gaze of expectation which the crowd of lookers-on direct towards the quarter from which the procession comes, and their unaccountable indifference to what has already passed; and secondly, the wonderful disappearance, the more or less sudden vanishing out of the very hands of the carriers, of a large majority of the facts and theories of which they make so pompous an exposure; few of them however seeming to be aware that thereby they have lost their right to participate in the pageant, and should retire from it into the throng of spectators, at least until good fortune should take pity on them and drop some new trifle at their feet to soothe their wounded vanity."

The audacity with which young students take up difficult problems should be discouraged. "Shall such themes as the nebular hypothesis, the probable solidity or fluidity of our planet, the metamorphosis of rocks, the origin of serpentine or petroleum, the cause of foliation, the stable or unstable geographical relationships of continent to ocean, the probable rate of geological time, the conditions of climate in the ages of maximum ice, the probable centres of life-dispersion, the unity or multiplicity of the human race, the evolution of species, be babbled over by men, the amount of whose efficient work in any branch of science is measurable with a foot-rule; while those, whose entire lives have been but one exhausting struggle with the shapes which people the darkness of science, speak with bated breath and downcast eyes of these great mysteries?"

Young scientists test the value of old truths by new discoveries, but veterans reverse the rule and try new discoveries by well-established principles. The progress of science depends on the interaction of these mode of procedure. "Not by the mere increment in number of facts learned, not by the mere multiplication of discoverers, teachers and students of those facts, but by the elevation of our aims, by the enlargement of our views, by the refinement of our methods, by the ennoblement of our personalities, and by these alone can we rightly discover whether or not our Association is fulfilling its destiny by advancing science in America."

Professor Lesley concluded his address by insisting on the absolute necessity for more "Dead-work" being done by the true scientist. This department of science "comprises the collection, collation, comparison and adjustment, the elimination, correction and re-selection, the calculation and representation—in a word, the entire, first, second, and third handling of our data in any branch of human learning,—wholly perfunctory, preparatory, and mechanical, wholly tentative, experimental, and defensive,—without which it is dangerous to proceed a single stage into reasoning on the unknown, and futile to imagine that we can advance in science ourselves, or assist in its advancement in the world."

In regard to this, five propositions were laid down: "(1) That without a large amount of this dead-work there can be no discovery of what is rightly called a scientific truth. (2) That without a large amount of dead-work on the part of a teacher of science he will fail in his efforts to impart true science to his scholars. (3) That without a large amount of dead-work no professional expert can properly serve, much less inform and command, his clients or employers. (4) That nothing but an habitual performance of dead-work can keep the scientific judgment in a safe and sound condition to meet emergencies, or prevent it from falling more or less rapidly into decrepitude; and (5) That in the case of highly-organized thinkers, disposed or obliged to exercise habitually the creative powers of the imagination, or to exhaust the will-power in frequently recurring decisions of difficult and doubtful questions, dead-work, and plenty of it, is their only salvation; nay, the most delicious and refreshing recreation; a panacea for disgust, discouragement and care; an *elixir vitæ;* a fountain of perpetual youth."

In the course of illustrating these propositions, President Lesley insists on the impossibility of delegating dead-work to other men. "The man who cannot himself survey and map his field, measure and draw his sections properly, and perfectly represent with his own pencil the characteristic variations of his fossils forms, has no just right to call himself an expert geologist. These are the badges of initiation, and the only guarantees which one can offer to the world of science that one is a competent observer and a trustworthy generalizer. Nor has one become a true man of science until he has already done a vast amount of this dead-work; nor does one continue in his prime, as a man of science, after he has ceased to bring to this test of his own ability to see, to judge, and to theorize, the working and thinking of other men." Teachers in science have special need to bear this in mind, for learning is not knowledge, but, as Lessing says, our knowledge of the experience of others. "Knowledge is our own. No man really comprehends what he himself has not created. Therefore we know nothing of the universe until we take it to pieces for inspection and rebuild it for our understanding. Nor can one man do this for another: each must do it for himself; and all that one can do to help another is to show him how he himself has morsellated and recomposed his small particular share of concrete nature, and inspire him with those vague but hopeful suggestions of ideas which we call Learning, but which are not Science."

If the science of Canada should profit by the matured wisdom of Professor Lesley, our educationists have greater need to listen to Sir Lyon Playfair's address. It would be idle to maintain that education in Canada is in an ideal state of perfection. We are haunted by the phantom of a literary and classical training which is a reality in England. If the literary system of education is out of date there, it is a sham here. "In a scientific and keenly competitive age," the President says, "an exclusive education in the dead languages is a perplexing anomaly." It is a still greater anomaly where the conditions of society are altered, and education is generally allowed to be a training for business rather than the acquisition of polish.

Sir Lyon Playfair's address naturally opens with remarks suggested by last year's visit of the Association to Montreal, in the course of which he pays graceful compliments to Canada, and alludes to Sir William Dawson's selection for the Presidency at Birmingham in 1886.

"Our last meeting at Montreal," he says, "was a notable event in the life of the British Association, and even marked a distinct epoch in the history of civilization. It was by no mere accident that the constitution of the Association enabled it to embrace all parts of the British Empire. Science is truly Catholic and is bounded only by the universe. . . . The inhabitants of Canada received us with open arms, and the science of the Dominion and that of the United Kingdom were welded. . . . Our great men are their great men; our Shakespeare, Milton, and Burns belong to them as much as to ourselves; our Newton, Dalton, Faraday, and Darwin are their men of science as much as they are ours. Thus a common possession and mutual sympathy made the meeting in Canada a successful effort to stimulate the progress of science, while it established, at the same time, the principle that all people of British origin—and I would fain include our cousins in the United States—possess a common interest in the intellectual glories of their race, and ought, in science at least, to constitute part and parcel of a common empire, whose heart may beat in the small islands of the Northern seas, but whose blood circulates in all her limbs, carrying warmth to them and bringing back vigour to us. . . . No doubt science, which is only a form of truth, is one in all lands, but still its unity of purpose and fulfilment received an important practical expression by our visit to Canada. This community of science will be continued by the fact that we have invited Sir William Dawson, of Montreal, to be our next President at Birmingham."

The four next sections of the address are devoted to the relations of Science to the State, to Secondary Education, to the Universities, and to Industry. Into the details of Sir Lyon Playfair's subject I have no intention of following him: I shall merely select such remarks as have special bearing upon the educational problem of Canada,—a problem which she has hitherto attempted to solve by following in the wake of the mother country and adopting, with little alteration, a system commenced before science in the modern sense was thought of, and continued because education in Great Britain is still too much regarded as the luxury of the few rather than a necessary training for the many.

"How is it," Sir Lyon Playfair asks, "that in our great commercial centres, foreigners—German, Swiss, Dutch, and even Greeks—push aside our English youth and take the places of profit which belong to them by national inheritance? How is it that in our colonies, like those in South Africa, German enterprise is pushing aside English incapacity? How is it that we find whole branches of manufactures, when they depend on scientific knowledge, passing away from this country, in which they originated, in order to engraft themselves abroad, although their decaying roots remain at home. The answer to these questions is that our systems of education are still too narrow for the increased struggle of life."

Too much attention is paid purely to Latin and Greek, too little to the studies that are vital to the present age. "Generally, throughout the country, teaching in science is a name rather than a reality." In only three schools in Great Britain, according to the testimony of Playfair, is science adequately taught.

Turning to the Universities, Sir Lyon Playfair complains that with the wealthy exceptions of Oxford and Cambridge these are starved by the State. "The universities and colleges of Ireland have received about £30,000 annually, and the same sum has been granted to the four universities of Scotland. Compared with imperial aid to foreign universities such sums are small. A single German university like Strasburg or Leipsic receives above £40,000 annually, or £10,000 more than the whole colleges of Ireland or of Scotland. Strasburg, for instance, has had her university and library rebuilt at a cost of £711,000, and receives an annual subscription of £43,000. In rebuilding the University of Strasburg, eight laboratories have been provided, so as to equip it fully with the modern requirements for teaching and research.[1] Prussia, the most economical nation in the world, spends £391,000 yearly out of taxation on her universities. The recent action of France is still more remarkable. After the Franco-German war the Institute of France discussed the important question:—'Pourquoi la France n'a pas trouvé d'hommes supérieurs au moment du péril?' The general answer was because France had allowed university education to sink to a low ebb."

Startled by the intellectual sterility demonstrated by the war, "France has made gigantic efforts to retrieve her position, and has rebuilt the provincial colleges at a cost of £3,280,000, while her annual budget for their support now reaches half a million of pounds. In order to open these provincial colleges to the best talent of France, more than

[1] The cost of these laboratories has been as follows:—Chemical Institute, £35,000; Physical Institute, £28,000; Botanical Institute, £26,000; Observatory, £25,000; Anatomy, £42,000: Clinical Surgery, £26,000; Physiological Chemistry, £16,000; Physiological Institute, £13,900.

five hundred scholarships have been founded at an annual cost of £30,000. France now recognizes that it is not by the number of men under arms that she can compete with her great neighbour, Germany, so she has determined to equal her in intellect. You will understand why it is that Germany was obliged, even if she had not been willing, to spend such large sums in order to equip the university of her conquered province, Alsace-Lorraine. France and Germany are fully aware that science is the source of wealth and power, and that the only way of advancing it is to encourage universities to make researches and to spread existing knowledge through the community. Other European nations are advancing on the same lines. Switzerland is a remarkable illustration of how a country can compensate itself for its natural disadvantages by a scientific education of its people. Switzerland contains neither coal nor the ordinary raw materials of industry, and is separated from other countries which might supply them by mountain barriers. Yet, by a singularly good system of graded schools, and by the great technical college of Zurich, she has become a prosperous manufacturing country."

After thus comparing the aids given to university and to technical training on the Continent of Europe with the sums given by the State for such purposes in England—sums which appear magnificent, if compared with the subsidies received by our own Royal Institutions—the President concludes: "Either all foreign States are strangely deceived in their belief that *the competition of the world has become a competition of intellect*, or we are marvellously unobservant of the change which is passing over Europe in the higher education of the people."

In speaking of Science and Industry, Sir Lyon Playfair happens, though with a different purpose in view, to touch upon a subject more fully discussed by Professor Lesley in his address. "Though the accumulation of facts is indispensable to the growth of science, a thousand facts are of less value to human progress than is a single one when it is scientifically comprehended, for it then becomes generalized in all similar cases." Passing on, however, to the practical side of the subject, the President shows how the progress of the arts, even before science came to aid them, was traceable to three conditions: (1) The substitution of natural forces for brute animal power. (2) The economy of time. (3) Methods of utilizing waste products, or of endowing them with properties which render them of increased value to industry. "All these results are often combined when a single end is obtained—at all events, economy of time and production invariably follows when natural forces are substituted for brute animal force." And Sir Lyon Playfair points out that, during the last twenty years, the steam power of the world has risen from 11½ million to 29 million horse-power, or 152 per cent.

The concluding section of the Address is devoted to "Abstract Science, the Condition for Progress." Sir Lyon Playfair guards himself against the misconception that he is opposed to literary training. "My contention is that science should not be practically shut out from the view of a youth while his education is in progress, for the public weal requires that a large number of scientific men should belong to a community. . . . No amount of learning without science suffices in the present state of the world to put us in a position which will enable England to keep ahead or even on a level with foreign nations as regards knowledge and its applications to the utilities of life." In illustration of this fact, the advantages that the world gained from the learning of Erasmus are compared with those that accrued from the discoveries of Newton. The impetus given by the latter was not confined to the world of science. "Newton's discovery cast men's minds into an entirely new mould, and levelled many barriers to human progress. This intellectual result was vastly more important than the practical advantages of the discovery. . . . Truth was now able to discard authority, and marched forward without hindrance. Before this point was reached, Bruno had been burned, Galileo had abjured, and both Copernicus and Descartes had kept back their writings for fear of offending the Church." Turning to the great intellectual revolution of our own day, Sir Lyon Playfair adds that, "the recent acceptance of biology has had a like effect in producing a far profounder intellectual change in human thought than any mere impulse of industrial development. Already its application to sociology and education is recognized, but that is of less import to human progress than the broadening of our views of Nature."

The address concludes with the following remarks: " Abstract discovery in science is, then, the true foundation upon which the superstructure of modern civilization is built; and the man who would take part in it should study science, and, if he can, advance it for its own sake and not for its applications. Ignorance may walk in the path lighted by advancing knowledge, but she is unable to follow when science passes her, for, like the foolish virgin, she has no oil in her lamp. An established truth in science is like the constitution of an atom in matter—something so fixed in the order of things that it has become independent of further dangers in the struggle for existence. The sum of such truths forms the intellectual treasure which descends to each generation in hereditary succession."

The importance to Canada of such an address as Sir Lyon Playfair's lies, as I have said before, in the application. Canada can hardly regard her educational system as more than tentative, when she has no institutions devoted to the study of science exclusively and supported by Government aid.

NOTE ON BOULDER DRIFT AND SEA MARGINS AT LITTLE METIS, LOWER ST. LAWRENCE.

BY SIR WILLIAM DAWSON.

At Little Metis, as elsewhere on the south side of the St. Lawrence, the coast is fringed with a broad belt of boulders, wholly covered at high tide, but exposed at low tide, and occupying in many places a breadth of 30 to 50 paces, within which the boulders are packed very closely. They vary in size from 9 or 10 feet in diameter downward, and consist principally of orthoclase, gneiss, Labradorite rock and other crystalline rocks from the Laurentian of the north shore, here about 35 miles distant at the nearest point. With these are masses of the hard sandstones of the Lower Silurian rock of the south coast, and occasionally, though rarely, blocks of the Upper Silurian limestone of the inland hills to the south.

The boulders of this belt, though stationary in summer, are often moved by the coast ice in winter. This is well seen where they have been partially removed to form tracks for launching boats. In this case it is not unusual to find in the spring that such tracks have been partially refilled with boulders. On my own property, a track of this kind was completely blocked a few years ago by an angular boulder of sandstone nine feet in length, which had been lifted from a spot a few feet distant; and it is quite usual to find in a boat-track, cleared in the previous summer, a dozen boulders of two feet or more in diameter that have been dropped in it by the winter ice. Whether any of these blocks are being drifted at the present time from the north shore, is not known; but they are moved freely up and down the coast, and in dredging in depths of eight to fifteen fathoms, I have found evidence that large boulders are not uncommon on the bottom; and judging from the small specimens taken up by the dredge, they are similar to those on the shore, though apparently with a larger proportion of flat slaty fragments.

If the coast were now in process of subsidence, there can be no question that the boulders would be pushed upward and would eventually form sheets and ridges of boulders embedded in mud, much in the manner of the marine boulder-clays now found inland.

Above high water, on certain portions of the coast, there is a low terrace, only a few feet above the sea, and consisting of sand, shingle, and gravel, often with fragments of marine shells. Boulders are not numerous on this terrace and are usually merely fragments from ledges of local sandstone. Bones of large whales occasionally occur on this terrace.

Proceeding inland, we find a second terrace about thirty feet above the sea, and consisting of sand, resting on hard boulder-clay or till. This last at different places along the coast is seen to vary in quality, being sometimes hard and loaded with boulders, in other cases a clay with marine shells, and again a clay with few boulders except at its junction with the sand above. On the inner side of this terrace, where it adjoins the rocky ledges inland, there is often a raised boulder-beach like that on the present shore, but with fewer and smaller boulders, as if the transporting power had been less than at present, and possibly the time of its action more limited. But still higher, on rocky ledges rising to the height of fifty to sixty feet, there are large Laurentian boulders, on the average larger than those of the present shore, perched upon the bare rock and with a few Upper Silurian boulders from the south, which become more numerous and larger further inland. In some places these Silurian limestone boulders are sufficiently numerous to afford the material for the supply of lime-kilns providing for local requirements.

The exposed ridges of rock on the second terrace are sometimes polished with ice action, but without distinct striation, and especially on the southern and eastern sides. I had no opportunity to observe the condition of the rock surface under the boulder-clay. On the greater part of the sixty feet terrace, the rock surfaces are rough, and yet large boulders often rest directly upon them.

The till or hard boulder-clay of this coast would be claimed by some glacialists as glacier work; but there can be no doubt that these clays locally contain marine shells, and there is therefore no need of invoking land ice for their deposition. In this respect they agree with the drift deposits of the Lower St. Lawrence generally, except in the case of certain lateral valleys of the north shore which seem to have been occupied with local glaciers descending from the Laurentian highlands. [1]

[1] See Notes on Post-Pliocene of Canada, *Canadian Naturalist*, 1871-2.

ORIGIN OF THE AMERICAN VARIETIES OF THE DOG.[1]

BY DR. A. S. PACKARD.

The impression that the domestic dog of the old world has descended from wild species distinct from the wolf may be well founded, but in America the evidence tends to prove that the Eskimo, and other domestic varieties of dogs, were domesticated by the aborigines and used by them long anterior to the discovery of the continent by the Europeans, the varieties in question originating from the gray wolf or prairie wolf. First as to the Eskimo dog. From the following extract from Frobisher it appears evident that the Eskimo had the present breed of domestic dogs long anterior to the year 1577. Frobisher's account of the Eskimo themselves is, so far as we know, the first extant, and is full and characteristic. After describing the natives he goes on to say: "They frank or keepe certaine dogs not much vnlike wolues, which they yoke togither, as we do oxen and horses, to a sled or traile: and so carry their necessaries over the yce and snow from place to place: as the captive, whom we haue, made perfect signes. And when those dogs are not apt for the same vse: or when with hunger they are constrained, for lack of other vituals, they eate them: so that they are as needful for them in respect of their bignesse, as our oxen are for vs." [2]

Regarding the Eskimo dog, Richardson remarks in his "Fauna Boreali-America," p. 75: "The great resemblance which the domestic dogs of the aboriginal tribes of America bear to the wolves of the same country, was remarked by the earliest settlers from Europe (Smith's 'Virginia'), and has induced some naturalists of much observation to consider them to be nearly half-tamed wolves (Kalm). Without entering at all into the question of the origin of the domestic dog, I may state that the resemblance between the wolves and the dogs of those Indian nations, who still pre-

[1] From the *American Naturalist*, September, 1885.

[2] The Second Voyage of Master Martin Frobisher, 1577. Written by Master Dionise Settle, Hakluyt, New Ed., London, 1810, iii. 62.

serve their ancient mode of life, continues to be very remarkable, and it is nowhere more so, than at the very northern extremity of the continent, the Esquimaux dogs being not only extremely like the gray wolves of the Arctic circle, in form and color, but also nearly equaling them in size. The dog has generally a shorter tail than the wolf, and carries it more frequently curled over the hip, but the latter practice is not totally unknown to the wolf. . . . I have, however, seen a family of wolves playing together, occasionally carry their tail curled upwards."

The Hare Indian dog is also supposed to be a domesticated race of the prairie dog, as shown by the following extract from Richardson's "Fauna Boreali-Americana":—

"*Canis familiaris*, var. *B. lagopus*, Hare Indian dog. This variety of dog is cultivated at present, so far as I know, only by the Hare Indians and other tribes that frequent the border of Great Bear lake and the banks of the Mackenzie. It is used by them solely in the chase, being too small to be useful as a beast of burden or draught." It is smaller than the prairies wolf. "On comparing live specimens, I could detect no marked difference in form (except the smallness of its cranium), nor in fineness of the fur, and arrangement of its spots of color. . . . It, in fact, bears the same relation to the prairie wolf that the Esquimaux dog does to the great gray wolf."

Another variety of Indian dog is Richardson's *Canis familiaris*, var. *D. novæcaledoniæ*, Carrier Indian dog. The Attnah or Carrier Indians of New Caledonia possess a variety of dog which differs from the other northern races. "It was the size of a large turnspit dog and had somewhat of the same form of body; but it had straight legs, and its erect ears gave it a different physiognomy."

The Spitz dog, Mr. J. A. Allen informs us, is with little doubt a domesticated subarctic variety of the prairie wolf.

Sir John Richardson, in the appendix to "Back's Narrative," Paris, 1836, p. 256, remarks: "Indeed, the wolves and the domestic dogs of the fur countries are so like each other, that it is not easy to distinguish them at a small distance; the want of strength and courage of the former being the principal difference. The offspring of the wolf and Indian dog are prolific, and are prized by the voyagers as beasts of draught, being stronger than the ordinary dog."

The origin of the ordinary Indian dog of North America is obscure, but Richardson, who names it *Canis familiaris*, var. *C. canadensis*, North American dog, throws much light on its origin :—

"By the above title I wish to designate the kind of dog which is most generally cultivated by the native tribes of Canada, and the Hudson Bay countries. It is intermediate in size and form between the two preceding varieties, and, by those who consider the domestic races of dog to be derived from wild animals, this might be termed the offspring of a cross between the prairie and gray wolves. . . . The fur of the North American dog is similar to that of the Esquimaux breed, and of the wolves. The prevailing colors are black and gray, mixed with white. Some of them are entirely black. . . ." He quotes from Theodot's "Canada," written in 1630, to show that in the early period, and "perhaps even before the arrival of Europeans, they formed an esteemed article of food of the natives." Confirmatory of the theory of the Pre-Columbian origin of the Indian dog may be cited the following extract from "Hakluyt's Voyages" regarding the Indian dogs seen on Cape Breton island, p. 1593 :—

"Here divers of our men went on land upon the very cape, where, at their arivall they found the spittes of Oke of the savages which had roasted meate a little before. And as they viewed the countrey they sawe divers beastes and foules, as blacke foxes, deere, otters, great foules with red legges, pengwyns, and certain others. . . . Thereupon nine or tenne of his fellows, running right vp over the bushes with great agilitie and swiftness, came towards vs with white staues in their hands like halfe pikes, and their dogges of colour blacke not so bigge as a grayhounde followed them at the heeles ; but wee retired vnto our boate without any hurt at all received." (The Voyage of the Ship called the "Marigold" of M. Hill of Redrise vnto Cape Breton and beyond to the latitude of 44 degrees and an half, 1593, written by Richard Fisher Master Hilles, man of Redriffe. Hakluyt, iii. 239.)

It is probably this variety, the bones of which have been found by Dr. J. Wyman, in the shell heaps of Casco Bay, Maine. "The presence of the bones of the *dog* might be accounted for on the score of its being a domesticated animal, but the fact that they were not only found mingled with those of the edible kinds, but, like them, were broken up, suggests the probability of their having been used as food. We have not seen it mentioned, however, by any of the earlier writers, that such was the case along the coast, though it appears to have been otherwise with regard to some of the interior tribes, as the Hurons. With them, game being scarce, 'venison was a luxury found only at feasts, and dog fleshwas in high esteem.' . . . A whole left half of the lower jaw of a *wolf* was found at Mount Desert, measuring 7.5 inches in length, making a strong contrast in size with a similar half from a dog found at Crouch's cove. This was more curved, and a length of a little less than five inches." (*Amer. Nat.*, i. 576, Jan., 1868.)

It is possible that the Newfoundland dog was indigenous on that island, and also an offshoot of the gray wolf allied to the Eskimo. In their "Newfoundland," Messrs. Hatton and Harvey say that there are few specimens of the world-renowned Newfoundland dog to be met with now in the island from which it derived its name. "The origin of this fine breed is lost in obscurity. It is doubtful whether the aborigines possessed the dog at all; and it is highly improbable that the Newfoundland dog is indigenous. Some happy crossing of breeds may have produced it here. The old settlers say that the ancient genuine breed consisted of a dog about twenty-six inches high, with black ticked body, gray muzzle, and gray or white stockinged legs, with deer claws behind." Judicious treatment has greatly improved the breed. "Their color is white with black patches, curly coats, noble heads and powerful frames. The favorite Newfoundland dog at present is entirely black, of large size, from twenty-six to thirty inches in height, remarkable for his majestic appearance. It is now generally admitted that there are two distinct types of the Newfoundland dog, one considerably larger than the other, and reckoned as the true breed; the other being named the Labrador, or St. John's, or Lesser Newfoundland. The latter is chiefly found in Labrador, and specimens are also to be met with in Newfoundland," pp. 194-195.

Regarding the dogs of the Mexican Indians, Nadaillac says in his "Prehistoric America": "The European dog, our faithful companion, also appears to have been a stranger to them.[1] His place was very inadequately filled by the coyote,[2] or prairie wolf, which they kept in captivity and had succeeded in taming to a certain extent."

In a recent visit to Mexico, not only along the railroads, but in the course of a stage ride of about five hundred miles through provincial Mexico, from Saltillo to San Miguel, we were struck by the resemblance of the dogs to the coyote; there can be little doubt but that they are the descendants of a race which sprang from the partly tamed coyote of the ancient Mexican Indians. At one village, Montezuma, we saw a hairless or Carib dog as we supposed it to be; similar dogs are sometimes seen in the United States.

Finally that the domestic dog and gray, as well as the prairie wolf, will hybridize has been well established.

Dr. Coues has observed hybrids between the coyote and domestic dog on the Upper Missouri (see the *American Naturalist*, 1873, p. 385.) To this we may add our own observations made at Fort Claggett on the Upper Missouri in June, 1877. We then were much struck by the wolf-like appearance of the dogs about an encampment of Crow Indians, as well as the fort; they were of the size and color

[1] Certain kinds of dogs were, however, domesticated in America. They were called *Xulos* in Nicaragua, *Tzomes* in Yucatan, and *Techichis* in Mexico. These were considered to afford very delicate food after having been castrated and fattened.

[2] *Canis latrans*, Baird. In a description of Virginia, published in 1649, we read: "The wolf of Carolina is the dog of the woods. The Indians had no other curs before the Christians came amongst them. They are made domestic. They go in great droves in the night to hunt deer, which they do as well as the best pack of hounds."

of the coyote, but less hairy and with a less bushy tail. They were much like those lately observed in Mexico, and I have never seen such dogs elsewhere. Their color was a whitish tawny, like that of the Eskimo dog.

Confirmatory of these observations is the following note by J. L. Wortman in the report of the Geological Survey of Indiana for 1884: "During extended travel in Western U. S. my experience has been the same as that recorded by Dr. Coues. It is by no means uncommon to find mongrel dogs among many of the Western Indian tribes, notably among Umatillas, Bannocks, Shoshones, Arrapahoes, Crows, Sioux, which to one familiar with the color, physiognomy and habits of the coyote, have every appearance of blood relationship, if not, in many cases, this animal itself in a state of semi-domestication. The free inter-breeding of these animals, with a perfectly fertile product, has been so often repeated to me by thoroughly reliable authorities and whose opportunities for observation were ample, that I feel perfectly willing to accept Dr. Coues' statement."

To these statements may be added that of Mr. Milton P. Pierce, published in *Forest and Stream* for June 25, 1885, as follows: "Hybrid wolves have always been very common along our Western frontiers. I have seen several of them, sired both by dogs and wolves, and all I have seen have resembled wolves rather than dogs." It is to be hoped that our mammalogists may collect and examine this subject, particularly the skulls and skins of numerous specimens both of dogs and wolves and of the hybrids between them. Farther observations are also needed as to the fertility of the hybrids.

Notes on Pleistocene Fossils from Anticosti.

By Lieut.-Col. C. E. Grant and Sir W. Dawson.

The late Mr. Richardson of the Geological Survey, to whom we owe most of our knowledge of the geology of Anticosti, notices in his Report for 1857, the occurrence of travelled boulders and of beds of clay, holding rounded fragments of limestone and forming cliffs sixty to seventy feet high, but makes no mention of any pleistocene fossils. The specimens collected by Col. Grant, and referred to in this note, are the first that have come under my notice, and have been kindly presented by their discoverer to the Peter Redpath Museum of McGill University.

The following are extracts from a letter of Col. Grant, referring to their localities, and the mode of their occurrence:—

"The Post-Tertiary shells were first noticed in patches of blue clay in the south-west of Anticosti, in the bed of Becscia River, close to its mouth. When first seen, I thought it probable they had been washed in by a high tide from the Gulf, but on proceeding a short distance up stream, I found the clay and shells *in situ*, capped by a considerable thickness of drift, boulders, etc., in the river bank. The shells appeared to be unusually large. I collected a considerable number. Many got subsequently broken in rough weather.

"The Pleistocene clay, (Leda Clay) occurs also in the bank and bed of Chaloupe River, and it is exposed along the cliff within a few miles west of the South-west Point lighthouse, and at several other points on the south shore. On proceeding up Salmon River, north of Anticosti, at about seven miles from the mouth, the high cliff on the right bank is capped by a deposit of drift.

"Eight miles from the village of English Bay (east), a small stream from the top of the cliff lays bare several feet of blue clay, containing great numbers of very large shells of Mya. The high tide reaches the base of the clay and washes out numbers of specimens, as does the brook adjacent. I was unable to examine the coast-line except for a short distance. The cliffs, for some miles beyond, from forty to seventy feet high, are crowned by drift deposits. Where they slope, the boulders or rounded pebbles from the top get mixed up with the clay below. Fragments of shells are here numerous; complete specimens are few.

"The cliff to the west of Ellis or Gamache Bay, called, I think, 'Junction Cliff,' by Richardson, is also crowned by a drift deposit. I succeeded in reaching part of the slope where some of the Leda Clay from above had lodged. I found it contained many specimens of *Saxicava rugosa*, and a few of *Mya truncata*, the latter much smaller than those at Becscia River and eight miles east of English Bay. Glaciated or polished flags (chiefly Hudson River limestone) are not unusual in the drift of this part of the island. Laurentian boulders were frequently remarked in the river beds, some of considerable size also on the land. There is one imbedded in the soil on a partly cleared farm near English Bay.

"The Island of Anticosti seems to be rising (the old residents on various parts of the coast think the sea is gradually retiring). I was assured by an inhabitant of English Bay, that the tops only of two large Laurentian boulders, lying on the reef in front of the village were visible at low water some twenty years ago; the base and many yards of the reef beyond are now exposed to view. A high ridge of shingle and sand in rear of the village represents the old beach. The bones of a whale were found on this beach. At Macdonald's cave, Mr. Macdonald, one of the oldest residents, informed me: 'This bay is filling up so fast that it will soon be dry land. I remember, when I first came here, there were about two or three feet of water where you now stand.' At Ellis Bay, about twelve miles from English Bay village, evidence also was obtained of the gradual elevation of the Island."

The collection contains the following species, all of them previously known in the Pleistocene of other parts of Canada, and occurring as recent species in the colder waters of the Gulf and River St. Lawrence:—

Buccinum undatum, L., var. *labradoricum*. A small and somewhat short specimen, probably not fully grown.

B. glaciale, L. A decorticated shell, probably this species.

Trophon clathratum, L. (*T. scalariforme*, Gould.) A well developed specimen.

Natica affinis. One young shell.

Mya arenaria, L. Shells of moderate size, some of them distorted.

Mya truncata, L., var. *uddevalensis*. The short Arctic variety, and one of them of unusually large size.
Macoma calcarea, Chem. Large specimens.
Macoma grœnlandica, L. One small valve.
Saxicava rugosa, L. Well developed specimens and apparently common.
Astarte banksii, Leach. One valve.
Balanus crenatus, L.
Rhynchonella psittacea, L.

Col. Grant has also noted as occurring in the beds the following species, of which there are no specimens in the collection:—

Pecten islandicus.
Mytilus edulis.
Natica grœnlandica.
Balanus hameri.

In sand and clay filling the interior of a Mya, which seems to have been entombed *in situ*, are many microscopic tests of Foraminifera and valves of Cythere and Cytheridea. Among the former were the following species :—

Polystomella crispa.
Nonionina scapha, (and var. *labradorica*.)
Polymorphina lactea.
Truncatulina lobata.
Lagena sulcata.
Entosolenia globosa.
E. squamosa.
Globigerina bulloides.

As usual in the Canadian Pleistocene, *Polystomella crispa* is much more abundant than the other species. *Nonionina scapha* comes next in this respect, and all the others are rare. The material also contains numerous spicules of siliceous sponges.

The above fossils may be regarded as characteristic of the Upper Leda Clay and Saxicava sand, both of which members of the Pleistocene formation appear to be represented in Anticosti.

It would also appear that, as elsewhere in Canada, the Leda Clay is overlaid by a second or newer boulder deposit connected with the Saxicava sand. To this it is probable that many of the travelled boulders of Laurentian rocks belong, as they are found in this connection not only along the whole south shore of the St. Lawrence, but even in Prince Edward Island, and in Nova Scotia. It would be important to distinguish in Anticosti this upper drift more particularly from the lower boulder clay when this may occur, and to observe any instances of glacial striation.

With reference to the levels above the sea, it is to be observed that along the shore of the St. Lawrence there is usually a raised beach only a few feet above the level of the sea, and on which shells and bones of whales frequently occur, and a well-marked terrace, with beach deposits and boulders, at a level of sixty or seventy feet above the sea level, and this would appear to be the case also in Anticosti.

Some Prehistoric and Ancient Linear Measures.[1]

By R. P. Greg.

11. *Pelasgic.*—Dr. Schliemann, in his "Troja," p. 56, speaking of the Acropolis of the second city at Hissarlik, says: "These towers stood approximately at equal distances of a little more than fifty metres (= 164 English feet); in which measure we must certainly recognize the number of 100 ancient Trojan cubits, though the precise length of the Trojan cubit is unknown to us [*i.e.*, to Dr. Dörpfeld and himself.] From the analogy of the oriental and Egyptian cubit, it may, however, be fixed at a little more than 0·50 metres. I call particular attention to the fact that on this computation the gate *RC* and *FM* is exactly ten cubits broad; and the vestibulum of the edifice *A* precisely twenty cubits both in length and breadth."

Dörpfeld gives one of the old Assyrian cubits as 0·50 metres = 19·7 inches, and Petrie an Eastern Mediterranean one as 19·96, so that either of these is here probably more

[1] *Academy*, Sept. 12, 1885. (Continued from the Canadian Record of Science, i. 228.)

applicable than the nearest Egyptian cubits, given by Petrie as 18·92 and 20·63.

I have collected about twenty-five of the best ancient Trojan measures I can obtain from Dr. Schliemann's works on Troy, and, having reduced them to English feet and inches, I have obtained a remarkably well-marked cubit of 19·85 inches: intermediate as between Dörpfeld's and Petrie's. It is interesting, however, that from thirteen measures of archaic tombs at Spata in Attica, as given by Dr. Schliemann in his "Troja," p. 111, I also get, very satisfactorily, a cubit of precisely the same length as this old Trojan one; and from eight measures from Tiryns (see "Mycenæ Tiryns," Chap. i.), also an exactly similar cubit. These buildings must date back from B.C. 800 to 1200, and are all more or less cyclopean in character; and may be all included in the term Pelasgic. Still more interesting would appear to be the fact that from an examination of nearly seventy of the best measures given by Dr. Schliemann, taken during his excavations at the ancient acropolis of Mycenæ, precisely the same cubit of 19·85 again is clearly obtainable.

From an examination of the measures, some seventy in number, of Etruscan tombs, as given by Dennis in his "Cities and Cemeteries of Etruria," it is very evident that this same cubit of 19·85 must also have been employed. It is, I believe, usual to include under Pelasgic a good deal of the archaic Etruscan architecture; and this remarkable persistency of the same unit of measure goes far to show an intimate connection with ancient Greece and Asia Minor.

I have, as yet, not been able to obtain measures of Lycian and Lydian tombs to carry on the further examination of this part of the subject. This cubit of 19·85 must have had some connection originally with the Assyrian. In my first letter I showed that the Hittite foot was probably = $12\frac{3}{4}$ English inches, probably derived from an old Babylonian cubit of ·533 metre = 21 inches, and also, very probably, connected with the Olympic foot of a similar derivation. This Pelasgic cubit was probably more nearly connected with the old Assyrian cubit of 19·7, first described by Dörpfeld.

As Mr. Petrie, however, in his "Inductive Metrology," gives the Pelasgic and cyclopean unit of measure, especially as applied to Mycenæ, Tiryns, and Etruscan tombs, to be a foot of about $\frac{23}{2}$ (see pp. 85, 89, and 93)= 11·60, "as most free from Roman influence, and the same as the ancient Greek foot of sixteen Egyptian digits," I here append in a short table some thirty-seven selected measures from the buildings of Troy, Spata, Tiryns, Mycenæ, and Etruria, showing, I think, that the cubit unit of 19·85 inches is preferable to a foot unit of 11·60. These reductions are made by the slide-rule, with sufficient accuracy for all practical purposes. Some little allowance must generally be made in the exactitude of most given measures of ruined buildings; but generally an error of two or three per cent. on either side will be sufficient:—

No. of times repeated.	No. of English feet and inches.	Cubits of 19.85 inches.	No. of times repeated.	No. of English feet and inches.	Cubits of 19.85 inches.
	3·4	2·00		23·0	14·00
2	5·0	3·00		25·0	15·00
	6·6	3·90	2	30·0	18·00
4	8–8⅓	5·00	5	33–34	20·00
3	10–10¼	6·25		40·0	24·25
	11·6	7·00	3	50·0	30·00
4	15·0	9.00		65·6	40·00
	16·6	10·00		74·0	45·00
	17·0	11·15		97·0	59·00
2	20 0	12·00		164·0	100·00
	Inches.				
3	19·7	1·0	} Trojan buildings.		
2	9·8	0·5			
	19·5	1.0 ?	Gold diadem, Mycenae.		

According to Mr. Petrie's Pelasgic unit of 11·6 inches:—

3·40= 3·50 feet.	23·0= 24·0 feet.
5·00= 5·20 "	25·0= 26·0 "
6·60= 6·70 "	30·0= 31·0 "
8·16= 8·50 "	33·6= 32·5 "
10·25=10.65 "	40·0= 41·5 "
11·60=11·10 "	50·0= 52·0 "
15·00=15 50 "	97·0=100·0 "
16·60=17·10 "	164·0=170·0 "
20·00=21·00 "	

12. *Phrygia.*—From about a dozen measures only, given

in the *Journal of Hellenic Studies*, I obtain a cubit of 19·6 inches—evidently the old Assyrian one of Dörpfeld—showing that the ancient Phrygians obtained their unit direct from Assyria, and probably not through either Pelasgic, Phœnician, or Hittite sources. But more measures would be here desirable if I could obtain them. From the tomb of Cnidus five measures give a probable cubit of 19·0 to 19·2, and, therefore, possibly = the Hittite unit.

13. *Phœnicia.* — From Perrot's and Chippiez's recent work on Phœnician art, etc., I have obtained a very probable cubit of 20·0 from only very archaic tombs and buildings in Phœnicia proper; but more measurements might be desirable. This is evidently Petrie's Eastern Mediterranean one, and probably, also, the Pelasgic one, showing how far-spread was Phœnician trading influence prior to B.C. 800, after which time Petrie's old Hellenic foot of 11·60 may have come into vogue. The curious result might seem very probable that the Phœnician cubit was one purposely averaged for convenience of a commercial and trading community like the Phœnicians from the old Assyrian cubit of 19·7 and the Egytian royal ell of 20·5 inches, giving one almost precisely of 20 inches. Prof. Sayce suggested to me that the Pelasgic cubit might possibly be of Phœnician origin.

14. *Oceania.*—Capt. Cook describes a *morai*, or stone terraces on the island of (?) Oberea, as a series of prodigious piles of stones, 267×87 by 44 high, that would be = 300×100×50 of my prehistoric feet of 11 inches.

15. *China.* — A French writer, Remusat, also gives a Chinese foot = 12 English inches, a further confirmation of what I stated in my first letter.

Prehistoric.—I have alluded to this unit of 11·0 inches in my two previous letters. I might further add that Mr. Lukis gives 36½ feet English as the diameter of the smallest of the Cornish stone circles: this would make precisely forty prehistoric feet. The cap-stone of the rocking-stone at Pierre Martine, near Livernon, is given by Ferguson as 11×22 feet English.

In Sinai in Arabia Mr. Holland mentions series of stone, probably in connection with tombs, some of the larger of which are 45 and 90 English feet in diameter. This proportion 11 : 12, would here give 50 and 100.

It is not unlikely that the prehistoric foot-unit of 11·0 inches has simply been derived, not from any cubit, but from the length of the human foot, which would also be about one third of the military pace of 33 inches.

In my next communication I hope to say something more definite with regard to Central American and Peruvian units of measure, and which appear to present certain peculiarities and difficulties.

An Electrical Furnace for Reducing Refractory Ores.[1]

By T. Sterry Hunt.

The application of electricity in the extraction of metals has hitherto been chiefly confined to the electrolysis of dissolved or fused compounds of these by various methods. The power of electric currents to generate intense heat in their passage through a resisting medium has, however, long been known, and the late W. Siemens thereby succeeded in fusing considerable quantities of steel. But it was reserved to Messrs. Eugene H. and Alfred H. Cowles, of Cleveland, Ohio, to take a new step in the metallurgic art by making the heat thus produced a means of reducing, in the presence of carbon, the oxides not only of the alkaline metals, but of calcium, magnesium, manganese, aluminium, silicon, and boron, with an ease that permits the production of these elements and their alloys with copper and other metals on a commercial scale.

In the apparatus devised and now employed by the Messrs. Cowles, a column of fragments of well-calcined charcaal, so prepared and arranged as to present the requisite electrical resistance, is imbedded horizontally in finely pulverized charcoal, and covered by a layer of the

[1] Read Sept. 17, 1885, before the Halifax, N. S., Meeting of the American Institute of Mining Engineers, and reprinted from the Transactions.

same material coarsely broken, the whole being arranged in a box of fire-brick, covered with perforated tiles and opened at the ends to admit two carbon electrodes an inch and a half in diameter. Through these, the current from a dynamo-electric machine of 30 horse-power is now made to traverse the central core of carbon fragments, whereby such a temperature is at once produced therein that platin-iridium may be instantly melted, and the most refractory oxides already named are not only fused and volatilized, but reduced to their elemental state, with formation of carbonic oxide gas.

If alumina in the form of granulated corundum is mingled with the carbon in the electric path, aluminium is rapidly liberated, being in part carried off with the escaping gas, and in part condensed in the upper layer of charcoal. In this way are obtained considerable masses of nearly pure aluminium, and others of a crystalline compound of the metal with carbon. When, however, a portion of granulated copper is placed with the corundum, an alloy of the two metals is obtained, which is probably formed in the overlying stratum, but, at the close of the operation, is found in fused masses below. In this way, there is got, after the current has passed for an hour and a half through the furnace, from four to five pounds of an alloy containing from fifteen to twenty per cent. of aluminium, and free from iron. On substituting this alloy for copper, in a second operation, a compound with over thirty per cent. of aluminium is obtained. Already, the small experimental plant, with a 30 horse-power dynamo, is producing daily over five pounds of aluminium in the form of a rich and brittle alloy, which, by suitable additions of copper, is converted into different grades of aluminium bronze. The valuable qualities of these are so well known that it is only their great cost hitherto that has prevented their more general use in the arts. They are now offered for sale at Cleveland on a basis of five dollars a pound for the contained aluminium.

The reduction of silicon is even more easy than that of aluminium. When siliceous sand, mixed with carbon, is placed in the path of the electric current, a part of it is fused into a clear glass, and a part reduced, with the production of considerable masses of crystallized silicon, a portion of this being volatilized and reconverted into silica. By the addition of granulated copper, there is readily formed a hard, brittle alloy, holding six or eight per cent. of silicon, from which silicon bronzes can be cheaply made. The direct reduction of clay gives an alloy of silicon and aluminium, and with copper, a silico-aluminium bronze that appears to possess properties not less valuable than those of the compound already mentioned. Even boric oxide is rapidly reduced, with evolution of copious brown fumes, and the formation in presence of copper of a boron bronze, that promises to be of value; while, under certain conditions, crystals of what appears to be the so-called adamantoid boron are formed. In some cases, also, crystalline graphite has been produced, apparently through the solvent action of aluminium upon carbon.

Remarkable results are got by alloying small quantities of aluminium with an admixture of copper and nickel. One of these compounds, designated as Hercules metal, broke with a strain of 111,000 pounds to the square inch, with an elongation of 35 hundredths, while a ten per cent. aluminium bronze broke with 109,000 pounds. An addition of from two to three per cent. of aluminium to brass greatly increases its tensile strength, and renders it less susceptible to oxidation. While fifteen or twenty per cent. of aluminium with copper yields a brittle compound, an addition of ten per cent. of copper gives to pure aluminium a great increase of hardness and tenacity, forming an alloy that may have a wide application. It may be added that the difficulties in the way of getting together the reduced aluminium without the aid of the copper promise to be overcome at an early day, so that we may expect the cheap production of such alloys, and of pure aluminium.

The Messrs. Cowles, in their later work, have been aided by the chemical skill of Prof. C. F. Mabery, now of Cleveland, who is associated with them in one of their patents. These now cover not only the reduction of aluminium, silicon, and boron, as described, but the extraction of manganese, magnesium, and the alkaline metals by the electric furnace. I had the pleasure of hearing Professor Mabery give the first scientific notice of this discovery before the American Association for the Advancement of Science, at Ann Arbor, August 28th, and then spoke of the early results of Deville and those of Debray on aluminium and its alloys, having myself witnessed many of the experiments of both of these chemists thereon. I also insisted that the importance of this new instrument that the Messrs. Cowles have placed in the hands of chemists, for producing and controlling degrees of temperature never before obtained, can scarcely yet be estimated, either in its economic or its scientific aspect. This heat of the furnace realizes the dream of the alkahest, or universal solvent of the alchemists, and he who can rightly use it will be worthy of the ancient title of *Magister Magnus in igni.*

I may add that, through the courtesy of these gentlemen, I have since been enabled to spend two entire days in their experimental works at Cleveland, with the brothers Cowles and Professor Mabery, when they explained to me several points not yet made public, and allowed me to direct experiments with one of their furnaces. The fusion of quartz and the reduction of silicon without the presence of copper was repeated; also the reduction of boron and the formation of boron bronze, with many other interesting experiments. I then suggested trials for the reduction of titanium, both from rutile and from titanic iron ore, which will probably soon be made.

The present plant at Cleveland is but a first experimental one, and has only been in operation a few months. The Cowles Electric Smelting Company has secured a large water-power at Lockport, New York, and a dynamo-electric machine of 125 horse-power is now building for them at the Brush Works in Cleveland, which will soon be in operation at Lockport, and will permit the establishment of the electric furnace on a larger scale. A series of experiments of the products got by this remarkable discovery is, by the courtesy of these gentlemen, placed before the members of the Institute.

The Late Dr. William B. Carpenter.

Science has experienced a severe loss in the recent lamented decease of Dr. Carpenter, for though he had attained an age when most men seek repose, he was still actively employed in scientific and philanthropic work, and might have done much more had his life been prolonged. Dr. Carpenter, with the acumen and thoroughness of a scientific specialist, combined a rare breadth of view and comprehension, and a wonderful facility for the clear expression of facts and principles as a teacher and popular writer. He was withal a man of large sympathies, and ready at any time to bear his part in any work of social, sanitary, or educational amelioration. As a physiologist and microscopist he had no superior; and no English man of science has done more in making his subjects of study popular and generally useful. His visit to Canada in the summer of 1882, the part which he took at that time in the meeting of the American Association in Montreal, and the admirable popular lecture which he delivered on the physical features of the Ocean, have made him personally known to many in this country, where he had long been esteemed as a writer. He entered heartily into the study of *Eozoon canadense*, when that fossil was discovered by Sir W. E. Logan; and the preparatory work, which had been done in its microscopic study by Sir Wm. Dawson in this country, was, by his request, submitted before publication to Dr. Carpenter as the most eminent specialist in the structures of Foraminifera. Dr. Carpenter, when in Canada, visited one of the most instructive localities of Eozoon, and had in course of preparation an exhaustive memoir on the subject, for which he had accumulated a large number of specimens illustrating the various forms and structures of this much disputed organism.

Dr. Carpenter was born at Exeter in 1813, and was the son of Dr. Lant Carpenter, an eminent Unitarian minister of Bristol, to which city he removed in Dr. Carpenter's infancy. He was the brother of Miss Mary Carpenter, so well-known as a philanthropist, and of Dr. Philip P. Carpenter, long a resident in Montreal and equally esteemed and beloved for his scientific eminence, public services, and Christian character.

The following notice of Dr. Carpenter's life and scientific work is extracted from the London *Athenæum*:—

"Dr. Carpenter had a life of hard work. He was for years actively engaged in the drudgery of teaching; he was always preparing and compiling valuable manuals; and he was an energetic writer for, and editor of, periodical publications. The activity of many of his best years (1856-1878) was devoted to the interests of the University of London, and much of the high position which that examining body bears is due to Dr. Carpenter's character, feelings and pursuits. He was constantly engaged in elaborate researches into the general or minute structures of animals, and he took more than his fair share in the duties which scientific men owe to the scientific bodies with which they become connected.

"But, in addition to all these engagements and studies, Dr. Carpenter was essentially a good citizen. He took the highest interest in social questions, on which he threw the light of scientific knowledge; he persistently endeavoured to expose such superstitions or follies as were based on ignorance or neglect of a knowledge of natural laws; and he entered actively into the pursuit of objects which appeared likely to improve the sciences he had at heart. It is sufficient to refer to his lectures on temperance, his letters on vaccination, his exposure of phrenology, his treatment of the spiritualists and their doctrines, and the share which he took in the early days of deep-sea dredging and in advancing the general cause of marine zoology, to prove abundantly the statements just made; if any other proofs are needed, a file of the *Times* has only to be consulted.

"In the department of zoology we must make especial reference to his reports on the microscopic structure of shells, presented to the British Association in 1844 and onwards; his work on the Foraminifera (and the consequent discussions on the organic nature of *Eozoon canadense*) published in the Transactions of the Royal Society and in a volume of the Ray Society's publications; and his monograph on the structure of the feather-star. He was a diligent student and a powerful writer on every point connected with the use and improvement of the microscope, and he devoted much thought and attention to the difficult problems of ocean currents.

"But a little knowledge or reflection will make it obvious that Dr. Carpenter made numerous personal investigations in every branch of animal biology; this is, indeed, sufficiently evident from the fact that, although his great and widely known works on human physiology and on the microscope were first published long before the biological sciences had attained their present magnitude, they were based on knowledge so wide and were so thoughtfully elaborated, that editions of both are still called for, and are still necessary to every advanced student.

"In addition to such honours as the fellowship of the Royal Society, the presidency of various societies, and an honorary doctorate of laws from his old university of Edinburgh, Dr. Carpenter was a corresponding member of the Institute of France and of the American Philosophical Society, and a C.B. He leaves a widow and several children, some of whom are well known as men of science, to lament his loss. Dying in his seventy-third year, respected and regretted by all who knew him, he was an example of arduous devotion to duty and of single-minded love of science such as the world will not easily forget."

We may conclude with the following vivid sketch of Dr. Carpenter, contributed by Dr. Ray Lankester to the *Academy*: — "Dr. Carpenter embraced early in life the profession of a student and teacher of biological science, and he never ceased to work with marvellous industry and extreme ability at the tasks which had thus become to him a duty. His interest in the problems which he had helped by his researches to solve, or by his speculations to simplify, was so keen that they were ever the chief occupation of his thoughts and conversation. Where another might have indulged in some trivial dialogue, Dr. Carpenter would, with a vivacity and sincerity that were the outcome of a contented and unwearied mind, captivate his interlocutor with a serious discussion of the grounds urged against his view of the animal nature of Eozoon, or as to the nervous system of Comatula; or, again, as to the theory of ocean currents, or the reform of the University of London. What he said on such occasions was admirable, and his willingness to meet fairly an antagonist was no less indicative of the true, single-hearted man of science than the almost boyish eagerness with which he would rush into the fray. The younger generations of biologists regarded him as a man of iron frame, destined to grow younger, more laborious, more fruitful of good works, as they themselves grew on in years and sunk into rest and obscurity."

Review.

Text-Book of Botany.[1]

Incident to the very rapid advances which botanical science has made within the last few years, it has become permanently split up into several important departments. It is, therefore, a difficult matter so to condense the subject into the compass of one volume, that it may adequately meet the requirements of an ordinary college course. The series of Gray's Botanical Text-Books, however, meets the difficulty in one way, by giving a comprehensive treatment of the entire subject, devoting one volume to each of four leading departments, viz., Structural Botany, Histology and Physiology, Cryptogamic Botany, and Special Morphology and Economic Botany. This is a method of dealing with the subject which has much to commend it to the consideration, not only of teachers, but of those who desire to pursue an independent course of study as well.

The present volume, which is the second of the series, is especially welcome, from the fact that it is the first work

[1] Gray's Botanical Text-Book. Physiological Botany, Parts i and ii. By G. L. Goodale, A.M., M.D. 1885. 8vo., pp. 499 + 36. Ivison, Blakeman, Taylor & Co.

on Botany published on this side of the Atlantic, which deals wholly with Histology and Physiology. Until the present time, we have been obliged to depend almost wholly upon reprints from the German for text-books of this subject; but it is to be hoped that the issue of this volume is an indication of a future change in this direction.

In its general appearance the book is very creditable, and a decided improvement upon the usual make up of text-books. The paper and letter-press are excellent, while the figures, of which the publishers have given the author a fairly liberal allowance, are fresh—an evident effort having been made to avoid stereotyped illustrations—and in most cases admirably well executed. The references to the literature of the various subjects treated, are fairly full, and will be found a most valuable aid to the student, as also will the large amount of matter embodied in the footnotes, explanatory of the text. The student is also provided, at the end of the volume, with a large number of suggestions as to the apparatus and material required in histological studies, and also an outline of work which may be taken up. Valuable as such suggestions are, the student must outline his own course to a very large extent, using the work here given as a basis, since he will otherwise find it a physical impossibility to accomplish all that would seem desirable.

The author has endeavored, with success, to leave no element of structure or physiological fact without discussion, while his entire treatment of the subject will commend itself to teachers generally, as clear and logical; although in more than one instance there appears to be a lack in fulness of treatment which would be highly desirable, but which would hardly be practicable in a book designed for an ordinary course of instruction. In some instances, however, this becomes a fault, since the compression is carried to such an extent as to give the student a very inadequate impression of the subject discussed. Thus, at page 64, collenchyma is dismissed with great brevity, without the reader's being given a proper conception of the structure of that tissue, nor is he assisted at all by the figure (44), which is by no means a typical example. Such, however, are minor faults which are readily corrected by any competent teacher, and the author is certainly to be congratulated upon having reduced errors of all kinds to a minimum. Our knowledge of histology and physiology is now advancing at such a rapid rate, that many errors of omission, and possibly in some cases of facts also, are almost inseparable from a work of this kind. The time which elapses between the reception of the manuscript by the publisher and of the book by the public, is sufficient to make many statements old, and often to upset previous views. Bearing this in mind, the book is fully up to the times, and we can commend it as destined to meet, in a most acceptable manner, a long-felt want.

D. P. P.

Miscellaneous Notes.

Microscopical Society of Montreal.—At the Annual Meeting held November 23, the following officers were elected: Rev. Dean Carmichael, *President;* J. H. Burland, *Secretary;* H. A. Holden, *Treasurer.* Dr. G. P. Girdwood exhibited sections of Diseased Potatoes, which appeared to have been connected with a recent development of fowl-cholera. Nothing could be determined in the specimens beyond the ordinary changes and putrefactive organisms which usually accompany decomposition. Prof. Penhallow called the attention of the Society to a simple device for lifting and placing Cover Glasses. An ordinary penholder having an unsplit ferrule is employed, the latter is cut off to such a length as to leave a tube about $\frac{1}{4}$-inch long, beyond the end of the wooden handle The tube is filled with wax until the latter, on cooling, forms a well-rounded end projecting beyond the metal. The end of the wax is cut down to a flat surface of about $\frac{1}{8}$ in. diameter. The handle is now complete and ready for use. To employ it, press the wax gently against the centre of the cover, when the latter may be lifted without trouble and placed over the mount in any direction of contact desired. The use of a needle, or slight lateral pressure on the handle, at once detaches it from the cover, leaving only a minute trace of wax behind, but this may be easily removed after the ring has hardened and the final cleaning is given.

Erosion of Glass.—Before a meeting of the Royal Microscopical Society, Dr. W. M. Ord described certain experiments to determine the cause of erosion, when surfaces of glass are exposed to the joint action of calcium, carbonate and colloids. The investigation was suggested by a note contributed by Dr. Bidie, of Madras, to *Nature*, xxvi. 549. (1882), describing an etching of glass vessels where white ant mud had been deposited. The particular direction of the experiments was largely suggested by the previous investigations of Mr. Rainey, who found that, when two separate solutions of gum—the one containing calcium carbonate, the other containing potassium carbonate—were allowed to mix slowly, and a glass slide was then introduced, a deposit of carbonate of lime was soon formed upon the surface of the slide, the incrustation being composed of minute spherules which adhered with considerable firmness. After removal of these spheres by the action of dilute hydrochloric acid, the surface of the glass was found to be somewhat opaque. From collodion casts, Mr. Rainey further proved that the opacity was due to minute depressions in the glass corresponding to the position of the carbonate of lime spherules. The formation of these bodies was shown to originate in minute granules, each with its own centre of attraction, but as they became more aggregated, the centre of attraction for each granule became replaced by one centre of attraction common to all within a certain radius, thus giving one spherule by agglomeration of numerous granules. Extending this hypothesis to the etching of the glass, Mr. Rainey argues that when such a spherule was found on a glass surface with the surrounding colloid gum sticking to the glass, and actually entering also into the composition of the sphere, the same attractive power which had determined the incorporation into one sphere of a number of spherules in contact with one another, would determine also the incorporation of adjoining molecules of glass into the incumbent sphere. Thus a pit would be found opposite each sphere.

Following up those conclusions, Dr. Ord coated a series of slides with paraffin, albumen, and glycerine, one each. These bore certain inscriptions cut through the coating so as to expose the surface of the glass. Slides of mother of pearl and of ivory were similarly treated, and all were then brought in contact with calcium chloride and potassium carbonate in such a way that evaporation was arrested and the two salts would gradually mingle over the coated surface of the slide. The results obtained at the end of twelve months showed the formation of spherules of calcium carbonate, in some cases densely aggregated, and a corresponding etching of the surfaces exposed to their contact.

The inferences drawn from these experiments are: (1) that without the use of acids or alkalies, which are known to be capable of dissolving glass, a glass surface may be eroded almost to opacity when placed in contact with carbonate of lime and a colloid; (2)

that the erosion so effected may be explained on the basis of Mr. Rainey's observations on molecular coalescence; (3) that in contact with glycerine and carbonate of potash, ivory and mother of pearl may be eroded, although as far as can be seen, no spherules of carbonate of lime are formed.

The first two conclusions are believed to be applicable to the erosion by ant mud, as observed by Dr. Bidie, while the third is held to have a much wider application, explaining by "Molecular disintegration," the formation of the Haversian spaces in bone; the excavation of shell surfaces to which Polyzoa are attached; the boring of Molluscous shells by sponges and other similar erosions. —*Journal of the Royal Mining Society*, Ser. 2nd, V. 761.

Proceedings of the Natural History Society.

The *First Monthly Meeting* of the Session of 1885-86 was held on Monday evening, October 26th, 1885, the President, Sir William Dawson, being in the chair.

The minutes of the last Council Meeting were read, and the following names proposed for membership, viz., Messrs. James M. Jack, W. C. Van Horne, P. A. Peterson, R. W. Boodle, Robert Mackay, Samuel Finlay, James McShane, M.P.P., Edward Radford and A. H. Sims.

Prof. Penhallow reported that there had been several important additions to the list of Exchanges since the regular issue had been resumed of the Society's quarterly magazine, the Canadian Record of Science. Mr. A. H. Mason, Honorary Curator, reported that, during the recess, the following additions to the Museum had been made, through the kindness of Mr. J. H. R. Molson, viz., the Teeth of Carcharoden, the Teeth of Oxyrhina, and the Vertebrae of Fishes (Eocene), found in the Phosphate beds near Charlestown, South Carolina; also the Egg of an Alligator from Jacksonville, Florida. Sir William Dawson offered some remarks upon the specimens presented, pointing out many peculiar features connected with them.

Mr. Mason called attention to the fact, that the President, Sir William Dawson, had been appointed to preside at the next meeting of the British Association, to take place at Birmingham in 1886, and considered it to be a most distinguished honor, in which we should all take much pride, as it was a position to which only the most notable men of Science were elected.

Prof. Penhallow then read a paper on "The Origin of the Ainos and their final Settlement and Distribution in Japan." After a vote of thanks to the lecturer, it was resolved that the paper should appear in the next number of the RECORD OF SCIENCE.

The *Second Monthly Meeting* of the Session was held on Monday evening, November 30th, 1885, Sir William Dawson in the Chair.

A circular was submitted from the Secretary of the Elizabeth Thompson Science Fund, "for the advancement and prosecution of Scientific research in its broadest sense," and it was resolved that Mr. Edward Murphy, Dr. Harrington, and Prof. Penhallow, be appointed a Committee to take action in reference to the claims of this Society, to obtain the assistance so beneficially bestowed by this fund, which had been founded by one of the most liberal and humane women of the present time.

It was moved by Mr. J. H. Joseph, seconded by Mr. Edward Murphy, and carried unanimously, "That the By-laws be suspended, and that Dr. Asa Gray, of Harvard, be elected an Honorary Member of this Society, in recognition of his long and valuable services to Science."

It was resolved, "That this Society has learned with deep regret, the unexpected decease of Dr. William B. Carpenter, C.B., F.R.S., etc., and while recognizing his world-wide reputation and great services to Science and to social and educational progress, desires to convey to Mrs. Carpenter and the other members of his family, its sincere condolence and sympathy; and that the notice of Dr. Carpenter's life and services presented to this meeting, be inserted in the next number of the CANADIAN RECORD OF SCIENCE."

Two pamphlets were presented by Mr. Edward Murphy, on "Testing for Colour-blindness in the Mercantile Marine," and "Arsenical Poisoning by Wall-papers and other manufactured articles," both written by Jabez Hogg, M.R.C.S., F.R.S.

The candidates for membership proposed at the last meeting, were duly elected, and the following names submitted for election, viz., Messrs. Wm. Drysdale, C. N. Bell, of Winnipeg, Man., Dr. T. Wesley Mills, and Mr. John Lawrence.

Sir William Dawson then read his paper on "Boulder Drift and Sea Margins at Little Metis, Lower St. Lawrence," succeeded by that of Lieut.-Col. Grant, of Hamilton, on "Pleistocene Fossils," collected on the Island of Anticosti.

Prof. Penhallow then read Mr. C. N. Bell's notes on the "Exploration of some Mounds in the Northwest," while Mr. A. H. MacKay's paper of notes on "New Fresh-water Sponges" was received as read.

A cordial vote of thanks was tendered to the authors of each paper with a request that they be published in the RECORD OF SCIENCE.

THE

CANADIAN RECORD

OF SCIENCE.

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THE FORESTS OF CANADA.[1]

BY ROBERT BELL.

The writer, who has had extensive opportunities during the last thirty years of becoming personally acquainted with the forests of the Dominion east of the Rocky Mountains, endeavoured to give an account of their extent, general characters, peculiarities, value, means of preservation, etc. Viewing the forests of the continent as a whole, only the northern portions come within the Dominion, a large part of which lies beyond the limit of trees of any kind. The central and eastern forest region of Canada and the United States presents the greatest variety of species. In the north,

[1] The above paper *in extenso* was contributed by the author to the Montreal meeting of the British Association for the Advancement of Science, in 1884, and was accidentally omitted from the volume of "Canadian Economics." Our abstract is somewhat fuller than that given by the authorized Report of the Association. We may mention that, at the late International Forestry Exhibition in Edinburgh, Dr. Bell was awarded a diploma for a large map showing the northern limits of some thirty species of timber trees.

a wide border of coniferous trees, which become smaller and more limited in number of species as we approach the verge of the forests, stretches across the continent; while toward the south deciduous forests prevail, but are interspersed with large areas of pines of various kinds. The sombre coniferous forests of the north are continuous over vast regions, which, from their high latitudes and the poverty of their soil, will never be cultivated to any great extent. This great coniferous belt has a crescentic form, curving southward from Labrador to the far Northwest, keeping Hudson Bay on its northern side. The distribution of our forests appears to be governed almost entirely by existing climatic conditions, although it may be modified to some extent by the geological character of different districts; and some of the peculiarities of their present distribution may be due to former conditions affecting their dispersion.

Beyond the northern limit of the forests on the mainland of the continent there is a large triangular area to the north-west and another to the north-east of Hudson Bay, called the Barren Grounds, which are destitute of trees solely on account of the severity of the climate, as the other conditions do not appear to differ from those of the adjacent wooded regions to the south. The treeless region of the Western States and the south-western part of the North-west Territories of Canada are called plains as distinguished from the prairies, which often are partially wooded. The latter occupy an immense space between the plains and the forest regions to the east and north-east. The plain and prairie conditions are also due to climate, and not, as some have supposed, to fires having swept away formerly existing forests. This is shown by the contours of the lines marking the western limits of the various kinds of trees which prevail in the east, as well as from the absence of water-courses, which would exist if sufficient rain had fallen in comparatively recent times to have maintained forest growth.

Although the Dominion embraces about half of the continent, only some ninety out of the 340 species of the forest trees of North America are found within her borders, including the Pacific slope. Yet the area under timber in

Canada is perhaps as great as that in the United States. It is, therefore, evident that the forests are less diversified in the north than in the south. This is in accordance with the general law of the greater richness of the flora of warm countries; but it may be due also in part to the fact that in the north we have greater uniformity of physical and climatic conditions over wide areas than in the south. For example, we have a similarity in these conditions from Newfoundland to Alaska, and hence throughout the great distance of 4,000 miles we find the same group of trees. Again in the great triangular area of the Northwest, between the United States boundary, the Rocky Mountains, and the Laurentian region, embracing over 600,000 square miles, very little difference could be observed in the climate, the soil, or the general level of the country, and hence the same group of trees—only about half a dozen in all—is found throughout this immense tract. In striking contrast with this is the fact that on the same farm lot in the south-western part of the Province of Ontario one may often count as many as fifty different kinds of trees. The richness in variety of the native trees of Ontario and the adjacent States is owing to the fertile soil and the favourable conditions as to summer temperature, constant moisture, and the absence of intense cold in the winter.

The writer exhibited a map showing the northern and western limits of the principal forest trees of the Dominion east of the Rocky Mountains. From this it appears that the range of species is not according to the mean annual temperature or precipitation, but rather to the absence of extremes of heat and cold, and of great dryness. For these reasons a number of the trees of the Province of Quebec and northern Ontario do not range west into Manitoba, although the annual means of temperature and precipitation are nearly the same in both. This map also shows in a striking manner that the northern limits of our various forest trees are by no means parallel to one another, although locally some groups may be nearly so for a certain distance. Some of them pursue extraordinary or eccentric courses, which are difficult to account for. The most remarkable of these is the white cedar, which in the central part of its trend reaches James Bay, but drops suddenly to the south at the Gulf of St. Lawrence in the east, and on reaching the longitude of the head of Lake Superior in the west. Yet the climate and other conditions appear to be the same for some distance both east and west of these lateral boundaries. An outlying colony of the white cedar is found at Cedar Lake near the north-western part of Lake Winnipeg. Colonies or outlying patches of other trees have been noted in different localities, such as of the basswood and sugar-maple at Lake St. John, north of Quebec, of the grey elm on Missinaibi River, near James Bay, and of the hemlock spruce at Thompson, near the west end of Lake Superior.

Rivers and lakes, by supplying heat and moisture and warding off summer frosts, often promote the growth of trees on their immediate banks which are not found elsewhere in the surrounding country. Instances of this may be seen along the North Saskatchewan, where the negundo, green ash, grey elm, white birch, alder, etc., thrive only on the river banks. In the cold regions, the white spruce grows to a much larger size on the shores and islands of rivers flowing north than elsewhere. It has been found that exotic fruit trees and other introduced plants can be successfully cultivated around the shores of the larger lakes, especially on their southern sides, which will not grow at a short distance inland. On the other hand, the immediate proximity of the sea, with a lower summer temperature than the land, is unfavourable to the growth of timber in the north. The habits of some trees are much modified in different latitudes. Species which grow in warm dry soil in the north may be found in cold, heavy, or wet land in the south. The larch, balsam, white cedar, white pine, white birch, etc., are examples of this tendency. Some species extend far to the south of their general home along mountain ridges, while others seem to refuse to follow such lines. The existence of extensive swamps, the shelter of hills, or the elevations which they afford, are therefore to be regarded as among the minor conditions governing the distribution of trees.

The peculiarities in the outline of the northward limit of the white cedar and other species of trees, may throw some light on questions as to the direction from which they have migrated or been dispersed. In some cases which the author has studied, the trees appear to have reached the most northern limit possible. For example, in its most northern range, the first tender leaves and shoots of the black ash are blighted almost every year by the spring frosts; the trees are of small size or stunted in height, and only occasionally bear seed. Sir John Richardson mentions that, on the barren grounds, outlying patches of dying spruces were sometimes met with far out from the verge of the main forest, and that he saw no evidence of young trees springing up beyond the general line of trees; from which he infers that the latter is retreating southward. A similar condition is said to exist in Siberia.

In tracing the northern limits of several of the trees as laid down on the author's map, it would be observed that the northward variations from the general direction usually corresponded with depressions in the country, while the southward curves occurred where the elevations were greatest. The height-of-land dividing the waters of the St. Lawrence from those of Hudson Bay has a general parallelism with the northern limits of many of the species; but as the watershed is not marked by any great elevation or by a ridge, the circumstance referred to may be owing simply to the accident of its trend coinciding with the average course of the isothermal lines.

The author divides the trees of the Dominion east of the Rocky Mountains into four groups in regard to geographical distribution, namely: (1) A northern group, including the white and black spruces, larch, Banksian pine, balsam-fir, aspen, balsam-poplar, canoe birch, willows and alder,—these cover the vast territory from the northern edge of the forests down to about the line at which the white pine begins; (2) a central group of about forty species, occupying the belt of country from the white-pine line to that of the button-wood; (3) a southern group, embracing the button-wood, black walnut, the hickories, chestnut, tulip tree, prickly ash, sassafras, and flowering dog-wood, which are found only in a small area in the southern part of Ontario; (4) a western group, consisting of the ash-leaved maple, bur-oak, cotton-wood, and green ash, which are scattered sparingly over the prairie and partially-wooded regions west of Red River and Lake Winnipeg.

The finest timber of the second group within the limits of Canada is to be met with along the east side of Lake Huron in the counties of Lambton, Huron and Bruce, where the button-wood, elm, maple, yellow birch, cherry, bass-wood and hemlock attain a height of one hundred feet and upwards. Although the Ottawa valley has produced more white pine timber than any other region in the Dominion, the largest and finest trees grow on the sandy soils of the counties bordering the northern sides of Lake Erie and of the western part of Lake Ontario, where extensive and splendid pineries stood when these regions were first invaded by the white man. In the Northwest Territories, the largest trees are the elms along the rivers (which, however, do not extend far north) and the rough-barked poplars, which, even as far north as the Laird and the lower Mackenzie, have trunks five feet in diameter. Along Athabasca River the author had seen spruces which measured ten and twelve feet in girth.

The distribution of our forest trees affords us one of the most obvious tests of climate, and although it may not be more reliable than that of the smaller plants, it is more noticeable by the common observer. In the older provinces of Canada the settlers are often guided to a great extent in their selection of land by the kinds of trees it supports, a thrifty growth of beech and sugar-maple, for instance, being generally considered a good sign; but such tests must necessarily be only of local application. In the prairie region, timber may be entirely absent from the finest soil, while the least hardy trees of the west flourish in the stiff clay-banks or among the stones along the rivers on account of the moisture and heat derived from the water.

The map which has been referred to is useful in defining the extent of country over which each kind of timber was to be found. But in estimating the quantities which may be yet available for commercial purposes in the regions still untouched by man, various circumstances require to be considered, such as the favourable or unfavourable conditions of soil, etc., as well as the proportion which has been destroyed by fire, and other causes. The amount of timber which has been lost through forest fires in Canada is almost incredible, and can only be appreciated by those who have travelled much in our northern districts. The proportion of white and red pine which has been thus swept away in the Ottawa Valley and in the St. Maurice and Georgian Bay regions, is estimated by the lumbermen as many times greater than all that has been cut by the axe. Yet all this is insignificant in quantity compared with the pine, spruce, cedar, larch, balsam, etc., which has been destroyed by this means in the more northern latitudes all the way from the Gulf of St. Lawrence to Nelson River, and thence northwestward. It is true that the commercial value of this timber was not so great as that of the more southern pine regions which have also been partially ruined. The total quantities which have disappeared are almost incalculable, but even a rough estimate of the amount for each hundred or thousand square miles shows it to have been enormous, and of serious national consequence. The writer had traversed these great regions in many directions, and could testify to the widespread devastation which had taken place. Nearly every district was more or less burnt, the portions which had been overrun by fire usually exceeding those which remained green. These northern coniferous forests were more liable than others to be thus destroyed. In the summer weather, when their gummy tops and the mossy ground are alike dry, they burn with almost explosive rapidity. Small trees are thickly mingled with the larger ones, and they all stand so closely together that their compact branches touch each other, thus forming a sufficiently dense fuel to support a continuous sheet of flame on a grand scale. Before a high wind the fire sweeps on with a roaring noise, and at a rate which prevents the birds and beasts from escaping. Thus, in one day, the appearance which a large tract of country is to wear for a hundred years may be completely altered. After a time the burnt district becomes overgrown, first with shrubs and bushes, then with aspens and white birches, among which coniferous trees by-and-by appear; but finally at the end of a hundred and fifty years or more they regain possession of the burnt tract. This process of alternation of crops of timber appears to have been going on for centuries, but in modern times the fires must have been more numerous and frequent than formerly.

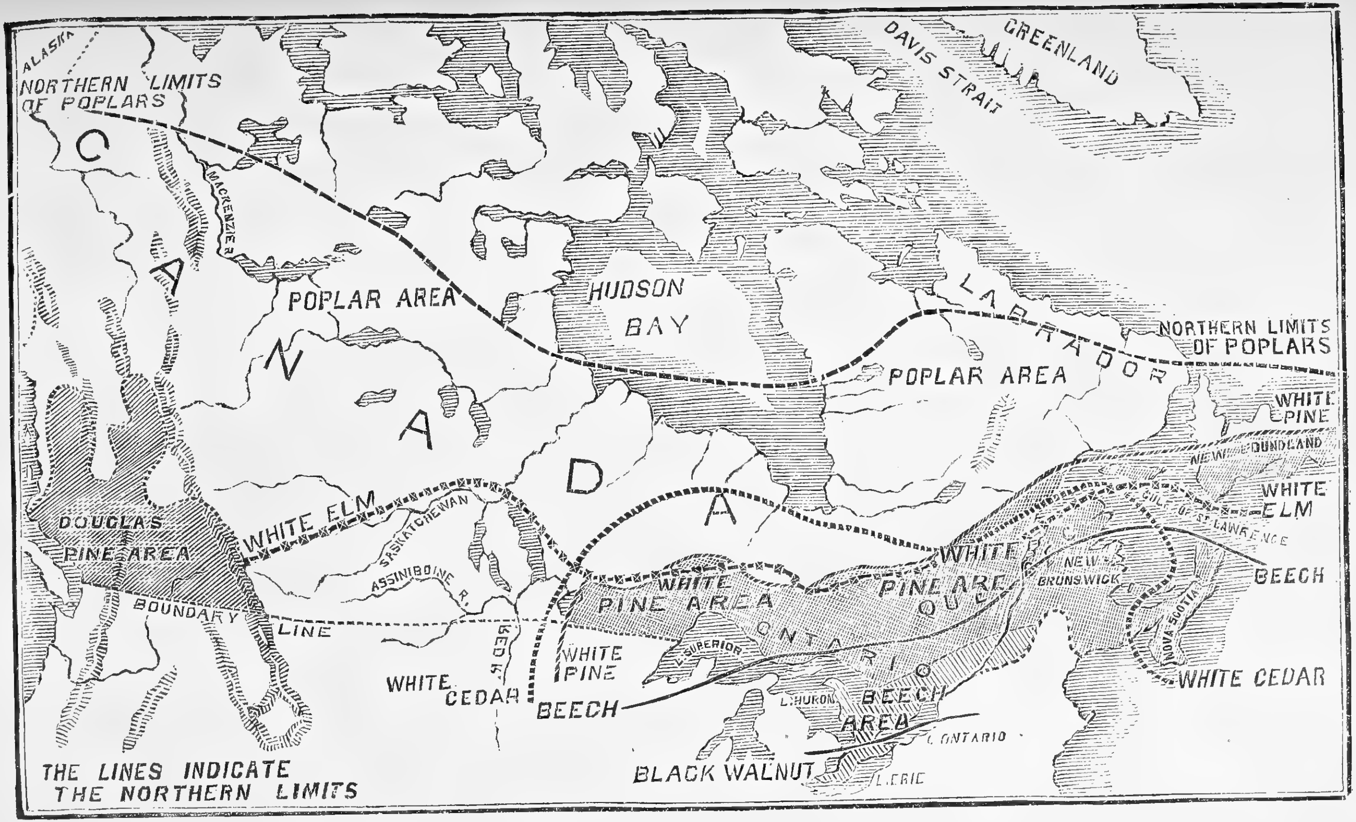
Along Moose River and the lower part of the Missinaibi, the original dark coniferous forest of these latitudes is replaced by the light green poplars and white birches, for more than a hundred miles, and this condition has existed since the memory of the oldest Indian of the district. Here and there may be seen a patch of large spruce—remnants of the original forest—and everywhere under the deciduous growth, the charred stumps of the old conifers may be found. On the east side of the southern part of Lake Winnipeg, and nearly all along Winnipeg River, the principal forests have been destroyed by fire, and replaced by aspen and white birch.

Forest fires are undoubtedly due occasionally to lightning, the author having once actually witnessed the origin of a fire in this way, and he had often been informed by the Indians that they had seen similar cases. But most of them are traceable to the carelessness of white men and demoralized Indians. In the partially inhabited regions, most of the forest fires originate by the settlers burning brush and log-heaps in clearing the land. It may be asked if we have no means of stopping this fearful destruction of the timber of the country. Laws on the subject do exist, but no adequate means appear to be provided for enforcing them. The author recommended a reform in this respect, before it be too late. Crown lands of real value for agriculture should be separated for the purpose of administration from those which are acknowledged to be useful only or principally for their timber, and settlement should be prohibited within the latter. Heretofore, the great consideration of Government was the peopling of the country, the timber being looked upon as of secondary importance, and it was willingly sacrified in the interests of the settler, who came to regard it as his natural enemy. The time has come when we must change all this. In the absence of forest guardians and proper regulations, lumbermen have often to submit to a species of blackmail from discharged employees and pretending settlers in order to keep them off their limits. Indians sometimes burn the forests off each other's hunting-grounds from motives of revenge, but as a rule the fires which they start are from carelessness or indifference. When cautioned in a friendly way, they are willing to exercise greater care, and the beneficial effects of this course are already manifest in the region between Lake Winnipeg and Hudson Bay, where the author had remonstrated with them on the subject. He suggests that the annuities which they receive from Government be withheld as a punishment for burning the woods, or that a bounty be paid each year that no fires occur. In this way the Indian chiefs and headmen may be made the most efficient and earnest forest guardians we could possibly have.

Fires are not so liable to run in forests of full-grown white and red pines, such as those of southern Ontario, which have suffered comparatively little from this cause, but have now been mostly cut down and utilized by the lumbermen. Hardwood forests are seldom burnt to any great extent, except where the soil is shallow and becomes parched in summer, as, for instance, on the flat limestone rocks of Grand Manitoulin Island and the Indian peninsula of Lake Huron, through much of which fires have run, burning the vegetable mould and killing the roots, thus causing the trees to fall over even before they have decayed. Hence the term "fire-falls" applied in such cases.

If we had educated and intelligent conservators of forests in Canada, appointed by the Government, their duties, in addition to preventing the destruction of the timber by fire and otherwise, might be directed to promoting the growth of existing timber, encouraging transplanting, the introduction of foreign trees which might grow in this country, the dissemination of information on practical forestry, etc., investigating the causes of diseases among trees, directing the attention of foreign purchasers to our woods and pointing out to our lumbermen possible new markets for timber products and for varieties of woods not now utilized. That disease does sometimes cause great havoc among our forests is illustrated by the recent fact that the spruces in New Brunswick, the principal timber tree of that province, died over extensive areas, a few years ago, and the disease has now spread into the Gaspé peninsula. It is supposed to be due to a fungus which attacks the roots, but it is not certain that the fungus itself may not be induced by the pre-existence of some other disease. In the Province of Quebec the larches or tamaracs, have sometimes died from unexplained causes in extensive tracts. As soon as coniferous trees have become scorched by fire or show signs of failing vitality, their trunks are attacked by boring beetles, and they must be immediately cut down and immersed in water if the timber is to be saved.

In regard to the future supplies of timber which may be available in Canada, the greater part of the white oak and rock elm has been already exported. The cherry, black walnut, red cedar, and hickory have likewise been practically exhausted. Red oak, basswood, white ash, white cedar, hemlock, butternut, hard maple, etc., as well as many inferior woods, are still to be found in sufficient quantity for home consumption. A considerable supply of yellow birch still exists, and in some regions it is yet almost untouched. Until recently there was an indistinct popular notion that the white pine, our great timber tree, extended thoughout a vast area in the northern parts of the Dominion, from which we might draw a supply for almost all time. The author's map showed, however, that its range was comparatively limited. The shaded portions of the accompanying little map will serve to give an idea of the extent of our pine lands, relatively to that of the whole Dominion. Even if we include the Douglas pine area of British Columbia, it will be seen to be small in comparison with the rest of Canada. And it must be observed that this shading represents the botanical and not the commercial distribution of the pine, and that the valuable timber has been already cut away or is very sparsely distributed through a large proportion of it. Although it was


ALASKA
NORTHERN LIMITS OF POPLARS
CANADA
MACKENZIE R.
POPLAR AREA
HUDSON BAY
DAVIS STRAIT
GREENLAND
LABRADOR
NORTHERN LIMITS OF POPLARS
POPLAR AREA
WHITE PINE
WHITE ELM
DOUGLAS PINE AREA
WHITE ELM
SASKATCHEWAN
ASSINIBOINE R.
BOUNDARY LINE
WHITE PINE AREA
WHITE PINE AREA
QUEBEC
ONTARIO
NEW BRUNSWICK
NOVA SCOTIA
GULF OF ST. LAWRENCE
BEECH
WHITE CEDAR
L. SUPERIOR
WHITE PINE
WHITE CEDAR
BEECH
L. HURON
BEECH AREA
L. ONTARIO
L. ERIE
BLACK WALNUT
THE LINES INDICATE
THE NORTHERN LIMITS

found over a very extensive district to the north-west of Lake Superior, it was very thinly scattered, of smaller size, and poorer quality than further south. Our principal reserves of white pine, as yet almost untouched, are to be found in the region around Lake Temiscaming, and thence westward to the eastern shore of Lake Superior. This tract lies partly to the north of the height-of-land. There is also more or less red pine in the district referred to. The newly constructed Canadian Pacific Railway between Lake Nipissing and Lake Superior has afforded a means of access to the centre of this great pine region, which could not so well be reached by any of the rivers. Lumbering operations have already begun near the railway west of Lake Nipissing, and unless the charges for transport prove too high, the probabilities are that hereafter a large amount of timber will be sent out of this district by rail. When the exportable white pine shall have become exhausted, as it must before many more years, we have still vast quantities of spruce and larch, which may even now be regarded as the principal timber available for this purpose in the future. But our stock of these woods is to be found mostly in the great country which drains into James Bay, whose numerous large rivers afford facilities for floating timber to the sea, and in the country thence westward to Lake Winnipeg. Fine white spruce is likewise found in some localities in the Northwest Territories between the prairie regions and the country of small timber to the north-east. The Banksian pine, which ranges all the way from New Brunswick to Mackenzie River, is often large enough for sawing into deals, and will afford large quantities of good railway ties.

If the vast northern forests can be preserved from fire in the future, our supply of small timber is practically inexhaustible. When larger trees elsewhere shall have become scarce, much of it may some day be sawn into boards, scantling, joists, rafters, flooring, etc. Supplies of timber for railway-ties, telegraph-poles, mines, fencing, piling, small spars, cordwood, charcoal, paper-making, etc., may be drawn from these immense districts for all time, since the greater part of the regions referred to are not likely to be required for agricultural purposes, and by a proper system of cutting, a new growth will spring up to replace the timber removed, and in its turn become available to keep up the supply. The practically interminable extent of these forests will allow ample time for the smaller trees, which may be left on any ground cut over, to come to maturity before it is again called upon to furnish its quota. Some of the woods of the more southern districts of Canada, which have had little value hitherto, except for fuel, only require to be better known to be utilized for many purposes.

The people of Canada have heretofore been accustomed to such an abundance of wood, and to the idea that trees stood in the way of the progress of the country, that tree-planting has as yet made but little progress among us. A beginning has, however, been made in the last two years in the provinces of New Brunswick and Quebec, where "Arbor Days" have been proclaimed. In Ontario an Act was passed in 1883, and a fund set apart for the encouraging of tree-planting along highways. The time has arrived for more vigorous action by the general Government and the Local Legislatures looking to the improvement and preservation of the forests which still remain in Canada, and for the partial restoration of those which have been destroyed.

The Mound-Builders.

By Rev. William J. Smyth.

When the early settlers began to pioneer the unbroken forests of North America, they considered the various Indian tribes to be the true Aborigines of this continent. But long before the red man, even long before the growth of the present forests, there lived an ancient race, whose origin and fate are surrounded with impenetrable darkness. The remains of their habitations, temples and tombs, are the only voices that tell us of their existence. Over broad areas, in the most fertile valleys, and along the numerous tributaries of the great rivers of the central and western portions of the United States, are to be found these wonderful remains, of the existence and origin of which, even the oldest red man could give no history.

Following in the track of these ancient tumuli, which have been raised with some degree of order and sagacity, we are bound to believe that they were constructed by a very intelligent and somewhat civilized race, who during long periods enjoyed the blessings of peace, but like most nations of the earth, at times were plunged in the horrors of war. We cannot tell by what name these strange people were known during their existence. But archæologists, to keep themselves safe, have given them the name of "Mound-builders," from the nature of the structures left behind them.

Of this wonderful, semi-civilized, prehistoric race, we have no written testimony. Their mysterious enclosures, implements of war, and comparatively impregnable fortifications, together with a few strange tablets, are the only evidence of their character, civilization, and doom. No contemporary race, if such there existed on this continent, has left any record of them.

The mounds they have left are found in the western part of the State of New York, and extend, it is said, as far as Nebraska. And as they have lately been found in the North-west, they have thus a much more northern limit than was at first thought, while the southern limit is the Gulf of Mexico.

Having seen only a few mounds in Illinois, Indiana and Kentucky, I must confine my paper to those found in the State of Ohio, where, during a residence of seventeen months, I made the closest investigation my time and duties permitted. In Ohio, the number of mounds, including enclosures of different kinds, is estimated at about 13,000, though it requires the greatest care to distinguish between the mounds proper and those subsequently erected by the Indians. In some parts they are very close together, which is strong evidence that these regions were densely populated. In others, a solitary mound, with adjacent burial mounds, gives us the idea of a rural village or town.

ENCLOSURES.—In the State of Ohio, alone, there have been found 1,500 enclosures. Some of these have walls ranging in height from three to thirty feet, enclosing areas of from ten to 400 acres. Those areas, enclosed by strong walls, erected in regions difficult of access, were undoubtedly intended as military enclosures; while those areas enclosed by slight walls, with no mounds to cover the openings, were intended as sacred enclosures. I shall leave the consideration of the sacred enclosures until I describe the temple, or sacrificial mounds, giving a brief outline of some of the famous fortifications built by those strange people.

Within convenient distance of the city of Xenia, on Little Miami River in Warren county, Ohio, can be seen at any time that famous enclosure known as "Fort Ancient." There can be no mistake as to the intention of this wonderful enclosure. It is situated on the east bank of the Miami on a most commanding position. On the east, two ravines originate, running on either side towards the river, leaving the great fortress on an elevation of 230 feet above the river. The whole is surrounded by a wall of five miles in length, but owing to the uneven course of the river, there are only enclosed one hundred acres. The wall has numerous openings, which, however, are well protected by inner walls, or mounds. These openings could be occupied by warriors while the interior would not be exposed to the enemy. Within the enclosure are disposed twenty-four reservoirs, which could be dexterously connected with springs, so that in time of siege, they would be comparatively independent. The strength of this fortress does not depend on the walls alone, which range in height from five to twenty feet, but upon its isolated position and steep sides. Near the fortification are two large mounds from which run two parallel walls for 1,350 feet, and then unite, enclosing another mound. We cannot tell what part these outer walls and mounds played in the defence of this fortification. But we know that all give evidence of an immense garrison occupied by an ancient and somewhat civilized race, whose numerous enemies, doubtless, forced such strong defence. In point of inaccessibility, engineering skill, and strength, this famous enclosure will compare not unfavorably with Edinburgh Castle, the stronghold of Quebec, or the impregnable Gibraltar.

Another stronghold of considerable importance may be seen at Fort Hill, in Highland county, on an elevation of 500 feet, and enclosing an area of forty acres. There is another near Piqua, on a hill 160 feet high; and another near the city of Dayton, on a hill 160 feet high, where a mound is enclosed, which like the ancient watch-towers of Scripture, can command a view of the whole surrounding country. Near Carlisle lies the site of another remarkable military enclosure, which overlooks the fertile valley, between the Twin and Miami Rivers. Two deep ravines fortify the north and south sides, while an almost perpendicular bluff fortifies the east. The wall which is partly of earth and partly of stone is 3,676 feet in length, and encloses a beautiful area of fifteen acres.

The settlers state that in early times there were two stone mounds and one stone circle, which contained such excellent building stone, that they removed them for building purposes. They had to cut a way and grade it, to remove the stones, which those rude architects of early prehistoric times found no difficulty in taking from a distant quarry to that high elevation. We must therefore agree that their knowledge of the mechanical powers was far superior to anything the Indian race has shown.

About the largest fortification in Ohio may be seen at Bournville. It encloses a magnificent area of fertility, on an elevation of 400 feet. The sides are remarkably steep, and are washed by small creeks, that empty into Paint Creek hard by. Within the fortification are several depressions, where water remains most of the year. The area, of itself, would be a beautiful farm, as it consists of 140 acres. The wall, which was about 2¼ miles in length, is very much in ruins, being chiefly built of stone. Some years ago the whole place was covered by the trees, and on the dilapidated stone wall, may still be seen immense trees, whose growth among the stones helped to displace them. The decayed wood beneath some of these trees indicates that successions of forests have flourished since these forts were abandoned by those who made them.

Graded Ways.—It is well known that, in most of these valleys, there are several terraces, from the river bottom or flats, up to the high lands in the distance. Near a place called Piketown there is a beautiful graded avenue. The third terrace is seventeen feet above the second and the second about fourteen feet from the river flat. These terraces form, when graded, this avenue, which has walls on either side in height twenty-two feet. These walls run for 1,010 feet to the third terrace, where they continue to run for 2,580 feet, terminating in a group of mounds one of which is thirty feet high. Some distance from these walls another wall runs 212 feet at right angles, and then turns parallel for 420 feet, when it curves inwardly for 240 feet.

Mounds.—I stated at the outset that the mounds in Ohio were very numerous. They are of various sizes, ranging from those which are only a few feet in height and a few yards at their base, to those which are about 90 feet in height, and covering some acres at their base. These mounds are mostly composed of earth, the material often differing greatly from the surrounding soil. When we consider the multitudes of these mounds, and the immense transportation of earth and stones required in their structure, it needs no stretch of imagination to conclude that the Mound-builders were a mighty race. Most of these mounds are located near large rivers or streams, and, consequently, in the valleys, although some few are to be found on high lands, and even on hills very suitable for military purposes. Sometimes they may be seen in clusters, indicating a great business centre and large population, while again only one may be found in a journey of fifty or one hundred miles.

During the last fifty years, these tumuli have been carefully examined, and, from their contents, shape and position, they are now classified as Temple or Sacrificial Mounds, Burial or Sepulchral Mounds, Symbolic Mounds, Signal Mounds and Indefinite Mounds. I shall briefly describe the characteristic of each class and give a few examples.

Temple Mounds.—These mounds are not so numerous in Ohio as in some other States, yet they occur in sufficient numbers to deserve a small share of our attention. The city of Marietta has slowly encroached upon some interesting remains of a sacrificial character, which consist of two irregular squares containing 50 and 27 acres respectively. They are situated on a level plain 100 feet above the level of the Ohio and Muskingum Rivers. The smaller square has ten gateways, which are covered by mounds, while the larger square, being strictly a sacred enclosure, has no mounds to cover the 16 openings, but contains nevertheless four temple mounds of considerable interest. On the top of these mounds, doubtless there were erected capacious temples, as there are significant avenues of ascent. There may still be seen the remains of the ancient altar, where, without doubt, these people assembled for worship, and where, from the presence of human bones, we may conclude human beings were offered in sacrifice. In all the sacred enclosures, evidences of altars have been found, on which, doubtless, the sacrificial fires blazed for ages. Often are to be found successions of alternate layers of ashes and blue clay, indicating a desire for pure sacrifice.

In the neighborhood of Newark, Ohio, at the forks of Licking River, may be seen most elaborate enclosures, square, circular, and polygonal in their form, covering in all an extent of four square miles. Like the ancient temples of the Druids, most of the enclosures have their openings to the east, or rising sun, so that the first rays shall strike the altar where doubtless a priest, from the early hour of dawn, performed mysterious rites.

On the west, there is erected a mound, 170 feet long and 14 feet in height, which overlooks the whole works, and has been styled "the Observatory". To the east is a true circle 2,880 feet in circumference, the wall being 6 feet in height. To the north of this is an avenue leading from the circle to an octogon of fifty acres, in the wall of which are eight gateways, which, however, are covered by mounds five feet in height. From this strange eight-sided figure run three parallel walls. Those to the south are about two miles in length, and those running towards the east are each about one mile in length.

About a mile east, where the middle line of parallel walls terminates, is a square containing twenty acres, within and around the walls of which are disposed seven mounds. To the north-east of this is an elliptical work of large dimensions. On the south-east is a circle, in the centre of which is the form of a bird with wings expanded. The body is 155 feet, the length of each wing 110 feet, and the head of the bird is towards the opening. When this structure was opened, there was found an altar, proving that, in this circular place, this ancient people must have assembled for worship.

There is a place three miles north of Chillicothe, where an extensive enclosure—now called "Mound City"—contains 26 well formed and regularly disposed mounds, covering an area of 13 acres. Many of those mounds contained altars at their base, but have been subsequently converted into ordinary mounds. One mound, which is 90 feet in diameter at the base and 7½ feet in height, contained an altar, within the basin of which was found a layer of solid ashes three inches thick, in which were numerous pieces of pottery and shell-beads. On the top of the altar was a layer of sand, then gravel for two feet, then a thin layer of sand, then one foot of gravel.

Buried three feet below the apex of the mound, were found two well developed and highly preserved skeletons, which, however, were not those of Mound-builders, but rather of the Indians who were buried there long after the mounds were abandoned. One altar was covered by a layer of opaque mica, which must have been brought from a great distance. In the centre of the basin was found, besides numerous other relics, a large heap of burned human bones, which would indicate it an altar of human sacrifice. From other evidences, we may safely conclude that they were Sun or Fire-worshippers. As to the cause of these altars being afterwards changed into common mounds, it is difficult to determine. Many such mounds are found, which for a long time were used for purposes of sacrifice, and then covered over by many feet of earth. We may not wonder, however, at this, as even now many old churches are abandoned to the fate of being turned into dwelling houses or barns.

It may be, however, that after the decease of the priest who performed his sacred functions before the altar for many years, the people, to whom he had so long ministered, laid, or burned his remains on the altar which they so much revered, and then, like the ancient builders of the pyramids, erected a monument to departed worth, and during the strange ritual deposited beside the respected remains whatever implements or ornaments they could part with, in honor of the dead.

Burial Mounds.—As in modern days, a place of sepulture is usually selected some distance from the city or town, so the burial mounds may be expected without the enclosures. In our own time we find some cemeteries densely populated with graves, and others have but few. So it was in the days of the Mound-builders; for we find in some places groups of burial mounds, and in other places only a few may be found scattered over the plain.

Burial mounds are of various sizes, I presume, according to the dignity of the individual entombed. Sometimes one large mound is found to possess a skeleton, and some interesting relics, which indicate the position of the departed, while a group of smaller mounds is situated around it. The large one perhaps contained the skeleton of a leader, surrounded by a few of his intimate followers. Or perhaps it was that of a patriarch, surrounded by his numerous progeny, much as, in our own day, burial plots are set apart for families.

Grave Creek burial mound, which stands at the junction of Grave Creek, Virginia, with the Ohio, is one of the largest and most important burial mounds in America. It is 70 feet in height and at its base it is 1,000 feet in circumference. When this mound was opened, two vaults were found, one at the base contained two skeletons, one of them a female. The logs of which this vault was composed were all decayed, and the earth and stones lay upon the skeletons. In the upper vault there was a single skeleton very much decayed. Within these vaults and beside the illustrous dead, were found more than 3,000 shell-beads, ornaments of mica, copper bracelets, and other stone carvings. Around the lower vault were found ten much decayed skeletons, all in a sitting posture.

The skeletons in the vaults, doubtless, were the remains of royalty, or some distinguished chiefs, whose memory these devoted people desired to perpetuate, while the ten skeletons, which surrounded the vault, were perhaps some of their loyal subjects who were sacrificed according to the custom of some of the heathen nations both ancient and modern. Foster, desiring to draw a comparison or rather identify this mode of burial with those of the Greeks and other nations, directs our attention to Herodotus, Book IV, Chaps. 71 and 190. And for identifying the ceremonial with the funeral of Achilles, our attention is called to the Odyssey, Book XXIV, with the burial of Hector in the Iliad, Book XXIV.

Dr. Wilson identifies the burial of the living with the dead by giving an account of the burial of Black Bird, the great chief of the Omahas more than 60 years ago. He caught the smallpox at Washington, and dying on his way home, he gave instructions to his braves around him how he was to be buried. "His body was clothed with the gayest Indian robes, decorated with scalps and war eagle plumes, and he was carried to one of the loftiest bluffs on the Missouri. He was placed upon his favorite war horse, a beautiful white steed. His bow was placed in his hand. His shield, quiver, pipe, medicine-bag and tobacco-pouch hung by his side, for his comfort on his journey to the happy hunting grounds of the great Manitou. After a significant ceremonial, the Indians placed turf and sod about the legs of the horse; gradually the pile rose, until living horse and dead rider were buried together in this memorial mound, which may be seen from the banks of the Missouri."

But to come back to the mound, I now describe a sandstone disk, $1\frac{1}{2}$ inch in diameter and $\frac{3}{4}$ inch thick, taken up from near the skeleton in the lower part of Grave Creek mound. According to Schoolcraft's analysis, communicated to the American Ethnological Society, "Of the 22 alphabetic characters, 4 correspond with the ancient Greek, 4 with the Etruscan, 5 with the old Northern runes, 6 with the ancient Gaelic, 7 with the old Erse, 10 with the Phœnician, 14 with the old British," and he also adds that equivalents may be found in the old Hebrew. It is, as some writers have described it, an exceedingly accommodating inscription. The following readings have been given:—

By M. Levy Bing: "What thou sayest, thou dost impose it, thou shinest in thy impetuous clan, and rapid chamois." By M. Maurice Schwab (1857): "The chief of emigration who reached these places, has fixed these statutes forever." By M. Oppert: "The grave of one who was assassinated here. May God, to revenge him, strike his murderer, cutting off the hand of his existence." We can only say of these readings what a Hebrew Rabbi said to an indolent student, who in reading a verse in the Psalms in the original, gave the translation of the next verse, "Gentlemen, that is a very free translation." Besides this, other readings have been given, all of which have the advantage that few can contradict them.

In the Scioto valley, where there are many very interesting remains of the Mound-builders, there are many burial mounds which have lately been opened. In many of these, the casts of unknown logs are still visible, showing that the dead were placed in a rude vault, which was afterwards covered by soil. One skeleton was found to have round the neck several hundred beads, made mostly of marine shells, others made of the tusks of animals and a few laminæ of mica. In the same mound from which this skeleton was taken, the vault gave strong evidence of its having been set on fire during the burial ceremony,—the large quantity of charcoal proving that it was suddenly quenched by the fresh soil heaped upon it.

If these Mound-builders were Sun-worshippers, as may safely be concluded from tablets and from rock markings, as well as from the fact of their sacred enclosures mostly looking towards the east, where the early rays would fall upon the altar, we may easily account for the fire having a share in the burial ceremony. Some have concluded that the blazing fire signified "life," and that the sudden quenching signified "death."

Let it not be thought, however, that there are no burying places but these few mounds. I believe the mounds of a burial character were only for persons of distinction, while in reality there are thousands of ancient cemeteries of vast extent, where multitudes have received common burial. The spring freshets yearly uncover many of these, exposing not only their bones, but many ornaments and implements that were used by this wonderful people, and which were deposited beside them when consigned to the silent tomb.

Symbolic Mounds.—There can be no mistake in affirming that the strange mounds, so prevalent in Wisconsin, and frequently found in other States, were the result of intention rather than accident. These are sometimes called "Effigy Mounds." In Wisconsin, even implements, as well as animals, are symbolized. The beaver, the tortoise, the elephant, the serpent, the alligator seem to be their favorite animals, whose images they have endeavored to perpetuate in mounds, of course on a large scale. In Adams county, Ohio, on a steep bluff, 150 feet above the level of Brush Creek, may be seen a huge serpent.

It is called the "Serpent Mound." The head of the serpent lies towards the point of the spur, and then like the serpent, its body winds gracefully back for 700 feet, the tail curved into a triple coil. From this and other evidences lately collected, we may assume that the serpent was among the sacred animals. Between the jaws of this serpent there is a stone mound, bearing marks of long use as an altar. The body, which is a mere winding wall, is, on an average, five feet in height, and thirty feet broad at the base near the centre. Doubtless this wall was much higher when first made, and owing to the rains of centuries it has become lower and broader.

Another mound, the shape and proportion of an alligator, may be seen in Licking county, Ohio, about one mile from Granville. This is also on a spur of land near the Licking River. Its length is 250 feet and height about four feet.

Its whole outline is strictly conformable to the alligator with which animal they must have been familiar along the Mississippi, where they could easily journey by boat. Rather than transport the animal from the south, they doubtless erected this representation of what they must have held sacred.

In the State of Wisconsin there is one symbolic mound more worthy of notice than any other. It is called "the Elephant Mound," from the fact that it bears the proportion and conformability of the Mastodon. This people must have known something of this animal which in early times roamed over this continent. I think we should not be going too far if we supposed that the Mound-builders lived contemporaneously with the last of these monsters of the Prehistoric forests.

Signal Mounds.—It seems quite in keeping with what we have already seen of the sagacity of this wonderful race, that they should erect stations of observation in various suitable regions, so that signals could be given to the multitudes who dwelt in the plain, when they were threatened by an approaching enemy. If a fire were lit on a much burnt mound at the ancient fort near Bournville, it could be seen over a large portion of the valleys, where numerous works are found. No doubt, this was a signal mound, where the appointed watchman, like the watchman of Scripture, could give the alarm of the coming foe, enabling the industrious people to reach the fortress in safety.

On a hill 600 feet high, near Chillicothe, Ohio, there is a mound, which in the days of the Mound-builders must have been a signal mound. A light on this can be seen for twenty miles either up or down the valley.

The great mound at Miamisburg, Ohio, which is 68 feet high and 852 feet in circumference at its base, served, no doubt, this important department of warfare, as a fire kindled on it could flash light into Butler county, near Elk Creek, where it would again be taken up by the watchman there, and light flashed in the direction of Xenia, and from one signal mound to another until it would reach the great works at Newark. Thus in the course of an hour the whole southern portion of the State of Ohio could be warned of danger and prepare for combat or shelter.

Such a system has been used by all nations, both civilized and savage. We need not wonder that the Mound-builders with such sagacity and forethought, should establish such a system of alarm by which the inhabitants could be apprised of invasion.

Indefinite Mounds.—Of this class there are many. Thousands of such indefinite mounds and squares and circles are to be seen scattered over the various States of the Union. Their structure, composition and contents, give us no clue by which they may be assigned a place. It is believed that many of the strange works that abound in Butler county, Ohio, and which cannot be classified, are among the incomplete works, that is, works left unfinished by the builders.

Implements.—The people of Ohio have appropriated the implements of the Mound-builders to a large extent. Almost every homestead in Ohio is ornamented with some of those ancient implements and relics, yet tons have been taken away to grace private and public museums in all parts of this country, and even the museums of Europe and Ásia. Among the implements are to be found spear heads, arrow heads, rimmers, knives, axes, hatchets, hammers, chisels, pestles, mortars, pottery, pipes, sculpture, gorgets, tubes, and articles of bone and clothing. Fragments of coarse, but uniformly spun and woven cloth have been found, of course not in preservation, but charred and in folds. One piece, near Middletown, Ohio, was found connected with tassels or ornaments, and may be seen at the Smithsonion Institute at Washington. In Anderson township, Ohio, native gold has been found for the first time. Several small ornaments of copper have been found covered with thin sheets of gold. Earrings also, made of meteoric iron, have been found, and a serpent cut out of mica. Some terra-cotta figures also, which give us an idea of the way the hair was dressed in the days of the Mound-builders. I cannot here name all the implements and ornaments that have been discovered. Though most of them are of hard stone, yet many have been found made of copper.

Mining, etc.—That these people were miners, is evident from the prevalence of various mineral fragments and implements. At Mound City, near Chillicothe, has been found galena, none of which can be found in Ohio. Obsidian also is found in the shape of instruments, which they must have transported from the Rocky Mountains. Ancient mining shafts are found in Minnesota, where the solid rock had been excavated to the depth of 60 feet. On Isle Royal there are pits 60 feet deep, worked through nine feet of solid rock, at the bottom of which is a rich vein of copper, and in the two miles of excavations in the same straight line have been found the mining implements in great numbers. Such advancement in mining, sagacity in warfare, industrial pursuits, and geometric skill, as their works display, prove their great superiority of race over the modern Indian. Their implements, some of them most elaborately made, their brick-making and various other ingenious works, enable us to place them high as an industrial people, while their sacred enclosures, and altars, and tablets, together with the numerous evidences of their being an agricultural nation, enable us to place them far above the modern Indian in the scale of civilization.

The people of the United States, though much to be commended because of their prudence and forethought in laying out their modern towns and cities along the various water courses, which serve as the different highways of commerce, have by no means shown a superior sagacity in that respect to the Mound-builders, whose great centres of population are now mostly occupied, or are encroached upon by the modern cities.

We may with safety assert that the population about Newark, and Xenia, and Mound City, was far above what it is now. The country about Dayton, Miamisburg, Oxford, Hamilton and Marietta was, undoubtedly, in the days of the Mound-builders moving with a greater mass of human beings than it can boast of to-day.

And if those peaceable and industrious inhabitants were as numerous as their remains indicate, what must have been the strength of those invading hordes who caused their downfall and perhaps wiped out forever every living representative of that ancient race, who could leave no more lasting memorial of their existence and struggles than those mysterious mounds which have given them their name.

Antiquity of the Mound-Builders.—Upon this point there are many theories, some regarding them as the earliest of the Indian tribes. Others give them a very great age and claim them to belong to preadamite man. By far the greater number of archæologists, however, place their existence at about 2,000 years ago.

In favor of the latter view we may call as evidence the present forest trees, which, though of great age, still flourish on some of the ancient remains. On one of the mounds at Marietta, Ohio, there stood a gigantic tree, which, when cut down displayed 800 rings of annual growth. In many other places, trees of the age of 750 years have been cut, and underneath them evidences of previous forests found. One tree 750 years old was found to have underneath it, on the walls of one of the forts in Ohio, the cast of another tree of equal size, which would carry us back at least 1,500 years since those trees began to grow on those deserted walls of that ancient fortification.

We have some data in the vegetable accumulations in the ancient mining shafts near Lake Superior, as well as in the vegetable and other matter deposited in the numerous pits and trenches found among the works. Though these evidences cannot give the exact time of their accumulation, yet they give it approximately by comparison with similar recent deposits.

There is another still stronger argument in favor of their antiquity, viz., the decayed condition of the skeletons. The skeletons of the oldest Indian tribes are comparatively sound while those of the Mound-builders are much decayed. If they are sound when brought out, they at once begin to disintegrate in the atmosphere, which is a sure sign of their antiquity. We know that some skeletons in Europe have lately been exhumed, which, though buried more than 1,000 years, are comparatively firm and well-preserved. We are, I think, bound to ascribe a greater antiquity to the Mound-builders' skeletons than to those found in the ancient burrows of Europe. Other considerations, such as stream encroachment, and river-terrace formation, might also be brought in as presumptive arguments in favor of their great antiquity.

Origin of the Mound-Builders.—This is a question not easily answered. It brings me into no discredit before the educated world to acknowledge ignorance on this mysterious point. The study of Craniology and Philology, in connection with Ethnology, shall alone throw light on this subject. Dr. Wilson says, in his "Prehistoric Man" (p. 123), "The ethnical classification of this strange race is still an unsettled question," and he declares without fear of contradiction, "that especially concerning the Scioto Mound skull, the elevation and breadth of the frontal bone, differs essentially from the Indian, and that the cerebral development was more in accordance with the character of that singular people, who without architecture have perpetuated, in mere structures of earth, the evidences of geometric skill, a definite means of determining angles, a fixed standard of measurement, and the capacity as well as the practice of repeating geometrically constructed works of large and uniform dimensions."

Undoubtedly they were skilled in agriculture, from the remains of ancient garden-beds, which were cultivated in a methodical manner. The modern Indians give no such evidence of labor. For wherever they are found they love to roam in undisputed possession of the forest, and lead an indolent life. Of course I do not assign this as a valid reason for their not being identified with the Mound-builders. An ancient race may have a degenerate offspring.

Nor shall I attempt to find in the various inscriptions any clue to their Hebrew origin, or to identify that ancient people with the lost tribes, as some have dared to do. Foster inclines to regard them as emigrating from the tropics, rather than coming from the north.

This would involve us in investigating the antiquity of the Mexican and Peruvian ruins, where vast works of high architecture and more advanced civilization were found than among the Mound-builders. There is little difficulty in concluding that the Aztecs, who occupied Mexico during the Spanish invasion under Cortez, were the conquerors of several races that preceded them. Among these conquered races, no doubt, were the Toltecs, who were afterwards found in such great numbers, and in an amazing state of advanced civilization. The crania of the Mound-builders and the Toltecs correspond. Now, whether they migrated to the north from the tropics, or journeyed south from the north, I cannot say. I should incline to the latter theory. Industry is sure to advance. The rude mounds of the United States are far surpassed by those immense pyramids in Mexico and Peru, surpassing the Egyptian in size. And those fine architectural palaces and temples, whose history we cannot fully know, far eclipse anything in the northern part of America.

Whoever they were and wherever they came from, they were doubtless driven southward by the invading tribes of the north. They nobly fought their way, contesting every foot, until superior numbers took them by force. Thus these quiet and inoffensive creatures were finally expelled from their home which doubtless their fathers had occupied through centuries. If any escaped they, no doubt, found an asylum southward, where there were other tribes equally civilized, and, forming an union with them or conquered by them, they began a higher and better civilization as seen in Mexico and Peru.

Geology and Geologists in New Brunswick.

By L. W. Bailey.

In a recently issued Bulletin (No. XI.) of the Museum of Comparative Zoology, relating to the Azoic System and its proposed subdivisions, the authors (Messrs. J. D. Whitney and M. E. Wadsworth) review the progress of geological investigation in New Brunswick and my connection therewith in a way which, in justice to myself and my colleague, Mr. G. F. Matthew, seems to call for some explanation. In the review referred to, it is the avowed object of the author or authors to show, by numerous citations, as well as by tabular representation, that great diversity of opinion has existed as to the age of the older rock-formations of this Province, that these opinions have had no reliable basis of observed facts, are a mass of confusion, and by consequence worthless.

To the first of the above statements I have no special objection to offer, but desire to emphasize the fact that the review in question embraces a period of over twenty years, and the work of not less than five different observers, engaged at different times and places, often independently, and in a region of the most varied and complicated character. During that period changes of the greatest importance have occurred alike in geological methods, in geological nomenclature, and in general geological theories; while, as regards more particularly regions of metamorphic rocks, these have everywhere been the subject of continued and keen controversy. Such diversities of opinion and the discussions to which they give rise are inseparable, as I believe, from investigations of this kind, and not only have occurred, but must occur in the study of all regions of disturbed and highly altered rocks. The comparative review of such studies over many different parts of the continent (and, I might add, of Europe also,) shows that the investigations in New Brunswick are in no way exceptional in this particular.

But I have now to add that the actual changes of opinion complained of have really been much less than the citations of Dr. Wadsworth and his colleague would seem to indicate. Thus, since the time of the first determination of the real age of the St. John City slates as Primordial, neither Mr. Matthew nor myself have ever held or expressed any other opinion than that the great bulk of gneissic, calcareous, siliceous, and felsitic rocks which underlie them (and which we compared with the generally accepted Laurentian and Huronian systems) were pre-Silurian, and that their sequence was that given in our first accounts of the region. Owing however to the successive study of adjoining districts and the often very different relations exhibited at these several points (members which were apparently conformable at one point ceasing to be so at another, while portions largely developed at some points failed to appear altogether at others), different views have at various times been held as to where the lines of separation between successive formations were to be drawn. Thus, while the base of the Primordial was at first believed to be marked by certain white sandstones or quartzites, while the underlying purple sandstones and conglomerates were thought to be more intimately connected with the Huronian, reason was afterwards found for regarding the real base of the Primordial as being *beneath* these coarser beds; thus accounting for the apparently contradictory statements, first, that no sandstones or even grits were contained in this formation, and later, that it included at its base heavy conglomerates filled with the debris of the underlying Huronian. As these conglomerates are at some points wholly wanting, the different views expressed above become readily intelligible. So again, while at St. John there is an apparent conformity and great similarity among all the rocks, notwithstanding that they are now known to contain in different parts fossils of widely different ages, a few miles away from the city that conformity fails altogether, and hence so long as the conditions of the formations at that city alone were known, the views of their relations might well be different from what later and more extended observations showed to be the more correct ones.

The conformity or unconformity of the Primordial to the Huronian (Coldbrook group) dwelt upon at length by the authors of the "Azoic System" will be apparent or not just according to what we regard as being Primordial. If the conglomerates and associated beds beneath the fossil-bearing strata be regarded as Huronian, the two series, so far at least as these beds are concerned, will be conformable; if included with the Primordial (as later investigations fully prove to be the case), then the want of conformity of the latter to the pre-Silurian is marked and general. I may here add that the observations on which these conclusions were based were far from being made in a day or even in a single season, but involved an amount of difficult exploration, in a region but little settled, which only those who have worked in such localities can fairly appreciate.

One point more. The authors of the "Azoic System" take exception to the work of Mr. Matthew and myself for introducing structural complications, such as faults, folds, and overturns, merely for the purpose of satisfying certain theoretical conceptions, and assert that these are entirely the work of the imagination. In the face of the fact that the authors referred to have probably no personal acquaintance with the district described, it is quite as fair to reply that *their* opinion in the matter has no solid foundation to rest upon. If the occurrence of a reversed succession is any proof of a reversed or folded position of the beds in which it is exhibited, then the evidences of such folds and reversals, as detailed in the reports, are certainly ample. As to faults, the country, as in most regions of highly disturbed rocks, is full of them, and where their existence explains relations which are otherwise inexplicable, I am at a loss to understand why they should be ignored. It is true that an error into which we had fallen as regards one of the groups described (the Bloomsberry group), from a want of knowledge of its relations to other formations beyond the district examined, was corrected by Dr. Hunt; but that in the main facts, as to the age and succession of the several groups and their structural relations, we were subject to the "dictum" of that gentleman, is quite incorrect. So far is this from being the case that the views of that succession as ascertained by us prior to Dr. Hunt's first visit to this region, have been steadily maintained by us and by the Canadian Survey, and I believe are generally accepted.

Want of space prevents my noticing a number of misconceptions and some mis-statements by the authors of the "Azoic System." A comparison of the recently issued maps of this region with those in existence twenty years ago, when our labors began, will sufficiently show how far a real progress has been made.

Studies in the Comparative Physiology of the Heart.[1]

By T. Wesley Mills.

RHYTHM AND INNERVATION OF HEART OF SEA TURTLE.

This investigation was undertaken partly as a continuation of previous work on the sea turtle, a short account of which had already been published in the *Journal of Physiology*, but chiefly as a continuation of my work on Chelonian heart physiology in general. A paper of mine, on the terrapin's heart, has recently appeared in Vol. VI, Nos. 4 and 5, of the journal referred to; but the whole of my work on the Chelonians is intended to furnish a systematic comparison from a physiological point of view of several of the genera and species of the Chelonians. It is thought that no such systematic comparison has ever before been attempted for physiology, though it is constantly being done in morphology.

The investigation on the terrapin was carried on in the Biological Laboratory at Baltimore; those on the sea turtle, alligator and fish, at the Marine Laboratory at Beaufort, N. C. Only a very brief account of this work is furnished here, the papers *in extenso* having been sent for publication in the *Journal of Physiology* of Cambridge, England, in which also due acknowledgement is made of my indebtedness to the authorities and teachers of the Johns Hopkins University for facilitating these investigations.

In all of them the direct method of observation has been used and the heart has been experimented upon mostly *in situ*. For electric stimulation, a Du Bois induction coil, fed by one Daniell's cell has been used, except in the case of one set of experiments on the alligator, in which a Bunsen's cell was substituted.

In order to insure the specimens of the sea turtle being in the best possible condition, those not used at once

[1] Contributed by Prof. Mills, of McGill University, Montreal, to *John Hopkins University Circulars.*

on being caught were kept on the sea shore in a "turtle pen," so arranged as to admit of free ingress and egress of water. They were also fed on crabs, their natural diet. In all, 20 specimens were employed, belonging to three species *Chelonia caretta* (Loggerhead), *Chelonia imbricata* (Hawksbill), *Chelonia midas* (Green Turtle). By way of comparison, experiments have also been made on a limited number of specimens of the land tortoise (*pyxis*).

The Sympathetic System of Nerves in the Marine Turtle.—It is very remarkable that *Chelonia midas* in its cervical and thoracic sympathetic should very closely resemble the terrapin, but differ widely from *C. caretta* and *imbricata.* In the latter, the sympathetic in the neck runs widely apart from the vagus and almost equals it in size. Its superior and middle cervical ganglia are ill-defined cordiform swellings, while the lower cervical and the first thoracic ganglia are fused together to form the ganglion cardiacum basale. The latter is very large and gives off upward many strong branches to the brachial plexus, and downward to the lungs, etc., and probably to the heart.

From the middle cervical ganglia a strong branch passes to the heart along the vagus. This is a cardiac accelerator. The corresponding branch in the terrapin is much less defined and often wholly wanting.

Chelonia midas differs greatly from *C. caretta* and *imbricata*, resembling very closely in its sympathetic system the terrapin. The sympathetic in the neck is very much smaller than the vagus, its ganglia well marked and it is often more or less united with (though easily separable from) the vagus. But a great difference is observed in the absence of fusion of the lower cervical and the first thoracic ganglia. These ganglia are in the terrapin often connected by an annulus Vieussenii.

Sympathetic Cardiac Accelerators.—Stimulation of the branch from the middle cervical ganglion referred to above leads in the sea turtle with greater constancy than in the terrapin to acceleration of the rate, and especially augmentation of the force, of the beat of the heart. Also stimulation of the ganglion cardiacum basale or the main chain between it and the first associated metamere below, leads to acceleration and augmentation. The same laws apply to this as to vagus acceleration.

The Results of the Stimulation of the Vagus.—The vagus when stimulated may arrest the auricle and ventricle in the manner described for the alligator. In no Chelonian thus far examined is the heart arrested by the vagus through the reduction of the force of the beat to zero, as in the frog. As in the terrapin, unilateral vagus effects are comparatively common; i.e., a strength of current sufficing to arrest one auricle, for example, when the corresponding vagus is stimulated, has much less effect on its fellow.

Comparative Effect of each Vagus.—A large number of experiments have given results very closely resembling those obtained for the terrapin, i.e., in the great majority of instances the right vagus has greater power, especially in maintaining the heart in stand-still or continued stimulation, than the left; but in both terrapin and sea turtle this difference appears to be less than in the land tortoise. This difference in the vagi seems to extend to other families of cold-blooded animals, and is to be explained not by a difference in the number of inhibitory fibres in each vagus, nor by inequality in the distribution of them, but by the fact that the right pulsatile venous area (right sinus and veins), to which the right vagus is mostly distributed, is the chief or dominating part in the driving machinery of the heart, for arrest of the heart is practically dependent on arrest of the sinus. In one case, in the sea turtle, prolonged alternate stimulation of the vagi gave perfect cardiac inhibition for more than six hours. This is the longest case of heart stand-still of this kind yet recorded for any animal.

Structure of the Chelonian Heart.—Between the sinus and the conspicuous auricle there is a part of the heart somewhat different in appearance, structure, and physiological qualities from either the sinus or auricle proper. A similar structure is found in some fishes. Especially have my experiments shown that the capacity for independent rhythm in this part is greater than in the so-called "bulged" part (Gaskell) of the auricles. I have, therefore, thought it well to name this part "sinus extension," and consider it a separate part of the heart. It is in reality more allied functionally to the sinus than to the auricle proper.

Very frequently in the Chelonians and especially in the marine turtles, stimulation of the vagus with a weak current suffices to arrest the auricles proper; in that case the contraction wave of the sinus is conducted along the sinus extension to the ventricle. The same occurs in the alligator and the fish.

The Law of Inverse Proportion.—My work on the various genera of Chelonians and the alligator has shown conclusively that, whether the vagus or the sympathetic cause the cardiac acceleration and augmentation, one law invariably applies, viz., that the increase in the rate and force of the heart-beat, after stimulation of the vagus or accelerating sympathetic, is always inversely as the rate and force at the time of stimulation, i. e., the slower and weaker the heart, the greater the increase. The vagus seems to be the most constant and powerful cardiac augmentor known to us.

Faradisation of the Heart directly has given for the sea turtle results analagous to those obtained in other Chelonians and the fish, but in the sea turtle there seems to be less effect, especially as regards dilation around the area stimulated.

The fact that arrest of the sinus by direct stimulation is not possible when the heart nutrition has much suffered (and especially, therefore, its nerves), and that the dilating effects are like those produced by vagus stimulation, etc., favors the view that the results of faradisation are not due to direct stimulation of the heart muscle but accomplished mediately through its nerves. The light-colored areas, which, I have pointed out, are seen in all cases at the exact points of contact of the electrodes, are due to direct effects of the muscle (contraction).

Spontaneous Rhythm.—The order in which spontaneous rhythm most readily arises and is best maintained is: sinus, sinus extension, auricle, ventricle. A large number of experiments on the ventricle, especially, of the sea-turtle, show that in the latter, as in all other Chelonians thus far examined, the ventricle has in most cases a certain capacity for independent rhythm, but that apart from all forms of stimulation, this rhythm is never very marked, though it may last for hours. This seems to be greater in the land tortoises than in other Chelonians.

The ventricle of the sea turtle is characterized by great sensitiveness as compared with that of other Chelonians, hence its spontaneous rhythm may be greatly increased by slight stimulation. Results, like those of Gaskell, obtained by suspending the heart, attaching recording levers and feeding it through its own system of vessels, without regard to the normal blood pressure therein, must not be considered as those of pure spontaneous rhythm, for such methods furnish stimulation. In my experiments, the heart was kept surrounded with nutriment and covered so as to provide a "moist chamber," but it remained *in situ*. The ventricle was separated by ligature in most cases, by section in a very few.

Is there a Depressor Nerve in the Chelonions?—Blood pressure experiments on the terrapin and the sea turtle have shown that no nerve, with the characters of a physiological depressor, exists in this family. Certain fine nerves in the neck of the sea turtle have, on stimulation, given results of a peculiar and puzzling kind. They have been inconstant in action, sometimes giving rise to acceleration, sometimes to retardation of the cardiac rhythm, or to both—now one, and now the other.

Stimulation of the Cerebral End of one Vagus, the medulla and other vagus being intact in all the Chelonians I have examined, has usually produced cardiac arrest. In the sea turtle, in one case, this was followed by decided after-acceleration, but the different genera of Chelonians and even different species and individuals show variation in this respect, as also in the degree to which the heart can be reflexly inhibited; the terrapin and *C. Midas* resembling each other most and giving the best marked results. In fact this research has confirmed the truth of the law, that with anatomical resemblances are usually associated physiological ones.

Evolution of Function.—The experiments on the sea turtle have shown that where the cardiac nutrition suffers considerably, the left auricle may even be quiescent when the right is still beating well ; also that the ventricle dies in a certain segmental order, the last part to get rigid being on its right side. Thus for some time before death an earlier condition (from a developmental point of view) is established, viz., reduction to sinus, one auricle, and a simplified ventricle. It is thus seen that the order of death for the different parts of the heart indicates its history, the oldest parts have greatest vitality. Further, the greater size and importance of the right (part of the) sinus, of the right auricle, etc., have also a relation to the order of acquisition. In the only fishes having a left auricle, the Dipnoï, this part is very small and insignificant as compared with the right.

Anomalous Results.—Stimulation of the liver in certain cases in the sea turtle, when reflex inhibition was being studied, has given results analagous to those obtained in the alligator, and especially in the fish, i.e., the effect has not been pure inhibition, but preliminary acceleration with or without after-retardation. The subject is of great interest, though very puzzling in the present state of knowledge. It is further considered in the account of the investigation on the alligator.

(To be continued.)

Aboriginal Trade of the Canadian Northwest.

By Charles N. Bell.

Articles of beaten native copper such as knives, chisels, awls, scrapers, bracelets, etc., have been taken from mounds situated on the banks of Rainy River. The metal in all probability was mined at Lake Superior; perhaps at Isle Royal, which is opposite the eastern terminus of a canoe route leading from Rainy River. On this island many mines, first worked by a prehistoric people, have been discovered during the past few years.

Sea shells of the genera *Natica* and *Marginella* (?) have been found in the mounds in close proximity to articles of copper. This fact gives us a clue to the direction of the line of trade and the articles which were exchanged by the Mound-builders of the north and south.

By ascending any of the several small streams which flow from the south into Rainy River, communication is had without difficulty with the Mississippi, along the banks of which, Mound-builders' remains may be counted in thousands. Articles made from the Lake Superior copper are found in many of the mounds to the far south, and when we find southern sea shells in the northern mounds, it may be taken for granted that one was exchanged for the other.

Gold, silver, mica, asbestos, lead, pyrites, etc., appear in the rocks of Lake of the Woods, close at hand to the mounds on Rainy River, but none of these minerals, so far as reported, have been taken from the tumuli. This is rather peculiar in the matter of the mica, as it is frequently found in the mounds of the Central States, generally in the form of thin sheets covering the interments, though often cut into shapes intended for use as ornaments.

So far as known, few manufactured articles of copper or pieces of the raw metal have been taken from the mounds on Red River in Manitoba, in striking contrast to the rich yields of the Rainy River tumuli. So little exploration has been done in the Manitoba mounds, that it is not possible to state with any degree of certainty that copper implements or ornaments will not yet be found in them; but, if we judge from the data to hand, there must have been a difference in the stock in trade, available for exchange with southern tribes, possessed by the Mound-builders living on Red and Rainy Rivers. The mound systems of these two rivers merge into one about the head of the Mississippi, and it seems impossible that the residents of the two districts were not in communication with each other.

The presence of pipes for smoking in some N. Mississippi mounds, makes it apparent that tobacco was an article of exchange, for though the Indians of the present day use various substitutes for tobacco, in the form of bark and leaves, there would be an eager demand for the tobacco of the south, the existence of which must have been known to this northern people through their intercourse with tribes to the south.

Fur was plentiful in the northern country, and would be traded with the people living in the south, who, though inhabiting districts possessing a milder climate, were glad to have the light fine furs for protection at certain seasons.

Mounds on Red River in Manitoba have been found to contain ornaments cut from shells of the *Busycon perversum*, which necessarily were transported fully 1,500 miles from the waters in which they are produced, to be made an object of barter.

Red River valley was, at a not very remote date, the feeding ground for countless thousands of bison, and their remains have been found by me in the mounds and amongst the kitchen middens of their old camp site in the immediate vicinity. The dried flesh of the bison was likely stored up for winter use, and became an article for exchange with the people of the wooded country and the copper miners.

At St. Andrew's, Manitoba, a limestone ridge topped with drift-gravel and boulders from the Laurentian formation to the east or north-east, crosses Red River. Near a group of mounds at this point I discovered an ancient camp site, and from the bank of the river took quantities of flint chips, partially worked and finely finished arrow-heads, scrapers, etc. The drift on the ridge supplied the raw material, and this place was evidently a resort where flint implements were manufactured to supply the wants of the residents of less favored localities.

From the quantities of broken pots found in the river bank and the fact that the clay and decomposed granite, entering into the composition of the earthenware, is to be had in abundance in the vicinity, it seems altogether likely that pottery was also made at this camp site and became an article of trade. I have examined an earthenware pot taken from a mound situated within the city limits of St. Paul, Minnesota, which, as regards size, composition, construction, and style of marking, is identical with specimens of the fragments taken from the Manitoba camp site, and with a complete cup from a mound situated at the International Boundary Line. Though 500 miles apart, these two localities are practically connected by a continuous line of mounds, and it is not improbable that pottery made on Red River was passed from hand to hand until it reached a distance of 500 miles from the workshop.

No article of European manufacture has been taken from the Manitoba mounds, not even from about the remains of the intrusive burials, so that there is every likelihood that the work of the builders in that country had ceased long before Kelsey, de La Vérendrye, and later European adventurers made their appearance in the Northwest and revolutionized trade.

Variation of Water in Trees and Shrubs.

By D. P. Penhallow.

The amount of water which highly lignified plants contain, particularly as influenced by season and condition of growth, obviously bears a more or less important relation to physiological processes incident to growth, and most conspicuously to those which embrace the movement of sap. Studies relating to the mechanical movement of sap in early spring, at once suggest the question as to how far this is correlated to greater hydration of the tissues at the time when this movement is strongest. It was with a view to exhibiting this relation more clearly, that determinations of moisture in a large number of woods, representing growth of one and also of two years, collected at different seasons, were made by me in 1874.[1] The range of seasons was not as complete as could have been desired, and no attempt was made to formulate a general law applicable to this question. With a view to extension of data in this direction, I undertook additional determinations in 1882. The final determinations were made in most cases by Mr. W. E. Stone, then acting as assistant. It is the object of the present paper to combine all the results thus obtained, together with such other facts

[1] W. S. Clark: Agriculture of Massachusetts, p. 289.

as have come to hand, and to see how far they indicate a general law.

Theoretical considerations lead us to infer that if there is any variation at all, the hydration of the structure must be greatest during the period of active growth, and least during the period of rest. How far this is supported by the facts, will appear in the following.

HYDRATION OF DEAD WOOD.

Incidentally to the main question, specimens of dead wood, devoid of the bark, and representing an age of four to six or eight years, were collected and the moisture determined. While the branches were dead, none of them were in advanced stages of decay, so that the contained water could not be regarded as that of active decomposition, but simply that which would be readily retained in the lifeless, air-dried substance as exposed on the tree. The results obtained from fifteen species of trees showed an extreme variation of 6.4 per cent., the range being from 12.9 per cent. to 19.0 per cent. of water. The mean hydration obtained from these determinations, was 15.1 per cent. The results appear in the following table:—

HYDRATION OF DEAD WOODS.

Determined at 100° C.

SPECIES.	PER CENT. WATER.
Acer saccharinum	18.8
Amelanchier canadensis	19.0
Betula alba	15.1
" excelsa	15.9
" lenta	13.7
Carpinus americana	13.8
Castanea vesca	14.0
Cydonia vulgaris	12.9
Cornus sericea	13.6
Pinus strobus	11.9
Pirus malus	12.9
Prunus serotina	17.4
Quercus alba	15.5
Tsuga canadensis	18.6
Ulmus americana	13.5
MEAN.	15.1

HYDRATION OF WOOD FROM LIVING TREES.

The specimens, upon which the principal facts of this paper are based, were collected as sections of living trees, representing on the one hand, branches of two years growth, and on the other, branches from two to four years old. For the obvious reason that the bark could not be properly separated from the wood with any degree of uniformity, it was left on in every case, so that in all the determinations here given, the results show the combined percentage of water in wood and bark. Obviously, this gives a result which differs materially from that which would be obtained if bark and wood were considered separately. Also, while care was taken not to collect specimens in which the dead bark was strongly developed, thus securing as great uniformity as possible, the very fact that the bark was present, as well as the certainty of its being variable in structural character and thus also in hydration, as collected even from the same species at different seasons, rendered variations in the results unavoidable. This will doubtless appear upon examining individual cases, but the error from this source is reduced in the aggregate, so that the mean results, in view of all the precautions taken, may doubtless be accepted as correct.

From an examination of the results that follow, it will appear that, comparing the younger with the older wood, the percentage of water is sometimes greater in one, sometimes greater in the other, apparently conforming to structural peculiarities of the species. The mean results, however, show clearly what we might infer upon theoretical grounds, viz., that in the youngest growth, as also in the sap wood, the percentage of water is higher by two per cent. than in the older growth where the heart-wood is in relative excess. This is found to hold true in the mean results, not only for each season, but also for all seasons; in the former case, however, this difference shows a variation of from 0.8 per cent. to 3.3 per cent. of water.

Species.	English Name.	February.		March.		April.		September.		December.	
		1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
Magnoliaceæ.											
Liriodendron tulipifera, L.	Tulip tree	......	55.8	52.7	54.9	......	......	......	......	......	59.30
Tiliaceæ.											
Tilia americana, L.	Bass wood	55.1	53.9	......	55.6	......	......	48.6	55.9	53.20	58.1
Rutaceæ.											
Ailanthus glandulosus, *Desf.*	Tree of heaven	48.6	46.0	......	......	......	......	......	......	......	......
Anacardiaceæ.											
Rhus glabra, *L.*	Smooth sumach	......	......	45.6	41.1	......	......	......	......	41.2	36.4
" typhina, *L.*	Staghorn sumach	......	......	51.3	33.3	......	......	......	......	......	......
Vitaceæ.											
Vitis cordifolia, *Michx.*	Frost grape	42.1	41.7	48.3	48.0	......	......	......	......	48.8	43.7
Ampelopsis quinquifolia, *Michx.*	Virginia creeper	......	......	59.2	60.7	......	......	......	......	76.4	62.4
Ilicineæ,											
Ilex verticellata, *Gray.*	Black alder	......	......	46.2	46.4	......	......	......	......	48.0	49.4
Celastraceæ.											
Celastrus scandens, *L.*	Bitter sweet	......	......	47 7	49.4	......	......	......	......	52.3	52.4
Rhamnaceæ.											
Ceanothus americanus, *L.*	New Jersey tea	......	......	17.3	37.6	......	......	......	......	19.5	41.4
Sapindaceæ.											
Acer saccharinum, *Wang.*	Rock maple	46.5	47.1	47.5	42.9	......	......	48.1	44.0	42.6	42.7
" rubrum, L	Soft maple	44.9	44.7	50.8	45.4	......	48.7	......	......	53.0	55.1
Æsculus hippocastanum, *L*	Horse chestnut	49.1	46.1	......	......	......	......	......	......	......	......
" flava, *Ait.*	Sweet buckeye	......	......	......	......	......	......	64.9	65.4	......	......

LEGUMINOSÆ.											
Gleditschia triacanthos, *L.*	Honey locust	34.9	......	......	......	......	......	......	......	......	......
Robinia pseudacacia, *L.*	Locust	......	......	44.0	38.3	......	......	......	......	51.3	......
ROSACEÆ.											
Amygdalus persica, *L*	Peach	46.1	40.4	50.9	49.4	56.0	43.7	......	......	55.3	42.0
Prunus domestica, *L.*	Plum	......	......	48.1	41.2	......	......	......	......	53.9	46.2
" serotina, *Ehrhart*	Black cherry	......	......	52.7	50.8	......	......	50.6	50.3	47.3	46.0
" cerasus, *L.*	Cherry	......	......	49.9	......	......	......	......	......	50.6	47.7
Cydonia vulgaris, *L.*	Quince	45.5	39.6	......	......	......	......	56.3	52.6	......	......
Pirus communis, *L*	Pear	49.9	47.7	49.7	48.1	55.4	54.0	54.0	51.5	53.7	50.0
" malus, *L.*	Apple	49.5	44.8	45.7	41.5	49.0	46.4	56.2	54.5	48.3	51.9
Amelanchier canadensis, *Torr & Gr.*	Shad bush	44.3	38.0	......	44.6	......	......	......	......	47.4	45.1
Cratœgus tomentosa, *L*	Thorn	......	......	43.1	40.4	......	......	......	......	55.9	43.4
HAMAMELACEÆ.											
Hamamelis virginica, *L*	Witch hazel	41.7	41.1	48.2	54.2	......	......	......	......	48.7	51.3
CORNACEÆ.											
Cornus florida, *L.*	Flower'g dogwood	......	......	55.1	43.2	......	......	......	......	53.6	52.8
" sericea, *L.*	Silky dogwood	......	......	50.6	49.2	......	......	55.4	......	51.2	......
Nyssa multiflora, *Wang*	Tupelo	50.9	49.0	48.0	49.3	......	......	51.1	50.9	50.8	58.7
CAPRIFOLIACEÆ.											
Sambucus canadensis, *L.*	Elder	......	......	58.2	48.2	......	......	......	......	56.3	55.1
" pubens, *Michx*	Red-berried elder	54.5	55.7	......	......	......	......	......	......	......	......
Viburnum opulus, *L.*	Cranberry tree	44.7	47.7	......	......	......	......	......	......	......	......
RUBIACEÆ.											
Cephalanthus occidentalis, *L.*	Button bush	......	......	54.1	42.8	......	......	......	......	42.8	......
ERICACEÆ.											
Andromeda ligustrina, *Muhl.*	......	......	......	46.7	45.9	......	......	......	......	38.0	59.0
Kalmia latifolia, *L*	Calico bush	......	42.5	50.7	44.4	......	......	......	......	49.4	42.3
Azalea nudiflora, *L.*	Azalea	......	......	41.8	43.8	......	......	......	......	45.8	49.9

Species.	English Name.	February.		March.		April.		September.		December.	
		1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
Oleaceæ.											
Fraxinus americana, *L.*	White ash	32.0	29.6	38.3	34.4	......	......	......	......	35.2	29.5
Thymeleaceæ.											
Dirca palustris, *L*	Leatherwood	51.8	......	......	......	......	......	......	......	......	......
Lauraceæ.											
Sassafras officinalis, *Nees*	Sassafras	34.9	33.9	40.7	38.1	......	......	......	......	......	41.4
Solanaceæ.											
Lycium barbarum, *L.*	Matrimony	......	......	......	......	......	......	......	......	65.4	58.0
Urticaceæ.											
Ulmus fulva, *Michx.*	Red elm	......	......	52.1	44.0	......	......	......	......	51.5	36.3
" americana, *L.*	White elm	41.4	39.8	45.6	36.8	......	......	57.1	52.3	43.0	43.9
Morus alba, *L.*	White mulberry	52.1	43.0	......	......	......	......	......	......	......	......
" rubra, *L*	Red mulberry	......	......	47.0	42.8	......	......	......	......	56.2	40.9
Platanaceæ.											
Platanus occidentalis, *L.*	Plane tree	44.5	51.6	50.2	52.1	52.5	53.8	......	......	48.2	50.6
Juglandaceæ.											
Juglans nigra, *L.*	Black walnut	45.5	46.1	50.2	56.1	......	......	......	......	50.6	53.8
" cinerea, *L.*	Butternut	......	......	50.5	52.2	......	......	54.2	54.1	49.5	50.4
Carya alba, *Nutt.*	Hickory	......	......	39.2	40.2	......	......	45.7	45.1	38.4	37.8
" porcina, *Nutt.*	Pig nut	......	......	40.8	38.0	......	......	......	......	38.1	35.4
" amara, *Nutt.*	Bitter nut	33.3	31.2	......	......	......	......	......	......	......	......

Cupuliferæ.											
Quercus alba, *L.*	White oak	38.0	35.2	40.6	38 7	41.2	36.7	43.1	39.5	45.0	41.9
" bicolor, *Willd.*	Swamp oak			45.0						46.9	
" coccinea, *var.* tinctoria, *Wang*	Scarlet oak			42.5	38.0					44.9	39.3
" ilicifolia, *Wang*	Scrub oak			40.6	39.4					42.2	38.4
" palustris, *DuRoi*	Pin oak			43.2	39.8					44.8	39.9
" prinus, *L.*	Chestnut oak			42.4	37.9					42.4	
" rubra, *L.*	Red oak		34.3	42.6	38.6					41.7	39.9
Castanea vesca, *L.*	Chestnut			47.4	45.6					45.1	44.5
Fagus ferruginea, *Ait*	Beech	44.2	44.7	45.4	45.7					45.2	45.8
" sylvatica, *var.* purpurea	Purple beech			43.8	43.3					43.7	43.5
Corylus americana, *Walt*	Hazel			49.8	48.6					50.9	52.8
Ostrya virginica, *Willd*	Lever wood	37.6	38.6	43.0	36.5					44.4	44.5
Carpinus americana, *Michx.*	Iron wood	38.7	39.4	45.6	42.8			51.7	48.7	44.5	43.9
Myricaceæ.											
Comptonia asplenifolia, *Ait*	Sweet fern	40.6	40.0								
Betulaceæ.											
Betula lenta, *L.*	Cherry birch			44.9	38.9					44.7	41.5
" lutea, *Michx*	Yellow birch	42.4	43.6		38.2			49.7	49.4	44.4	42.5
" alba, *var.* populifolia, *Spach*	White birch	46 2	42.0	41.1	37.7			53.9	48.5	45.0	39.1
Alnus viridis, *D.C.*	Green alder			47.9	43.2					48.9	55.0
" incana, *Willd*	Speckled alder	50.4	51.5								
Salicaceæ.											
Salix alba, *var.* vitellina, *L.*	White willow	49.9	51.7	55.5	55.5			53.1	49.7	55.4	55.5
Populus tremuloides, *Michx*	Aspen	49.8	50.9	47.9	52.5			53.3	51.0	52.8	51.5
Coniferæ.											
Larix europea, *L.*	Larch	40.9	47.8								
Juniperus virginiana, *L.*	Red cedar			57.6	45.9					56.2	45.1
Tsuga canadensis, *Carriere*	Hemlock	48.7	49.6	46.8	49.9					44.1	45.6
Pinus rigida, *Miller*	Pitch pine			54.2	54.3					53.8	57.6
" strobus, *L.*	White pine			58.8	52.1	56.3	55.5	62.9	58.3	63.1	51.6

If we next inquire into the relation which seasons bear to the contained water, we shall observe that the percentage continually rises from the midwinter period until spring, and that it again falls from the close of summer to the midwinter period. The extreme variations as exhibited in our figures, show, between February and September, a difference of 8.4 p. c. for the youngest growth, and 7.1 p. c. for that which is older.

MEAN HYDRATION OF WOODS.

MONTHS.	Per Cent. Water.		No. for Average.	
	1st Year.	2nd Year.	1st Year.	2nd Year.
February	44.7	43.9	37.0	38.0
March	47.2	44.8	59.0	60.0
April	51.7	48.4	6.0	7.0
September	53.1	51.0	19.0	18.0
December	48.3	47.2	61.0	58.0
MEAN	49.0	47.1	36.4	36.2

Our figures also indicate that the maximum hydration of the tissues must occur either in September, or at some period intermediate to this month and April. By graphic representation of these results, it will become possible to determine with approximate accuracy the true period at which this maximum is reached. The figures show that, from February to April, the rate of percentage increase is much more rapid than the rate of percentage decrease from September to December. A curve which will show this, should also show the period of maximum percentage. By reference to the chart, it will be seen that the curves for both young and old wood run nearly parallel, but that they tend to approach at their greatest depression, and to separate more widely at their greatest elevation. It is also seen that, from midwinter to spring, the curve rises rapidly and reaches its greatest elevation about May 18th for the youngest wood, while that for the older wood attains its maximum a few days later, or about the 22nd. From this time on, the curve descends at a more gradual rate until December, when it suddenly drops to its minimum depression, which evidently occurs in January.

PERIODS OF CESSATION OF GROWTH.

As, upon theoretical grounds, the tissues contain most water when the growth is most active, data which will enable us to fix accurately the limiting periods for the season's growth, will have an important bearing upon this question. Mr. W. E. Stone, [1] accepting the completion of terminal buds as marking completion of the longitudinal growth for the entire year, has obtained the following data, as establishing periods limiting growth in trees for the latitude of West Point, New York, 41° 23′ N.:—

JUNE 1ST.

Acer saccharinum. *Wang.*
" rubrum. *L.*
Amelanchier canadensis. *Torr & Gr.*
Carya alba. *Nutt.*
Fagus ferruginea. *Ait.*
Fraxinus americana. *L.*
Hamamelis virginica. *L.*
Kalmia latifolia. *L.*
Populus tremuloides. *Michx.*
Quercus alba. *L.*
" bicolor. *Willd.*
" coccinea. *Wang.*
" prinus. *L.*
Sambucus pubens. *Michx.*
Tilia americana. *L.*
Ulmus americana. *L.*
" fulva. *Michx.*

JUNE 15TH.

Betula lenta. *L.*
Carpinus americana. *Michx.*
Castanea vesca. *L.*
Juglans nigra. *L.*
Lindera benzoin. *Meissner.*
Morus rubra. *L.*
Ostrya virginica. *Willd.*
Prunus cerasus. *L.*

[1] Bull. Torrey Bot. Club., xii. 8, 83.

JULY 19TH.

Andromeda ligustrina. *Muhl.*
Alnus incana. *Willd.*
Nyssa multiflora. *Wang.*
Staphylea trifolia. *L.*

INDETERMINATE PERIOD.

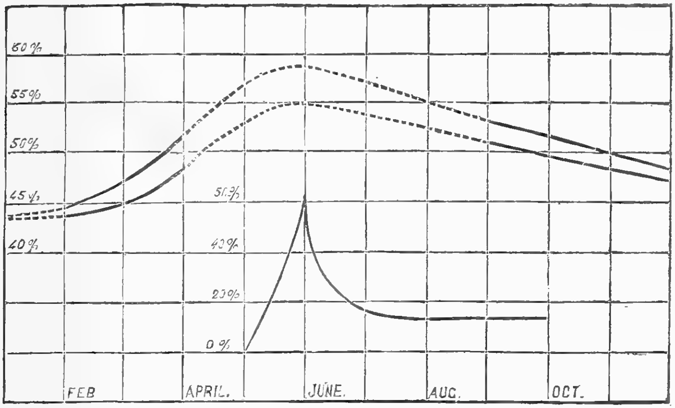
Ampelopsis quinquifolia. *Michx.*
Celastrus scandens. *L.*
Rhus. *Sp.*
Vitis. *Sp.*

This, therefore, gives us the following percentage quantities, showing cessation of growth at different periods :—

May 1st, commencement of growth.				
June 1st, cessation of growth in			51.5	p. c.
June 15th,	"	"	24.2	"
July 19th,	"	"	12.1	"
Indeterminate period		"	12.1	"

Growth in length having ceased at these periods, the energy of the plant then becomes directed to the lignification of tissues and the deposition of reserve material for growth the following year. These changes, however, involve of necessity, a continual decrease in the contained water. The data above, also, show that the majority of plants complete their longitudinal growth within the first six weeks of the growing season ; that most of these complete their growth in from three to four weeks ; and that, as the season advances, the number of plants still growing rapidly diminishes until the middle of July, after which there are left but few, those being plants like the grape, which continue to grow to the very end of the season.

A graphic representation of these changes will enable us to institute a comparison with the relations of seasons to hydration of the structure. The lower figure of the chart is the curve expressing this decrease of growth with advancing season. A comparison of both curves will show most conspicuously, that that period, during which growth for the season is most rapid, is coincident with the period of maximum hydration of the tissues.



It is evident from the facts stated, that the amount of water contained in trees can have no direct relation to their bleeding when punctured. Indeed, it is a well-known fact that the bleeding of trees, such as enables us to collect maple sugar, is a purely physical process, wholly dependent upon the effect of external temperature in producing variable internal tension, hence in no sense connected with physiological processes; that this bleeding may occur at any time during the rest period, provided the conditions of temperature are favorable; hence, that it is most pronounced when there is the least water in the tissues: that during the seasons of most active growth, when the plant contains most water, no bleeding occurs.

CONCLUSIONS.

From the foregoing facts, we are justified in the conclusions which follow:—

(1.) The hydration of woody plants is not constant for all seasons, and depends upon conditions of growth.

(2.) The hydration reaches its maximum during the latter part of May or early June, and its minimum during the month of January.

(3.) Hydration is greatest in the sap wood; least in the heart wood.

(4.) Greatest hydration is directly correlated to most active growth of the plant,—lignification, and storage of starch and other products, being correlated to diminishing hydration.

These conclusions are to be understood as applying only to latitudes lying between New York and Boston. For other latitudes, certain modifications might be necessary.

A Natural System in Mineralogy.

By T. Sterry Hunt.

In farther illustration of the system set forth by the writer in his memoir on "A Natural System of Mineralogy," which appears in the third volume of the Transactions of the Royal Society of Canada, and of which a partial analysis has already appeared in the Record (Vol. I. pp. 129, 244), we make the following extracts:—

The same mineral types, which serve to divide each of the suborders of natural silicates into well-defined tribes, reappear in the non-silicated oxyds, and serve for their classification. Reserving for another occasion the details of classification of this great order of Oxydates, we may note that while the Oxyadamentoid tribe embraces such species as periclasite, chrysoberyl, the spinels, magnetite, corundum, diaspore, hematite, quartz, rutile, cassiterite, etc., the Oxyspathoids include cuprite, zincite, crednerite, pyrolusite, tridymite and senarmontite, and the Hydroxyspathoids, gibbsite, gothite, and manganite. Among the Oxyphylloids are brucite, pyrochroite, massicot, minium, melaconite, hydrotalcite and pyraurite, while the Oxycolloids or Opaloids embrace bauxite, limonite, opal, urangummite and eliasite.

The metals proper, together with the bodies of the sulphur and the arsenic series, and the various binary and ternary compound of all these, make up the great natural order of Metallates, which includes two suborders. Of these the first or *Metallometallates*, distinguished by opacity and metallic lustre, is divided into six tribes, which are: 1. Metalloids,—native metals and metal-like elements; 2. Galenoids,—argentite, galenite, stannite, chalcopyrite, pyrrhotite, alabandite, etc.; 4. Smaltoids,—smaltite, niccolite, breithauptite, with other arsenids, antimonids, etc.; 5. Arsenopyritoids,—including arsenopyrite, cobaltite, etc.; 6. Bournonoids,—enargite, bournonite, zinkenite, etc. The various selenids and tellurids form subtribes distinct from the sulphurous or Thiogalenoids. In the second suborder are included those species more or less resinous or adamantine in lustre, generally red in color or in streak, and often transparent or translucent, whence the distinctive name of *Spathometallates.* In this suborder we distinguish at least two tribes: 1. Sphaleroids, corresponding to galenoids, and including cinnabar, realgar, christophite, marmatite, sphalerite, greenockite and hauerite; 2. Proustoids, corresponding to bournonoids, and embracing proustite and other red silver ores, tetrahedrite, livingstonite, dufrenoysite, binnite, etc. It is worthy of notice that while sulphid of mercury, in the forms of metacinnabar and cinnabar, appears in both suborders of the Metallates, the sulphid of antimony is also represented among the Spathometallates by the red and generally uncrystalline kermes. The various forms of sulphur and of phosphorus, together with vitreous selenium, will constitute a third tribe of the second suborder of Metallates. The Spathometallates, as seen in their typical forms, sphalerite, wurtzite, greenockite, cinnabar, proustite, etc., serve, through the sulphoxydates, kermesite and voltzite, and through sulphosilicates like helvite and danalite, to connect the order of Metallates with spathoid Oxydates and Silicates.

In these various tribes the relations of hardness to condensation are not less apparent than in Silicates and Oxydates. Dividing the simplest atomic formula of the complex Metallates by the number of atoms, we get, as the most convenient term for comparison, the mean weight of the elemental unit from which to deduce the volume V. We thus find for the pyritoids, pyrite and marcasite, values for V of 4·0 and 4·2; for linnæite, 4·4; for pyrrhotite and chalcopyrite, 5·0 and 5·3; and for alabandite, 5·4. The smaltoids, niccolite and smaltite, give 4·4 and 5·1; the arsenopyritoids, cobaltite and gersdorffite, from 4·3 to 4·6; the thiogalenoids, for chalcocite, 7·0, for stibnite, 7·4, for galenite, 7·9, and for argentite, 8·5. Of the sphaleroids, hauerite gives 5·8; sphalerite, 6·0, and other species, 7·0–7·4. The contrasts between the last two tribes and the preceding three, alike in their hardness, and in their condensation, as shown in the different values of V, are apparent; and these are not less marked, when the hard and dense arsenopyritoids are compared with the chemically analogous, but softer, bournonoids and proustoids. Of the former of these, enargite gives for V, 6·9, and bournonite, zinkenite and jamesonite, 7·7–7·8; while of the proustoids, miargyrite, proustite, pyrargyrite and polybasite give from 8·0 to 9.0, and dufrenoysite, and tetrahedrite, from 7·2 to 8·3. By reason of the variations in the recorded specific gravities of most of the species compared, the values here given for V must be regarded as but approximations to be corrected with the help of more exact determinations.

The native compounds of the haloid elements may be included under the order HALOIDATE, with the four suborders of *Fluorid*, *Chlorid*, *Bromid* and *Iodid.* Titanates, niobates, tantalates, tungstates, molybdates, chromates, vanadates, antimonates, arsenates, phosphates, nitrates, sulphates, borates, carbonates and oxalates constitute as many distinct orders. Of these the soluble chlorids, sulphates, borates, carbonates, etc., belonging to the salinoid type, form tribes under their respective orders, as Chlorosalinoid, Sulphatosalinoid, Borosalinoid and Carbosalinoid. The native combustible carbons and hydrocarbonaceous bodies are included in a single order, which, from the fire-making property of these may be aptly designated as the order of PYRICAUSTATES. This is divided into two suborders: 1. *Carbates*, including the phylloid, graphite, and the adamantoid, diamond, representing two tribes; and 2. *Carbhydrates*, which may be conveniently grouped in the four tribes, Naphthoid, Asphaltoid, Resinoid and Anthracoid.

Of these orders, Metallates, Haloidates and Pyricaustates will each constitute a Class,—all the remaining orders being included in another Class. These four classes, with their orders and suborders, may be tabulated as follows:—

CLASSES.	ORDERS AND SUBORDERS.
I.	1. METALLATES: *a.* Metallometallates; *b.* Spathometallates.
II.	2. OXYDATES.—3. SILICATES: *a.* Protosilicates; *b.* Protopersilicates; *c.* Persilicates.—4. TITANATES. — 5. NIOBATES. — 6. TANTALATES. — 7. TUNGSTATES.—8. MOLYBDATES.—9. CHROMATES. 10. VANADATES.—11. ANTIMONATES.—12. ARSENATES.—13. PHOSPHATES.—14. NITRATES.—15. SULPHATES.—16. BORATES.—17. CARBONATES.—18. OXALATES.
III.	19. HALOIDATES: *a.* Fluorids; *b.* Chlorids; *c.* Bromids; *d.* Iodids.
IV.	20. PYRICAUSTATES: *a.* Carbates; *b.* Carbhydrates.

PHYSICAL CHARACTERISTICS OF THE AINOS.

BY D. P. PENHALLOW.

The great timidity of the Ainos, coupled with an instinctive delicacy with reference to all matters of a personal nature, offers a great obstacle to the acquisition of exact knowledge concerning their physical development. That these feelings are not easy to overcome and often raise an insuperable barrier, has been the experience of nearly if not quite all those who have undertaken a study of them. Many important measurements are thus wanting, but the following determinations may be of some value as contributing to a more exact knowledge of their leading characteristics.

The Ainos, occupying Yezo and the Kuriles, are usually spoken of as the "Hairy Kuriles" in allusion to one of their more prominent characteristics. They constitute that group usually designated as "Yezoines" or "Kurilians," to distinguish them from those of markedly different aspect, occupying the Russian territory of Saghalien, Kamschatka and the lower Amoor district in Siberia.

Among those who have attempted to study the Ainos, there appears to be a greater diversity of opinion with regard to their hirsuteness, than any other subject concerning them. This has arisen too often from superficial observation; again from second-hand evidence, and yet again from the expression of an unrestrained enthusiasm. "Covered with hair like animals," is the unqualified description which has more than once been applied to this people; while Mr. Griffis as boldly asserts to the contrary, that they are "Not more hairy as to their bodies than many Japanese or other peoples who eschew pantaloons and shirts," and that the term "*Hairy Kuriles* or *Ainos*, is rather the pet phrase of some closet writers than the expression of a fact."[1] It would appear, however, that Mr. Griffis did not have a sufficient number of typical Ainos, upon the examination of whom he could base a reliable opinion, since his studies were confined to the few who were sent to Tokio for education. From my own personal acquaintance with these same men, it was evident that a study of them could lead to no other conclusion than that reached by Mr. Griffis, but unfortunately they were few in number and not types.

Wood [2] remarks that "Esau himself could not have been more hairy than are these Ainos." Again, Mr. B. S. Lyman, [3] for several years geologist to the Kaitakushi, and thus possessing unusual opportunities for the study of these people, says "It was surprising to see how many of them were wholly or partially bald, and though they are reckoned by the Japanese as so very hairy, how many were, naturally, comparatively free from hairs on their faces and bodies." Miss Bird[4] correctly observes that "There is frequently a heavy growth of stiff hair on the chest and limbs." Prof. Wm. Wheeler employed a guide during one of his surveys, of whom he afterwards said to me, "The hair on his back and over the entire chest was long and matted, and reminded me strongly of the fur coating of an animal."

[1] Bull. Amer. Geog. Soc., 1878, No. 2.

[2] Trans. Eth. Soc., New Ser., iv. 34, etc.

[3] Rept. Horace, Capron., p. 390.

[4] Unbeaten Tracks, ii. 10.

My own experience, extending over four years of intimate acquaintance with these people, hundreds of whom were brought under observation, shows that while all these views express a measure of truth, they do not accurately represent the true facts. With reference to the baldness spoken of by Mr. Lyman, it should be pointed out that, while it is a very common occurrence, it is by no means a true physical characteristic, since it arises, in large part at least, from the great prevalence of scalp diseases among the children and youth.

As to the hairiness of the body and limbs, one remarks the most extreme variations. During one of my own expeditions, eighteen Ainos were employed as boatmen. Of these, twelve were exceedingly hairy, more so than I had ever before observed man to be. Of the others, three, formerly students at Tokio, and studied by Mr. Griffis, were quite smooth, and one had a very fair skin. It has repeatedly been brought to my notice that the Yezoines are not more hairy than Europeans, while in many more cases I have observed the exact reverse to be conspicuously true. The conclusion appears justifiable that, the Yezoine in general, is to be regarded as possessing a more than ordinarily hairy body, enough so at least, to make him deserving of the epithet of "Hairy Kurile."

A stranger gains his first impression of the great hairiness oi these people from their exceedingly bushy hair and beards. The latter are a general feature of the men, their absence being rather exceptional; but their very bushy growth is doubtless due as much to the fact that the men never shave and seem rarely even to clip their beards, as to any natural excess of growth.

The hair of the head is straight, black and rather coarse. It is never brushed, but is allowed to fall naturally, usually to the base of the neck, being trimmed uniformly to this length all round. There is also a frequent tendency in the hair to stand straight out from the head. The effect of all this upon the stranger is to impress him at once with the uncouth aspect and great hairiness of the people.

We shall see, however, that the Saghalien Ainos present a striking departure from the rule of hairiness which essentially characterizes the Yezoine; and this would, therefore, rather appear, not as a race characteristic, but as a feature due to the peculiar and widely different conditions of life, dress and exposure to which these people have been subjected.

In stature, the Ainos are much below the average height of Europeans, but their bodies are generally well formed and robust, shoulders square, chests full, and limbs muscular. Accustomed to a forest life, and depending for sustenance upon the product of the chase and fishing, the men are early accustomed to considerable hardship and are soon capable of much endurance. This renders them invaluable as boatmen and as porters, in which latter capacity they will carry very heavy loads over long distances for days at a time. In my journal of an expedition into the interior, I find the following note with reference to this: "During the whole of our tramp of eighteen miles, the three men carried loads on their backs weighing from fifty to one hundred and twenty pounds, and that too through places where it was enough for me to carry myself and gun; yet they never seemed exhausted, but walked with a firm, strong step to the last."

The following determinations will show some of the leading features of the Aino physique:—

IJIRI AINO.—

Shoulders square; breadth 17.25 inches.
Chest well formed, full.
Height 5 feet 4.25 inches.
Forehead well formed; breadth 5.5 inches; height 4 inches.
Eyebrows well developed and prominent.

FACE (exclusive of forehead):

Facial angle 67°.
Height 5.25 inches.
Breadth 6.0 inches.
Cheek-bones high.
Eyes brown and dull.
Chin well formed, medium.

MATAIJI AINO.—

Shoulders rather square; breadth 16.2 inches.
Chest medium.
Height 5 feet 3.75 inches.
Forehead rather contracted and narrow in front; breadth 4.4 inches; height 4 inches.

FACE (exclusive of forehead):

Facial angle 74.30°.
Breadth 5.33 inches.
Height 5.5 inches.
Chin medium and well formed.
Cheek-bones rather prominent.
Eyebrows large and overhanging.
Eyes medium, dark brown and dull.

ENNOSKI AINO.—

Shoulders sloping; breadth 16.75 inches.
Chest medium.
Height 5 feet 2.75 inches.
Forehead broad in front; breadth 5 inches; height 4 inches.

FACE (exclusive of forehead):

Facial angle 73°.
Height 5.5 inches.
Breadth 5.5 inches.
Eyebrows poorly developed and flat.
Chin well formed and small.
Eyes large, dark-brown and rather bright.
Cheek-bones prominent.

UTTEGURU AINO.—

Shoulders square and well formed; breadth 17 inches.
Chest well developed.
Height 5 feet 5.25 inches.
Forehead narrow towards the front; height 4 inches, breadth 5.33 inches.

FACE (exclusive of forehead):

Facial angle 73°.
Breadth 5.33 inches.
Height 4.6 inches.
Chin small and rather retreating.
Cheek-bones prominent.
Eyebrows rather flat and poorly developed.
Eyes rather large, brown and dull.

Nurian Aino (Woman).—

Shoulders well formed; breadth 15.5 inches.
Height 4 feet 7.62 inches.
Forehead rather well formed; breadth 5.17 inches, height 3.67 inches.
Chin well developed.
Cheek-bones very prominent.
Eyebrows well formed, medium.
Facial angle 74.30°.

So many valuable data have been obtained by Mr. B. S. Lyman, that it seems desirable to introduce them here in his own words:—

"The average weight of the Ainos with their light clothing was 141 pounds, varying from 108 pounds—the boy—to 183 pounds—the ferryman. In general, their hair was thick, with a tendency to stand out all over the head. The forehead varied from low to high, commonly of middling height; it was always round. Their brows were always overhanging; their eyes commonly of middling size and always black; their cheekbones were rather high; their nose commonly with a very low bridge and with broad nostrils, was often turned up, but sometimes straight. Their mouth, lips and chin commonly hidden by the beard, seemed to be of middling character, the mouth not very small, the lips, as compared with Europeans, not unusually thick and the chin not very large, perhaps even rather small. Of those who had special compensation and were therefore bound to submit to anything, we took a number of other dimensions. Their average age was twenty-six, height 5.46 feet, and weight 161 pounds. Their heads measured on the average from front to back 0.68 feet; from side to side 0.55 feet, and from chin to crown or rather vertical height 0.77 foot; from chin to mouth 0.10 foot. The facial angle was taken very imperfectly but seemed to be about 65 degrees. The upper arm measured on the average 1.08 foot long; the forearm 0.83 foot; the hand from the wrist bone 0.66 foot; in all from shoulder to finger tips 2.57 feet, a rather unusual length, I believe, for Europeans of their height. The average length of the leg down from the hip bone—taken by mistake instead of the joint—was 3.10 feet or probably the true length of the leg 2.70 feet, of which 1.14 was thigh and 1.56 feet, measured, foot and leg below the knee. The foot averaged 0.85 foot long by 0.37 foot wide, and the heel was always short. The shoulders averaged 1.46 feet in breadth, the neck 0.20 foot in length, the body from shoulders to hip bone 1.60 feet, or to the hip joint probably 2.00 feet. But their muscles were the most striking feature from their enormous size. The men seemed one mass of hard muscle, and in feeling for the hip bone I could not perceive it, even when they pointed out to me its place. Around the chest they measured on the average 2.99 feet; around the upper arm 1.04 feet; forearm, 0.97 foot; wrist, 0.56 foot; thigh, 1.76 feet; calf, 1.26 feet; ankle, 0.86 foot. A few other measurements were also taken, but probably less important ones."

The following detailed list is also from the same source :—

NAME.	AGE.	WEIGHT. POUNDS.	HEIGHT. FEET.
Chabo	36	135	4.80
Atashite	35	147	5.38
Taegato	35	136	5.28
Chilkamakura	33	133	5.07
Shinangura	33	150	5.49
Kusarengara	32	155	5.46
Ikuyange	27	142	5.53
Yoshimatsu	26	150	5.40
Shussa no Aino	25	184	5.74
Shokubashite	23	150	5.40
Huriranku	25	135	5.37
Patekuwengum	28	150	5.35
Idatsiba	28	137	5.22
Naoba	28	133	5.20
Jasnutoku	25	150	5.34
Pashikura	22	145	5.28
Yukyashito	21	133	5.22
Krotokura	16	142	5.29
Okonokara	40	142	5.22
Youde	34	128	5.06
Tetta	28	155	5.37
Nisago	26	128	5..33
Kinshuka	26	132	5.18
Fugari	25	137	5.11
Taro	23	132	5.05
Itakichari	13	108	5.16

From the facts thus obtained, we may fairly summarize the physical characteristics of the Ainos as follows.—

The forehead is usually high, though narrow; eyebrows heavy and overhanging; nose somewhat inclined to flatness, though but little more so than in Europeans; mouth wide, but well formed; chin well formed and medium size; eyes straight, brown and dull; cheekbones inclined to be prominent; facial angle high, the mean of our measurements giving an angle of 72°; the body is compact, well built and muscular; much more than ordinarily hairy; skin of light color, comparable to that of Europeans.

With regard to the ages given, it may be stated that the Ainos have no definite method of reckoning age, and it is exceedingly difficult to determine how old a man really is. The same standards according to which we would estimate age among our own people, will by no means apply here, and one is as likely to guess too much as too little. Thus most of the ages given are only approximations. In a few instances they seemed to be known with some degree of accuracy.

From the heights given it would appear that Davis' conclusion, based upon measurements of skeletons, "That the Ainos average not far from 5 feet 2 inches in height,"[1] is not very far from the actual truth, though it possibly falls a little below.

The Ainos from Saghalien and other Russian territory, are in some respects quite different from the Yezoines. In stature and general proportion of both men and women, there is no essential difference. Their hair is also worn long, but, unlike that of the Yezoines, it is not cut so squarely; it is also not so bushy, but falls more gracefully around the head and neck, while the ends frequently have a strong tendency to curl, and in both men and women it is usually neatly brushed and parted, much care frequently being displayed in this respect. Doubtless this, as many other striking departures from a more savage appearance, as common to their southern relations, is to be traced to the

[1] Man. Anthrop. Soc., iii. 366, etc.

influence of more intimate contact with civilizing influences. Whatever the cause, however, the result is a total disappearance of that extreme uncouthness which so impresses the stranger when first brought in contact with a Yezoine. The latter, however, are capable of the same change, as is amply proved by those Ainos of the Ishikari tribe, who spent some time at the Tokio schools. In their case, the removal of accumulated dirt and unkempt beard and hair, did much to reveal, in a fair skin and intelligent face, the natural good qualities they possessed.

One peculiarity which at once distinguishes the Saghalien Aino from the Yezoine, is the greater absence of beards, nor do they appear to have so hairy bodies generally. I have frequently seen Saghalien Ainos divested of their clothing, and their bodies were in no case more hairy than those of Europeans, and it seems highly probable that the great difference in hairiness, between these people and the Yezoines, is to be ascribed to their different conditions of life; the Saghalien usually being provided with plenty of warm clothing, furs, etc., while the Yezoine makes little or no change between his summer and winter clothing.

The skin is quite light and may very properly be compared with that of the Caucasian, the hue of which it very closely resembles. The foreheads are high but narrow, in some cases conspicuously so. The carriage of the men is active, and their general bearing and facial expression denote an intelligence much superior to that of the Yezoines; in fact, if we are to measure their mental ability by their achievements, then the Saghaliens must certainly be accounted the superior, for since their residence in Yezo they have applied themselves with success to various pursuits, including silk-weaving, boot-making, tanning, harness-making and several other industries in which the Yezo Aino does not or cannot engage. One or two have also become petty officials in the agricultural bureau, showing that they have capacities capable of improvement and expansion.

As one first encounters the Aino, their general appearance is by no means calculated to produce a favorable impression, but rather as Wood remarks[1] "The uncouthness and wildness of their aspect is calculated at first to strike a stranger with dismay or repugnance." Upon closer examination, however, the forbidding exterior is largely lost sight of in view of their quiet demeanor and gentle though rude politeness which is so constantly manifested. In respect to external features, the Saghaliens produce a really favorable impression which is in very marked contrast to the feelings developed by contact with a Yezoine. It is hardly to be doubted, however, that this arises largely from the fact that the former are usually cleanly in appearance, while the bodies of the latter look as if water had never come in contact with them.

The opinion is sometimes expressed that the Japanese are an offshoot of the Ainos, but a critical examination of the pure types would not permit such a belief to be entertained. There is an undoubted mixture of Japanese and Ainos, as invariably occurs along the border line of contact between two distinct people, and this half-breed type is as easily recognized in those parts of northern Japan where it chiefly occurs, as it is in our own Northwest. The Japanese, however, are unquestionably Mongoloid, while the facts here stated not only show the Ainos to be physically distinct, but the accounts given by our best authorities all agree in the great resemblance which they bear to Europeans,—the prevailing view being that they are distinctly Aryan.

Meteorological Observations for 1885.

By C. H. McLeod.

The table on a succeeding page is a summary of the meteorological observations made in 1885 at the McGill College Observatory, Montreal. The observatory is situated at the height of 187 feet above the level of the sea. Latitude N. 45° 30′ 17″. Longitude $4^h\ 54^m\ 18^s.55$, W.

The year 1885 had an average temperature of 2°.6 below

[1] Trans. Eth. Soc., New Ser., iv. 34, etc.

the normal and was the coldest year since 1875. The deviation in temperature for the year is almost entirely due to the very low temperatures of the months of February and March, which, as will be seen on inspection of the table, made the very marked departure of over 10° below the mean. August and September were also considerably below the average. The year may be described as having a very cold winter, a cold summer, and a spring and autumn of average temperature. The greatest heat 87°.1 was on July 17th, the greatest on the records of the past eleven years is 93°.9. The lowest temperature, 21°.3 below zero, was on Jan. 22nd, while the lowest on the records is 26°.0. The greatest range of the thermometer on one day was 35°.9 on April 23rd, and the least range 3°.0 on Nov. 6th. The mean temperature of the warmest day, July 30th, was 75°.5 and that of the coldest day 15°.0 below zero. The highest barometer reading was 30.747 on Jan. 23rd, and the lowest 29.104 on Jan. 12th. The extremes of barometric pressure which have been recorded here in eleven years are 30.999 and 28.766. The average weight of vapour in the air was slightly less than the lowest in eleven years, the lowest value being 0.234 for 1883. The driest state of the air was on May 29th, when the relative humidity was 21. The greatest mileage of wind in one hour was 46 on January 17th, when the velocity in gusts was at the rate of 64 miles per hour. The total mileage of the horizontal component of the wind during the year was 93,279, and the resultant mileage 46,290 in the direction S. 67°.6 W. The rainfall is slightly in excess of the average, and the snowfall very decidedly so, being 55 inches above the normal and the greatest, by 17 inches, for any one year on the records. The rainfall in October, of which 4.06 inches fell during 28 hours, is the greatest recorded here during any one month in the past eleven years. Although the amount of precipitation measured in depth was above the average the number of days on which rain or snow fell was considerably below the average. The year is thus marked as one of heavy falls of both rain and snow. The amount of clouded sky has been slightly less than usual, while there has been

Month.	Thermometer. Mean.	¶ Deviat'n from 11 year means.	Max.	Min.	Mean daily range.	* Barometer. Mean.	Max.	Min.	Mean daily range.	†Mean pressure of vapour.	‡Mean relative humidity.
January	12.13	+0.32	48.0	—21.3	16.7	30.0043	30.747	29.104	.358	.0753	79.2
February	5.88	—10.42	34.0	—16.3	15.6	29.9415	30.451	29.111	.249	.0534	83.7
March	13.25	—10.45	39.8	—14.4	15.8	29.9809	30.466	29.339	.270	.0720	76.6
April	37.68	—1.76	76.9	10.7	16.0	29.9930	30.542	29.347	.232	.1634	69.2
May	55.43	+1.29	81.0	25.2	19.7	29.9532	30.254	29.529	.148	.2623	58.4
June	62.13	—2.29	85.4	38.0	18.0	29.8896	30.178	29.355	.169	.3768	66.6
July	69.23	+0.30	87.1	49.5	16.4	29.8735	30.150	29.565	.143	.5282	73.5
August	62.98	—4.72	82.6	44.5	16.7	29 9128	30.185	29.481	.163	.4383	74.0
September	55.36	—3.67	74.3	38.2	16.7	29.9700	30.311	29.426	.175	3325	74.6
October	44.08	—1.87	68.3	22.6	12.7	30.0068	30.396	29.468	.178	.2348	76.8
November	32.82	+0.08	51.0	11.6	8.1	29.9161	30.380	29.506	.176	.1580	84.1
December	19.38	+0.45	44.6	— 3.4	14.7	29.9579	30.717	29.165	.318	.0983	82.6
Means 1885	39.20	—2.65	....	.....	15.6	29.9500	.....	.....	.215	.2328	74.9
Means 11 years, ending 1885.	41.85	......	....	.....	.....	29.9728	.....	.....	....	.2509	74.3

Month.	Mean Dew point.	Wind. Resultant direction.	Mean velocity in miles per hour	Sky clouded per cent.	Bright sunshine per cent.	Inches of Rain.	No. of days on which rain fell.	Inches of Snow.	No. of days on which snow fell	Inches of rain and snow melted.	Number of days on which rain *and* snow fell.	Number of days on which rain *or* snow fell.
January	6.7	S. 75° W.	14.50	63	23.5	1.11	5	21.5	18	3.24	3	20
February	1.7	S. 78° W.	13.36	49	49.9	0.50	1	43.5	13	4.79	1	13
March	7.0	S. 65° W.	12.70	56	53.2	0.36	3	29.1	15	2.98	3	15
April	27.8	S. 78° W.	12.58	49	55.5	1.16	10	29.8	9	4.05	5	14
May	39.6	S. 18° W.	8.76	54	63.1	1.66	10	0.0	0	1.66	0	10
June	50.2	S. 55° W.	11.08	57	49.2	3.61	15	0.0	0	3.61	0	15
July	59.9	S. 66° W.	7.43	52	64.1	2.85	9	0.0	0	2.85	0	9
August	54.0	S. 64° W.	8.83	62	55.4	2.46	14	0.0	0	2.46	0	14
September	46.9	S. 64° W.	9.05	45	64.4	4.16	12	0.0	0	4.16	0	12
October	36.8	S. 62° W.	8.51	66	34.6	7.17	15	2.8	1	7.49	1	15
November	28.0	N. 72° W.	9.20	77	16.7	2.27	12	14.4	9	3.70	3	18
December	14.9	S. 73° W.	11.52	74	26.3	1.38	8	36.5	18	5.07	4	22
Means 1885	31.1	S. 67°.6 W.	10.63	58.7	46.3	....	..	....	..	....	..	..
Totals 1885	....	....	....	...	....	28.69	114	177.6	83	46.06	20	177
Means 11 years, ending 1885.	....	....	11.00	60.8	§46.8	27.40	134	122.1	85	39.56	16	203

* Barometer readings reduced to 32° Fah., and to sea level.

† Inches of mercury.

‡ Relative, saturation being 100.

§ For 4 years only.

¶ "+" indicates that the temperature has been *higher*; "—" that it has been *lower* than the average for eleven years, inclusive of 1885. The monthly means are derived from readings taken every 4th hour, beginning with 3h. 0m., Eastern Standard time.

an average amount of bright sunshine. Auroras were observed on 17 nights, but may have occurred oftener. There was hoar-frost on 15 days, fogs on 19 days, lunar halos on 9 nights, thunderstorms on 13 days, and lightning without thunder on 3 days.

The sleighing of the winter closed on April 17th. The first snow of the autumn fell on October 30th. The first sleighing of the winter was on Nov. 25th. Upper river navigation opened on May 5th, and the river was open to ocean ships on May 6th.

Miscellaneous Notes.

Natural History Society of Toronto.—This Society has amalgamated with the Canadian Institute of this city, of which association it forms the Biological Section. We have received their programme for the Winter Session which was as follows:—Jan. 18th, Medicinal Plants, by Mr. Hollingworth; Fauna Canadensis, by Mr. Brodie. Feb. 1st, The Acadian Owl, by Mr. Melville; Flora of Ontario compared with that of England, by Mr. Moore. Feb. 15th, Buds, by Mr. Noble; Destruction of Wild Animals, by Mr. Williams. March 1st, Chlorophyll, by Mr. Pearce; Blood, by Mr. Pursey. March 15th, Entomological Reports, by Mr. Armstrong; Fauna Canadensis, by Mr. Brodie.

Natural History Society of New Brunswick.—At the regular January meeting a preliminary paper on the "Algæ of the Bay of Fundy" was read by G. U. Hay. It contained an enumeration and description of the principal species of marine plants found on the northern shore of the Bay of Fundy from collections made at St. John and Frye's Island, Charlotte County, in the summer of 1886. The causes of the paucity of our marine flora were alluded to—chiefly, the erosive action of the tides, the influence of Arctic currents, etc. The economic plants, such as *Chondrus crispus, Porphyra vulgaris, Rhodymenia palmata* and the Fuci, were described with their uses and characteristics.

The Annual Meeting of this Society was held on Jan. 26th, at which Dr. Botsford, the President, read his annual address on "Some Thoughts on Social Science." Dr. Botsford was re-elected President. The following officers for the current year were elected: *Vice-Presidents,* G. F. Matthew, M. A., Edwin Fisher; *Corresponding Secretary,* G. U. Hay; *Treasurer,* Alf. Seely; *Recording Secretary,* W. J. Wilson; *Treasurer,* Alf. Morrisey.

At the February meeting, a paper on the "Occurrence of Arctic Plants" in New Brunswick from the pen of Rev. Prof. Fowler, of Queen's University, Kingston, was read. Quite a large proportion of the Arctic plants are found in New Brunswick and the paper from Prof. Fowler was accompanied by a list showing their distribution and occurrence.

MOVEMENT OF TENDRILS.—D. P. Penhallow contributes an important paper to the *American Journal of Science* (xxxi. 46, 100 and 178,) on the movement of tendrils in *Cucurbita maxima* and *pepo,* incidentally dealing with other phenomena of growth in these plants. The results obtained are based upon observations covering a period of ten years, the original and principal facts having been obtained in 1875 by a series of experiments which involved almost continuous observation through night and day, for a period of one week. He fully discusses the relation which meteorological conditions bear to growth, and confirms previous observations concerning the stimulating influence of combined heat and moisture, but the retarding effect of the former, when acting alone. The daily periodicity in growth, dependent upon alternation of day and night, is shown to be quite marked, the influence of conditions during the day being found to be greater in promoting the general growth than the retarding influence of sunlight, so that the general extension of parts during the day exceeds that for the same number of hours of night as 44.4 to 34.3, a result which confirms that previously obtained by Rauwenhoff. The most important facts, however, are those relating to the mechanism of movement. This is found to depend primarily upon the presence of three active bands of parenchyma tissue, which traverse the tendril throughout its entire length, and by their more rapid rate of growth produce, through unequal tension of the various tissues, all the phenomena of torsion and circumnutation usually noticed. These bands, which the author calls *Vibrogen,* in allusion to their peculiar relation to movement, are found, one on the upper side of the tendril arm, and one on each side, somewhat above the horizon of the major and transverse axis of the section. Their direct connection with the circumnutation is most ingeniously obtained from the figures described by the circumnutating tip of the tendril. Each figure is shown to exhibit changes of direction in movement, which are exactly reversed or follow an intermediate course, accordingly as any one band is directly succeeded by greater activity of its opposite or the remaining two bands; the direction thus taken being the direct expression of more vigorous growth in one band, or representing the resultant of activity in two bands at the same time. He next shows that the total latitudes of movement are one-half the total departures, thus bringing out in a more conclusive manner the precise relation of vibrogen to motion.

The final conclusions, with reference to the cause of motion, are as follows:—(1) Movements of the tendril and petiole are due to unequal growth, as producing uuequal tension of tissues. (2) The unequal growth is chiefly defined in the vibrogen tissue, which may therefore be regarded as the seat of movement. (3) The band of unequal growth does not arise at successive points of the circumference. (4) The vibrogen tissue consists of three longitudinal bands, each of which becomes more active in turn, without regular order. (5) The collenchyma tissue is that which is chiefly concerned in variations of tension under mechanical stimuli. (6) Bending or coiling under the influence of irritation results from release of tension, or (free coiling) from inequality of tension through maturity of tissues. (7) Transmission of impulses is effected through continuity of protoplasm in the active tissues.

Dr. C. J. E. Morren.—On February 28th Dr. Morren died at the age of 53 years. He was Professor of Botany in the University of Liége, Director of the Botanical Institute of the same city, and Secretary of the Belgian Horticultural Society. In all of these positions he rendered important services to Botany and Horticulture.

Prof. Edward Tuckerman, LL.D.—Dr. Tuckerman died at Amherst, Mass., on March 15th, at the age of 69 years. Although not actively engaged in teaching, he filled the chair of Botany at Amherst College from 1858 to the time of his death. He will be chiefly remembered for his studies of Lichens, having been recognized as one of the leading lichenologists of the day, and the highest authority on this continent.

Feeding Insects with "Comma" Bacillus.—Dr. R. L. Maddox, in a paper before the Royal Microscopical Society, details the results of further experiments in feeding insects with the comma bacillus. His observations were chiefly made upon the common blow-fly (*Musca vomitoria*), and included a very large number of microscopical determinations, special cultures of the comma bacillus being used for the purpose of feeding. The results of all his investigations lead him to believe that the comma bacillus from cultures can pass through the digestive tubes of some insects in a living state, and through this fact, such insects are likely to become an important means of distributing disease, especially to animals, birds and fishes which feed upon them. This, therefore, is in accord with the quoted views of Dr. Grassi, "That insects, especially flies, may be considered as veritable authors of epidemics and agents in infectious maladies."—*Journal Royal Mic. Soc.*, 2nd S., V. 602 and 941.

Proceedings of the Natural History Society.

The *Third Monthly Meeting* of the Session took place on Monday evening, January 18th, 1886, Sir Wm. Dawson being in the chair. The minutes of the previous meeting were read, also those of the council meetings of December 22nd, 1885, and January 12th, 1886.

Dr. W. H. Hingston presented the Society with a copy of his work on "the Climate of Canada."

Mr. T. D. Watson, through Dr. T. Sterry Hunt, presented the Society with a specimen of Walking Stick, *Spectrum femoranthum* (Say), and a dipterous insect, *Pyrgota undata* (Weidman).

Dr. Harrington reported that the list of the Course of Sommerville Lectures had been completed as follows, viz. :—

February 4th, "Antiseptics and Disinfectants." By Alfred H. Mason, F.C.S., F.S.Sc.

February 11th, "The Chalk Formation." By Rev. W. J. Smyth, M. A., Ph. D.

February 18th, "The Source of Igneous Rocks." By Thos. Macfarlane, F.R.S.C.

February 25th, "The Chemistry of Bread and other Farinaceous Foods." By Dr. Casey A. Wood, C.M.

March 4th, "Cotton and Cotton Manufactures." By William Hobbs.

March 11th, "Breathing and Ventilation." By Dr. J. B. McConnell.

March 18th, "The History of a Modern Volcano." By Sir William Dawson, LL.D., F.R.S.

Prof. Penhallow reported that, having been in Quebec a few days ago, the question of a renewal of the annual grant was referred to, in the presence of some of the members of the Cabinet, when the assurance was given that the proposed petition to be presented to the Government, on the eve of the next session of the Provincial Parliament, would receive favorable consideration.

The President named the following Committee to prepare the necessary petition and press upon the Ministry the urgent claims of the Society for a renewal of the grant, viz., John S. Shearer, Major Latour, P. S. Ross and the Corresponding and Recording Secretaries.

Dr. J. Baker Edwards gave notice of motion to change the date of the Annual Meeting from the 18th day of May to the last Monday in May of each year.

The following candidates were duly elected:—Wm. Drysdale, C. N. Bell, F.A.G.S., Dr. T. Wesley Mills and Captain John Lawrence; while Mr. R. R. Stevenson, Rev. Dr. Wm. J. Smyth, and Dr. Thomas Roddick were proposed as Ordinary members. The Hon. Thomas White was proposed as a Corresponding member.

Prof. Penhallow then read a paper on "the Hydration of Wood Tissues in Trees and Shrubs," and Dr. J. Baker Edwards followed with one on "the Danger of Poisoning from the Commercial Uses of Arsenic."

Prof. Penhallow also read a paper on "Physical Characteristics of the Ainos," which elicited some discussion.

A suitable vote of thanks was passed to both gentlemen for their respective papers.

Mr. Edward Murphy exhibited some microscopic specimens of arsenic in connection with Dr. Edwards' paper.

The *Fourth Monthly Meeting* of the Session was held on Monday evening, February 22nd, 1886, the President Sir Wm. Dawson occupying the chair. The minutes of the previous meeting, with that of the last meeting of council, were read and approved.

Mr. Charles Robb presented several volumes of rare works to the Society, which were accepted with thanks and an acknowledgement was ordered to appear in the Record of Science.

Mr. Wm. G. Oswald, of Hill Farm, presented the Society with a curiosity of vegetation in the form of a natural budding or grafting by the interlacing of Beech root branches, for which a vote of thanks was passed to the donor.

It was moved by Edward Murphy and seconded by J. H. Joseph, "that in accordance with notice of motion by Dr. J. Baker Edwards, the date of the Annual Meeting be changed from the 18th day of May to the last Monday in May of each year." The same motion also embodied the following resolution, viz., "that the Bye-laws as revised be and are hereby adopted." Carried.

Dr. Harrington then proceeded with a very interesting description of Canadian minerals, and displayed a fine selection of specimens from the collection of the late Mr. Miller, of Ottawa, recently purchased by Mr. John H. R. Molson for McGill College.

Sir Wm. Dawson, Charles Robb, C. E., and Mr. Thomas Macfarlane followed with some remarks on the different forms of crystals found in Norway and Canada.

Sir Wm. Dawson next read extracts from a letter by Professor Bailey, referring to recent criticisms on the Geologists of New Brunswick.

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Studies in the Comparative Physiology of the Heart.

By T. Wesley Mills.

(*Concluded.*)

ON THE PHYSIOLOGY OF THE HEART OF THE ALLIGATOR.

The animals experimented upon belonged to the species *Alligator Mississippiensis*. The heart in the *Crocodilia*, with its two auricles and paired ventricles, though showing much resemblance to lower forms and retaining the pulsatile sinus venosus, both in its general appearance and in its action, approximates sufficiently to that of the higher vertebrates to suggest on superficial examination the heart of a mammal or bird (with slower action). The blood, too, is more highly oxidized than in the Chelonians, so that altogether the circulatory system shows physiological as well as anatomical advance. With the exception of Gaskell's short paper on the crocodile, (*Journal of Physiology*, Vol. V., No. I), nothing has been published on the heart physiology of this group of animals.

The work of the present writer, while it confirms Gaskell's conclusions as regards the cardiac accelerator, is wholly at variance with his views as to the functions of the vagus. The vagus in the *Crocodilia*, at least in the alligator, is not a pure cardial depressor, but is on the contrary a powerful cardiac augmentor.

The result of the stimulation of the vagus may be thus stated:

(1.) Stimulation of the vagus with a weak, interrupted current may weaken the cardiac beat with or without arrest of the auricles; the latter may be arrested and give rise to a brief stop of the ventricles.

(2.) With a stronger current, the sinus may be so weakened as to lead to arrest of the auricles and ventricles; or the sinus may be arrested wholly, in which case the auricles and ventricles invariably cease to beat.

(3.) When the cardiac beat recommences, it may be in the order, sinus, sinus extension, ventricles; or sinus, auricles, s. extension, ventricles, *i. e.*, the auricles may remain quiescent as in the Chelonians and fishes when all the rest of the heart is beating.

(4.) The rhythm after vagus stand-still may be (*a*) without acceleration, or (*b*) accelerated.

The augmentation in the force of the beat is more marked than acceleration in the rate. Both rate and force follow, as in the Chelonians, the law of *inverse proportion.*

Comparison of the Vagi and Results of their Prolonged Alternate Stimulation. The vagi in the alligator, as in the Chelonians, have not, as a rule, equal power in causing and *maintaining* cardiac inhibition; the right, as in the other cold blooded animals examined, being more effective. Prolonged stimulation of the vagi alternately leads to corresponding lengthened cardiac arrest.

Accessory Vagi. Certain small nerves are in the alligator given off from the Glossopharyngeal shortly after its exit from the skull, proceed downwards, apart from the vagus, and pass beneath the trachea over the vessels to the heart.

Stimulation of these nerves has led to similar results to those furnished by stimulation of the vagus, *i. e.*, retardation of the rate, weakening of the beat and after acceleration. Hence they have been called by me *acccssory vagi.* There seem to be nerves of somewhat similar function in the sea turtle.

Peculiar Cardiac Inhibition followed by Acceleration. Special attention is called to the following experiment which is believed to be *unique* in physiology. In a small alligator with the *whole brain destroyed* for some time, *both vagi divided* and dead throughout the greater part of their course (stimulatation not producing cardiac arrest), a sharp tap over the liver and stomach with a dissecting forceps caused cardiac arrest of brief duratio n, then slowed irregular rythm followed by acceleration of a very pronounced kind (from 40 to 50 beats). Here then were the usual phenomena of reflex vagus inhibition, as when the vagi and medulla are intact. *This experiment was tried three times.* It does not seem possible to explain this unparalleled result by present theories. I conclude that the impulses passed through the sympathetic system of nerves and that probably other inhibitory fibres than those of the vagus were concerned, and that accelerating fibres were also involved. It is also possible to conceive that terminations of the vagi were in some way reached by these impulses, but in any case the results are new to physiology, the only published case at all resembling it being Marshall Hall's experimcnt on the eel's stomach (*Todd's Cyclopedia of Anat. and Phys.*, article "Heart.")

Cardiac Augmentors. As described by Gaskell, there is in the *Crocodilia*, from the ganglion of the eleventh metamere of the sympathetic chain, a strong well-defined branch passing to the heart.

Stimulation of this nerve has given rise to [1] acceleration following the law of *inverse proportion*, which seems applicable to all kinds of acceleration. [2] Decided augmentation of the force of the beat. This is more marked than the acceleration in rate, and in fact may disguise the effects of the nerve, for no actual acceleration of beat may follow.

In all cases, stimulation of a genuine cardiac augmentor causes *increase in the work* done by the heart, hence these nerves should be called augmentors rather than accelerators.

Application of the Rapidly Interrupted Current to the Heart itself. In addition to the white dots seen at the points of application of the electrodes and the dilation and blue appearance following the use of a weak or moderate current, another effect noticed in the alligator, on the use of a very strong current deserves mention. From the part where the electrodes touched the auricle, a considerable area took on a pale, even whitish aspect and seemed to diminish in size; by gradually moving the electrodes along, more and more of the auricle passed into the same condition. The part involved was thrown out of action, as in the case of the dilated position. This condition seemed to be one of pronounced contraction, probably tetanic, and confirms the view that the white dots seen in all cases just where the electrodes touch are caused by the contraction of the muscle fibres.

THE CARDIAC RHYTHM OF FISHES AND THE ACTION ON THE SAME OF CERTAIN DRUGS AND POISONS.

The object of the investigation was (1) to ascertain whether there were considerable physiological differences in the hearts of different fishes, and (2) to ascertain the laws regulating the rhythm of some one fish heart specially suitable for investigation, and (3) to determine the action of certain drugs and poisons on the fish's heart; these being, many of them, such as have been studied in their influence on the heart of the frog.

In general it may be said that the hearts of fishes are so sensitive to changes in normal conditions, and that most fishes are so easily killed, that it is not possible to pursue prolonged investigations on their hearts *in situ.* This remark applies especially to the Selachians, whose hearts, from many points of view, are exceedingly interesting.

Batrachus Tau (toadfish), is a fish of great vitality, resisting unfavorable conditions admirably, and its heart has a corresponding vital resistance, and being excellently suited for experimentation, this fish was the subject of a majority of the experiments of this investigation. Most of the work was done on the heart *in situ*, but the isolated heart was also studied. For the former experiments, the fish was kept on its dorsal surface in a dish of water, the latter reaching sufficiently high to cover the gills but not flow over the exposed heart. The respirating centre was left intact. Under these circumstances, the heart may be maintained fairly normal for several hours.

Considerable differences in physiological behavior have been found in the hearts of fishes, some of which will be noticed under different headings in this synopsis.

The Structure and Action of the Fish's Heart. In the Selachians, as examined by the present writer in the shark and and skate, the heart consists of a *Conus arteriosus*, in addition to the sinus, auricle and ventricle. This structure is pulsatile and seems to be the most sensitive part of the whole heart.

The corresponding *Bulbus arteriosus* of other fishes is highly elastic but not pulsatile.

In observing such a heart as that of *Batrachus* during systole of the ventricle, the longitudinal and transverse diameters of the latter are seen to be shortened and the antero-posterior lengthened. It is seen that the apex ascends and the bulbus descends.

In the Selachians, the beat is more highly peristaltic than in the hearts of other fishes, and in the former, a reversal of the order of pulsation for the different parts is most easily originated and maintained.

In some fishes, as in the eel [McWilliam] and *Batrachus*, there is a part of the heart intermediate between the sinus and the auricle proper, as to appearance, structure, and functions; and, as it is in most respects physiologically like a corresponding part in the Chelonians, has been named by me sinus extension in both fishes and Chelonians [" basal" wall, and " flattened " portion of Gaskell, " Canalis Auricularis " of McWilliam]. This part of the heart is often, under peculiar circumstances, in action when the auricle proper is quiescent, and then serves to conduct the wave of construction on from the sinus to the ventricle.

Influences Affecting the Natural Rythm of the Heart. Among these, in addition to mechanical excitation inducing a reversed rythm already referred to, must be especially mentioned the condition of the blood supplying the heart as to degree of oxidation. Blood, poor in oxygen, with greater readiness than in other cold-blooded animals, causes irregularity or arrest of the heart in a fish.

Faradisation of the heart in the fish leads to results very closely allied to those obtained in the Chelonians.

Reflex Cardiac Inhibition. The ease with which the heart of a fish can be reflexly inhibited by the stimulation of various parts of its body, is one of the most remarkable facts brought out by investigation on the heart physiology of the animal.

The results are much the same whether mechanical or electrical stimulation with the rapidly interrupted current be employed. The parts that have been found most effective in *Batrachus* are the gills, the air bladder, the abdominal viscera, the mucus lining of the mouth, the tentacular appendages of the mouth, the pectoral fins, the anus and the tail.

The results may be either (1) decided arrest of the heart for several seconds, followed by a slowed rythm, or (2) brief arrest of the slowed and irregular rhythm or (3) the latter lasting from one to two minutes or longer without any actual stop of the heart. In some cases the operative procedure necessary to expose the heart is sufficient stimulus to keep the heart long inhibited. *The results of inhibition* are not uniform. In some cases no acceleration seems to follow, but in others and the majority, there is decided acceleration of the rythm.

Peculiar Results associated with Reflex Cardiac Inhibition. Stimulation of several of the parts mentioned above, and especially of the anus and tail, have given the following results:

(1.) At first an accelerated rhythm followed by a slowed rhythm, or

(2.) An accelerated rhythm followed by a slowed rhythm on increasing the current, or

(3.) Only an accelerated rhythm.

This subject is further treated in the account of the turtle and aliigator above.

It should be noted that in the *skate*, stimulation along certain lines on the ventral surface of the fish, apparently the course of mucous glands and likely associated with special sensitive structures, has produced remarkably good cardiac inhibition, and the results have been constant. The mucous membrane of the mouth, is also in the skate, a part giving decided results.

Independent Rhythm of Various Parts of the Heart. A large number of experiments on both the isolated heart and the heart *in situ* have brought out the following facts:

(1.) There is very great variety in the hearts of different fishes as to capacity for independent rhythm; between such fishes as the skate, the shark and the toadfish (*Batrachus*) this difference is enormous.

(2.) In *Batrachus* every part of the heart is capable of good, independent rhythm; even the apex of the heart when isolated has shown such.

(3.) The order of the parts of the heart with greatest independent rhythmic power is—sinus, sinus extension, auricle, ventricle.

[4.] The independent rhythm of the ventricle *begins* soon after its separation from the rest of the heart (by ligature), speedily reaches a maximum and gradually declines.

The *Action of Certain Drugs and Poisons on the Heart.* Ex periments have been made on the heart *in situ* and the results confirmed on the isolated heart. The agent was in each case applied in solution directly to the heart itself. The results are stated below very briefly.

Pilocarpin and *Atropin* in one per cent. solution. (1.) These agents are antagonistic in action. (2.) Pilocarpin is a cardiac depressant; atropin an excitant; the former lowers cardiac excitability; the latter most decidedly heightens it; the former weakens the beat and tends to arrest the heart in diastole, the latter calls into action the resources of the heart quickly and fully.

Carbonates of Soda and *Potash* in five per cent. solution. These agents are antagonistic in action. Sodium carbonate is a cardiac excitant, potassium carbonate a depressant. The former tends to quicken the beats and diminish diastole. A heart arrested in diastole by potassium carbonate may be excited to action by sodium carbonate. Potassium carbonate must be regarded as a cardiac poison.

Lactic Acid. (1) In five per cent. solution this is a rapid cardiac poison. (2) In one per cent. solution its action is slower, but it proves a decided depressant, and the heart arrested by lactic acid cannot be excited to action by digitalis, sodium carbonate, &c.

Nicotin in one per cent. solution. (1) Its first action was often to arrest the heart in diastole. (2) This was sometimes followed by an irregular, slowed rhythm giving way to a more rapid but weaker heart beat. But the fish heart shows great power of resistance against the effect of nicotin in weak solution and can, it would seem, recover almost wholly from the effect of this poison. Nicotin tends strongly to produce inco-ordination of the beat.

Chloroform (undiluted) acts as a decided cardiac depressant, tending to arrest the heart in diastole. The heart can, however, recover fairly well from a considerable quantity of this poison applied directly to it.

Acetate of Strychnia in one per cent. solution. This poison did not seem to have the most pronounced action, but *tended* to strengthen the systole, diminish diastole and arrest the heart in systole.

Veratria in rather less than one per cent. solution. The most distinct action is on the diastole, which it retards. The heart in action has a generally sluggish movement rather than a weakened one; the systole may in fact be slightly improved. It also tends to cause arythmic phenomena—want of harmony in the sequence of the beats of different parts and of different fibres in the same part, *e. g.*, there may be two or more beats of the auricle for one of the ventricle, &c., or one part of the ventricle may be pulsating out of harmony with the rest.

Digitalin in somewhat less than one per cent. solution has more than any other of the agents tested a *constant*, decided and well-defined action. (1) A short time elapses before its action is manifested; but when this begins it quickly and steadily rises to a maximum. (2) It causes diminished diastolic relaxation; but especially characteristic is the effect on the systole which is both more perfect and when complete more prolonged than usual. (3) The ventricle is always arrested in most pronounced (tetanic?) systole and then always looks very small aud pale. It is inexcitable.

The action of drugs on such sensitive hearts as those of the Selechians was found correspondingly rapid. The action on the isolated heart was also more rapid than in the heart *in situ*, as was to be expected.

In many cases the first effect of a drug was to arrest the auricle proper, leaving the sinus extension comparatively unaffected.

Our North-West Prairies, their Origin and their Forests.

By A. T. Drummond.

The origin of our North-West prairies may be traced to two causes, one long since removed, the other still operating. During the pre-glacial and glacial periods, the inequalities of the surface over vast tracts of the country in our North-West were filled up by clays and gravels, and more or less levelled. These clays were, to some extent, subsequently re-arranged under water, and at the same time new material, chiefly gravels, sands and sandy loam, was deposited. Then these extensive tracts were gradually upheaved above the level of the water or were left dry by the fall in the water through the diminution in the sources of supply, or by the greater facilities afforded for rapid drainage. There had been previous upheavals during the drift period, and there were traces of resulting vegetation. The second cause, then, or immediately previously, came into play, and consisted in the annual growth and decay, for long periods of time, of grasses, sedges and aquatic plants generally, over extensive areas in the shallower waters and along the shallow lake margins, each year forming a deposit there on the lake bottom and gradually thus increasing the encroachments of the land upon the water.

There is strong evidence which seems to point to the fact that about the close of the drift period, or immediately after it, when the glaciers, probably, were slowly retreating, the central portions of the continent formed the bed of a vast fresh water inland sea, of which Lakes Winnipeg, Manitoba and Winnipegosis, are now the mere remnants. The outlet of this sea to the ocean was probably at that time by way of the Mississipi Valley. Into this sea the glaciers from the Rocky Mountains and from the country north and east of the Saskatchewan, perhaps for long periods of time, flowed, and huge icebergs freighted with boulders, debris and earth were continuously floated off to wend their way at the will of winds and currents. It was nòt the first time during the drift period that this part of the country had been under water. The resemblance to the Polar Seas of to-day was probably very striking, except in these points that the icebergs would be more deeply sunken, for the water was fresh, and that this inland sea was more vast, covering not merely our North-West prairies, but extending probably as far south as Iowa and Illinois. Boulders were thus scattered at random over the bottom of the sea hundreds of miles away from their point of origin. Huge masses were carried enormous distances. Dr. George Dawson mentions one of the Huronian quartizite, lying near the Waterton River, which measured forty-two feet long, forty feet broad and twenty feet high, and which must have come from east of Lake Wînnipeg or the Red River.

The very uniform nature of the deposits over very great areas would indicate quiet waters, at least in later periods of the occurrence of this inland sea, probably ending, as the land rose, in the creation of vast marshes, like the existing great grass swamps at Westbourne, and on the Boyne River in Manitoba, but on an immense scale. The successive annual growth and decay of sedges and grasses in these marshes gave rise to deposits of vegetable loam which have gone on increasing since the rise of the land to its present level, by the annual decay of the ordinary prairie grasses, and perhaps of forest trees. The elevation which took place in the land was greatest at the Rocky Mountains and the different steppes between these mountains and the eastern limits of the prairie, would seem to indicate different stages or intervals in the elevation during which the various sandhills and stretches of sand at the extended edges of these steppes have been formed. The contraction in the area of this inland ocean took place from the Rocky Mountains eastward, so that the present Province of Manitoba east of the Duck, Riding and Pembina Mountains, is the most recently formed as well as the lowest in level. Between the mouth of the Saskatchewan at Grand Rapids and the Assiniboine River between Portage la Prairie and Winnipeg and thence to the United States boundary line, there is not much difference in level, as the following heights above the sea indicate:

Lake Winnipeg	710	feet.
St. Martin's Lake	737	"
Lake Manitoba	752	"
River Assiniboine, near Baie St. Paul	766	"
Lake Winnipegosis	770	"
Cedar Lake, near Grand Rapids, on the Saskatchewan	770	"

This comparatively level area occupies a stretch of country 330 miles in length by an average of 150 miles in breadth.

Lakes Winnipegosis and Manitoba, and St. Martin's and Water Hen Lakes, are mere shallow depressions on the surface of the prairie. The two first named lakes are each over a hundred miles in length, but increase in depth so gradually that at the narrows where they nearly unite, Winnipegosis has only six feet of water at 2,000 feet from the shore, whilst Lake Manitoba, at a mile from the shore, shows a depth of only three feet. St. Martin's Lake, again, has only eight feet, and Water Hen Lake an average of three feet of water. Lake Winnipeg is deeper, being an average of forty feet to sixty feet, with a somewhat uniformly level bottom, but it is relatively very shallow for a lake of its great extent. Its eastern shores form here the western limits so far as observable, of the great eozoic rocks, and were also, no doubt, the eastern shore of the great inland sea.

It has been proposed to lower the level of Lake Manitoba by removing the obstructions in the channel through which its waters are conducted by way of St. Martin's Lake to Lake Winnipeg, and there is no doubt that if this could be effected to the extent of only a few feet, large tracts of country would be reclaimed which around its margin are presently more or less under water. The southern end of the lake is now bounded by a narrow sand bank elevated a few feet above the water. Inside of this are very considerable tracts once forming a part of the lake and now more or less submerged, but in which the process of growth and decay of the grasses and aquatic plants and the resulting annual deposit of soil will eventually end in their reclamation from the water. This same process is going on in a large tract covering four or five townships about ten miles to the westward of Lake Manitoba, known as the Big Grass Marsh, as well as in many other places in the province, and will, in coming years, result in the formation of prairie land with a rich covering of black vegetable loam.

The County of Essex in Ontario has a considerable extent of prairie land which was no doubt largely formed under similar conditions of annual growth and decay, and which in its origin points to a time when Lakes Erie and St. Clair, were more intimately connected than they now are. Long Point, Point Pelée and Sandusky Harbour, all on Lake Erie, are illustrations of prairies now in process of formation. These prairies all have a fresh water origin. Those south of Montreal, and extending beyond St. Johns and St. Hyacinthe, are rather of marine origin, dating back to the Leda clay period, when the drift clays were re-assorted under water and added to, and the land then elevated to its present level.

Probably contemporaneous with the formation of the prairies was the creation of the deep valleys of the Assiniboine and the Qu'Appelle Rivers. The valley of the Assiniboine above Brandon has an average depth of towards 200 feet; that of the Qu'Appelle is somewhat less. Their width varies from half a mile to a mile. As the waters fell in the prairie country to the east of Brandon, these rivers, which appear to have been enormous streams with strong currents, cut their way into the drift deposits of the upper steppe gradually downward to the level of the lower steppe below Brandon. The sources of supply for these streams may have been in part the retreating glaciers, but were more probably a greater rainfall than now and the general drainage of the country through which they ran. This country must have been in its earlier days covered with grass marshes. The smaller river valleys as those of the Souris, Cut Arm Creek and the Little Saskatchewan have probably somewhat similar origins. A contributing cause in every case has however no doubt been the annual spring freshets which extend into the month of July in the larger rivers, and which year by year carry down with them in their constantly turbid waters large quantities of soil to the Red River.

A writer in the February number of The Century, speaking of the vast prairies of the valley of the Mississippi and its tributary streams, tells us "This region was not originally wooded. This is proved not only by the story told by the soil, but by the fact that though it was not without its woodlands at its settlement, it has no characteristic trees. All are derived either from the Appalachian region or from the west and north, ninety varieties coming from the east and only nine or ten from the west and north. The great prairie region has sought all the trees it possesses from adjoining regions." This opinion probably expresses the generally prevailing impression of the relations of forest trees to the prairies. And yet in regard to our Canadian prairies, whether in the North-west or in Ontario and Quebec, it is not altogether correct. The subject is in some respects associated with the early history of the prairies. There is no doubt that when these prairies were in process of formation, when immense areas were in the condition of marsh in which tall grasses were the leading feature, and when this marsh was being gradually changed in its character to dry land by the successive annual growth and decay of these grasses, circumstances existed which rendered the growth of forest trees impossible. Great tracts of country are still in this condition. There are also many areas of great extent, as on the Pembina branch of the Canadian Pacific Railway, around Gladstone and Westbourne on the Manitoba & Northwestern Railway, and between Baie St. Paul and Lake Manitoba, where, during the wet seasons—and these seem periodically to follow each other for two and three years in succession—very extensive tracts of magnificent prairie land, which in other seasons are dry and capable of cultivation, are practically under water for most of the summer months. Thus trees, which in dry seasons might spring up in such stretches of country, would during the successive wet seasons be gradually killed. Wherever such conditions have prevailed, whether in far distant or present times, forests, for the time, could not be expected to appear.

The question however arises whether, once the condition of dry land was attained, did trees spread over the prairies as they have elsewhere, and whether subsequent causes may not have prevailed in removing them. That certain trees will freely grow on the prairies is proved by the frequent bluffs of timber, especially to the north of the Assiniboine and Qu'Appelle. These bluffs often occur in stretches of miles in extent and often again are found isolated. North of the Qu'Appelle they are so frequent as to give the country a park-like appearance and to render that country very attractive for settlement. Beyond this point northward they continue to occur until they finally merge into the true forest region which in this section extends from Lake Winnipeg westward to the sources of the Athabasca River, and from between these localities northward to the extreme limits of forest growth—including within this are a great stretches of what should correctly be termed prairie country. On the prairies proper the prevailing trees are the poplars, and only in the deep river valleys or skirting the margins of the lakes and the smaller streams and on the hills are the other trees of the prairies found in numbers.

It is quite true that the total number of species of trees in our North-west is limited. Most of the Ontario and Quebec species do not range west of Lake Superior or Lake of the Woods and probably Manitoba, west of the Red River, does not include more than sixteen species. Were there, however, forests in this part of Manitoba as there are in Ontario and Quebec, this paucity of species would probably not be so marked. That there has been a time when the present prairies of Manitoba and the North-west Territories have been more or less under wood is extremely probable. There seems no reason why the true forests should have extended everywhere northward, often covering, even there, what would be otherwise prairie, and should have left the vast country to the south an open, more or less treeless, plain. The deep valleys of the Assiniboine, Qu'Appelle and other streams would seem to indicate a greater rainfall to have at one time prevailed, and this greater rainfall would result from extended areas of forest. It is not an argument against this that the prairies with us can hardly be said to have any characteristic trees. The vast forests to the northward have none. It is not because trees will not grow, as bluffs of timber are of frequent occurrence and wherever tried, hardy trees, when properly protected, readily thrive. Those who have observed the almost yearly occurrence in almost every part of the prairie country of great fires, sweeping sometimes over immense stretches of country, and of the destructive effects of forest fires in Ontario and Quebec, can readily suppose that such fires may have been an important factor in rendering the prairies largely treeless and that, aided by the light rainfall and the dry atmosphere, they have gradually widened the areas originally burned, until these areas have attained their present extent. The general flatness of the country and consequent exposure to winds has contributed much to the rapid accomplishment of this. In the country bordering the upper reaches of the Peace and Athabasca Rivers and their tributaries there are at present large stretches of prairie land completely surrounded by forest, and which suggest an origin resulting from forest fires. Prairie fires are almost invariably the result of human agency, so that the present condition of the prairies probably dates its origin within a comparatively recent period. Certainly these prairie fires now prevent the encroachments of the forest upon the plain, as otherwise these forests would in the natural order of things extend themselves westward and southward if allowed to do so. The same is true of the bluffs or stretches of timber found growing in frequent places south of the true forests, though even there the trees are of relatively moderate size proving that these bluffs are of comparatively recent or of very slow growth. There can be no question that as prairie fires cease with the progress of cultivation of the land and with the enforcement of preventive laws, the tendency of these stretches of timber and of the true forests will be to extend themselves further over the prairie. In the meantime, the effect of the absence of timber is to create a drier climate by diminishing the rainfall, and on account of the general flatness of the prairie by exposing every object upon it to constant and unbroken, drying winds. That there is, therefore, a general tendency of trees to skirt the river banks can be readily understood, as there they obtain that moister atmosphere which is absent on the open prairie. Even in the valleys of such great streams as the Assiniboine and the Qu'Appelle, trees are generally found on the southwestern or western sides, the eastern being frequently bare, and this can only be accounted for by the greater protection from drying winds the western and southern banks have, and therefore the greater moisture in the soil there.

Again, only in the river valleys, on and near the lake margins and on the hills or rising grounds are the forest trees of the North-west completely represented, and it is suggestive whether the trees there are not the relics of a larger forest flora which more or less covered the whole country. At present the cosmopolitan poplars are the chief occupants of the plains, their very hardiness, however, constituting them fitting pioneers of new forests some day to appear.

I cannot help thinking that as the prairies become thickly settled and protective laws are properly enforced, prairie fires will largely cease and trees will have an opportunity to extend their area of growth in every direction. Further, as cultivation increases and a drainage system is more generally carried out, summer frosts will largely disappear and the climate become more suitable for forest trees as well as grain. The extension of the forests will, no doubt, have its effect in somewhat increasing the rainfall, but will also afford breaks to the winds which now prevail. The general effect must be a modification of the climate in some degree, probably rendering the atmosphere less dry and somewhat moderating the cold in winter.

The Protection of North American Birds.

By Alfred H. Mason, F.C.S.

A communication on this subject having been addressed to the Society by Mr. Montague Chamberlain, a member of the Council of the "American Ornithologists' Union" and Canadian Superintendent of that union, the Council of the society decided that it was a subject of importance to naturalists, and I was invited to bring the matter forward.

The American Ornithologists' Union was organised in 1883 at New York, at a convention of the leading scientific workers in that branch of study. The object of the Union is to advance the study of ornithology and to organise for systematic and combined action in the determination of important questions. It has issued a new classification of North American Birds, established a successful journal "The Auk," and organised and made successful a very large body of observers of the phenomena of bird migration. Allen, Baird, Coues, Merriman, Ridgway and Henshaw, are among the leading professional Zoologists of America.

Author's Note.—This paper consists mainly of a résumé of the work of the American Ornithological Union, and of extracts from its recent circular, and the chief object aimed at is to aid in directing general attention to the ruthless destruction of birds.

Brewster and Lawrence are gentlemen of large fortune, who study the science for occupation, and for the love of it, and stand high as scientists. Lawrence helped Baird with his greatest ornithological work, published in 1859.

One of the investigations being conducted by the Union is that of Bird migration and the geographical distribution of North American Birds, and during the first year of its existence, it received communications from more than a thousand observers. The area over which these observers are scattered is co-extensive with the boundaries of the inhabited portions of the North American continent, and includes parts of the West Indies, and Central and South America.

Stations now exist in every state in the Union, and in every Territory excepting Nevada. The extreme points from which reports have actually been received will appear from the following: in the east, the southernmost station is Sombrero Key, off Southern Florida (Lat. 24°37′); and the most northern, Belle Isle off Labrador (Lat. 51°53′), whilst from the west, reports have been received from Arizona and Southern California, as well as from Point Barrow, the most northerly point of Arctic Alaska (Lat. 71°18′). The most eastern station from which data have been obtained, is St. John's Newfoundland (West Long. 52°45′) projecting well into the Atlantic; while on the Pacific, the committee has observers at various points in California, Oregon, Washington and British Columbia.

Hence it appears that the migration stations are sprinkled over 46°41′ of latitude (approximately three thousand two hundred miles in a north and south direction) and 72°15′ of longtitude (approximately three thousand five hundred miles in an east and west direction.) The distance in a straight line between the two most remote points (Sombrero Key and Point Barrow) is about four thousand three hundred miles. This territory is divided into sixteen districts, each under the immediate direction of a competent superintendent. In Canada there are stations with the following superintendents:—North West Territories: Ernest E. T. Seton, Assiniboia, via Carbery, Manitoba; British

Columbia: John Fennin, Burrard Inlet, B. C.; Manitoba: Prof. W. W. Cooke, Moorhead, Minnesota; Quebec and Maritime Provinces: Montague Chamberlain, St. John, New Brunswick; Ontario: Thomas McIllwraith, Hamilton.

Each observer is asked to give a brief but careful description of the principal physical features, including latitude, longitude, and altitude, of the locality which is the seat of his observations, and the data collected arranged in three general classes; (a) Ornithological Phenomena, (b) Meteorological Phenomena, (c) Contemporary and Correlative Phenomena. The first class requires the observer to prepare a complete list of the Birds known to exist in the vicinity of his station, indicating to which of the following five categories each species pertains:—

1. *Permanent Residents,* or those that are found regularly throughout the year.

2. *Winter Visitants,* or those that occur only during the winter season, passing north in the spring.

3. *Transient Visitants,* or those that occur only during the migrations, in spring and fall.

4. *Summer Residents,* or those that are known to breed, but which depart southward before winter.

5. *Accidental Visitants,* or stragglers from remote districts.

The second class requires information upon:—

1. The direction and force of the wind.

2. The direction, character and duration of storms.

3. The general conditions of atmosphere, including rainfall.

4. The succession of marked warm and cold waves, including a record of all sudden changes of temperature.

Whilst the committee ask for a large amount of information upon a variety of subjects, they are also glad to receive meagre and isolated records. Comparatively few of the observers are ornithologists or even bird collectors, the great majority being intelligent farmers, tradesmen and light-keepers. Those who know only the commonest birds, such as the Robin, Bluebird, Bobolink, Martin, Hummingbird and Chimney Swift, can furnish important data and their services are eagerly sought.

Another object engaging the attention of the Union is to determine as nearly as possible the true status in America, of the European Home Sparrow (*Passer Domesticus*), commonly known as the English Sparrow—by collecting the facts necessary to settle the question of the eligibility or ineligibility of this sparrow as a naturalized resident of the country. The question is regarded as one of great economic consequence, to be determined primarily by ascertaining whether this bird be, upon the whole, directly or indirectly, injurious or beneficial to agriculture and horticulture, its economic relations, depending directly and mainly upon the nature of its food; indirectly upon the effect, if any, which its presence may have on useful native birds and beneficial insects.

The chief object of my communication this evening, is to call attention to that portion of the work of the Union which relates to the consideration of the important question of the destruction of the native birds in North America, and more especially, to join in the crusade against the fashion of wearing birds for decoration. This work is not likely to have been initiated by those scientists whom I have named, had they not been quite certain that there was an urgent need for it.

In the bird-world, as elsewhere, the struggle for existence even under natural conditions, is a severe one, undue increase being held well in check. Birds and their eggs and young, are not only the natural prey of many predaceous mammals and reptiles, but also of predaceous birds. Squirrels spermophiles and mice, although not in a strict sense rapacious, are among the worst natural enemies of the smaller birds, whose eggs and young they seek and devour with avidity; while many birds, not usually classed as predatory--as the jays, crows, grackles, cuckoos, and some others, wage unremitting warfare upon the eggs and young of the weaker species. "The elements are also far more destructive of bird-life than is commonly recognized. Late cold storms in spring destroy many of the early migrants, sometimes nearly exterminating certain species over considerable areas where they had become prematurely settled for the season. The unusual southward extension of severe cold waves and heavy snow-falls, such as have marked the present winter, are destructive to the bird-life of the regions thus exceptionally visited. During the migrations, both in the fall and spring, immense numbers of birds are sometimes caught by storms, and blown far out to sea and drowned, or perish in attempts to cross the larger inland lakes. There is abundant evidence to show that the annual destruction of birds by the elements alone must prove a severe check upon their increase. But all this is a part of nature's routine, which has characterized past ages as well as the present, and which, so far as we know, may be only the natural and necessary check upon undue increase. It is only when man comes upon the scene that nature's balance is seriously disturbed.

"Man's destructive influence is to some extent unavoidable, but in far greater part selfish and wanton. The removal of forests, the drainage of swamps and marshes, the conversion of wild lands into farms, and the countless changes incident to the settlement of the country, destroy the haunts and the means of subsistence of numerous forms of animal life, and practically result in their extermination over vast areas. The birds, particularly the larger species, suffer in common with vertebrate life in general. Electric-light towers, light-houses, and light-ships are also a fruitful and modern source of disaster to birds, particularly during their migrations, when, in thick weather, thousands upon thousands kill themselves by dashing against these alluring obstructions. Telegraph-wires contribute also largely to the destruction of bird-life. While the destruction by these agencies is greatly to be regretted, it is not directly chargeable to cupidity and heartlessness, as is the far greater slaughter of birds in obedience to the dictates of fashion.

"The history of this country, as is well known, is the record of unparalleled destruction of the larger forms of animal life. Much of this destruction, it is true, was unavoidable, sooner or later. But it is no less true that the extirpation of our larger game animals has been needlessly hastened by what may be fairly termed a disgraceful greed for slaughter,—in part by 'pot hunting' on a grand scale, in part for the mere desire to kill something,—the so-called 'love of sport.' The fate of extermination, which, to the shame of our country, has already practically overtaken the bison, and will sooner or later prove the fate of all of our larger game-mammals and not a few of our game-birds, will, if a halt be not speedily called by enlightened public opinion, overtake scores of our song-birds, and the majority of our graceful and harmless, if somewhat less 'beneficial,' sea and shore birds.

"The decrease in our song and shore birds is already attracting attention; and the protest against it, which reaches us from many and widely distant parts of the country, is not only painful evidence of this decrease, but gives hope that the wave of destruction, which of late years has moved on in ever-increasing volume, has at last reached its limit of extension, and that its recession will be rapid and permanent. But to secure this result, the friends of the birds—the public at large—must be thoroughly aroused as to the magnitude of the evil, and enlightened as to its causes and the means for its retrenchment."

The American Ornithologists' Union, through its Committee on Protection of Birds, "has caused the publication of a series of papers to throw some light upon the extent, the purposes, and the methods of the present wholesale slaughter of native birds. Birds are killed for food, for sport, for natural history specimens, to stuff as objects of curiosity or ornament, and for personal decoration. The birds killed for food are, of course, mainly the commonly so-called game-birds,—pigeons, grouse of various kinds, ducks and geese, and the great horde of smaller waders, known as 'peeps,' snipes, plovers, rails, etc. The slaughter of these has been so improvident, and their decrease of late so marked, that they are now more or less cared for by the numerous game-protective associations, but are still, in the main, very inadequately guarded. In addition to the birds commonly recognized as game-birds, many song-birds are hunted for food, notably the reed-bird, or bobolink, the robin, the meadow-lark, the blackbird, and the flicker, and, in some localities, all the larger song-birds. This is particularly the case in portions of the south, where strings of small birds may be seen suspended in the game-stalls. In March of last year, a well-known ornithologist reports finding in the market at Norfolk, Va., hundreds of wood-peckers and song-birds exposed for sale as food, the list of species including not only robins, meadow-larks, and blackbirds, but many kinds of sparrows and thrushes, and even warblers, vireos, and wax-wings. While some of the stalls had each from three hundred to four hundred small birds, others would have but a dozen or two. 'Nearly all the vendors were colored people, and doubtless most of the birds were captured by the same class.' This 'daily exhibition in southern markets' indicates an immense destruction of northern-breeding song-birds which resort to the southern states for a winter home," and we in Canada must not overlook the fact that many of our birds migrate to these districts, to escape our severe winter, never to return, and hence this is a subject for serious consideration by us.

The eggs of many species of terns, gulls, plovers, and other marsh and shore breeding species, are systematically taken for use as food, the egg-hunting busines being prosecuted to such an extent as to prove a serious cause of decrease of the species thus persecuted, while the value as food of the eggs thus destroyed, is too trivial to be for an instant regarded as of serious importance.

Mr Sennett writes a paper in which he refers to the destruction of young birds rather than to eggs, and makes a statement which he says, for fiendish enterprise, exceeds anything that has ever come under his notice. In 1877, and also in 1878, while studying the birds about Corpus Christi Bay, Texas, he examined a low grass-flat called Pelican Island, so named on account of the numbers of brown pelicans that had for years taken it for their breeding-place, to the exclusion of all other species. Here many thousands of these great birds were tending their eggs and young, breeding in such numbers that one could step or jump from nest to nest, over nearly, if not quite, every square yard of the island. Four years later he cruised over the same course, and noticed that the pelicans had deserted this grassy island entirely, and were scattered, in diminished numbers, on other islands which were not occupied by them when he made his former trips. On inquiring into the cause of this change, he learned from prominent citizens, that two or three enterprising (?) men had conceived the idea of making their fortunes from pelican-oil, and had erected 'trying-out' shanties on the mainland. They went to the island in question in large boats, and carried off cargoes of young pelicans in all stages of growth, and boiled them up for their oil. The only satisfaction he could get from the history of this experiment was, that the men could not sell the oil, and had nothi g but their nefarious labor for their pains. Think of the enormous sacrifice of life for a foolish experiment! This heartless slaughter is hardly equalled in cruelty by the so-called sport of the union troops during the war against secession, who, while idly lying in transports off the passes along the coast, amused themselves by fastening a fish to a plank which was so weighted as to be quite submerged; they would then watch the pelicans dive for the fish, while bets were freely interchanged as to the probability of the bird getting a broken neck, with the odds decidedly in favor of the death of the pelican. Instances without number might be given to show that man, unchecked by law, will ruthlessly destroy the very things most useful to him if preserved and protected.

"The same havoc prevails all along the coast lines; and many localities might be cited where the destruction is equally sweeping, as on the Pacific coast and at frequent points on the Atlantic coast from Florida to Labrador,—wherever, in fact, the birds occur in sufficient numbers to render such wholesale plundering practicable. The marsh-breeding rails are at some localities subject to similar prosecution. At one locality on Long Island, it is reported, a 'bay-man,' who keeps a house of entertainment for sportsmen during 'the season,' supplies his table for weeks at a time with the eggs of the rails that breed numerously in this vicinity,—in strange conflict, too, with his own interests, since, by destroying the eggs of rails, he 'kills the goose that lays the golden egg' for the rail-shooting season.

"In general, the game and quasi-game birds are killed for sport rather than for gain or for their intrinsic value as food; exception, however, is to be made of the 'professional' or 'market' gunners, by whom the ranks of the water-fowl are so fearfully thinned, and who often resort to any wholsesale method of slaughter their ingenuity may be able to devise. But the slaughter of birds in general is doubtless largely due to the mere fascination of 'shooting.' Many song-birds are killed 'for sport' by the 'small boy' and the idler, whose highest ambition in life is to possess a gun, and whose 'game' may be any wild animal that can run or fly, and wears fur or feathers. Some slight depredation on the small fruits of the garden, or on field-crops, is ample pretext for a war of extermination on robins, catbirds and thrashers, jays and chewinks as well as blackbirds and crows, and the birds so unfortunate as to fall into the category of hawks and owls, notwithstanding the fact that every one of these species is in reality a friend. Yet the slaughter is winked at, if not actually encouraged, by those who are most injured by it; while the 'general public' of the districts where such practices prevail are either too ignorant of the real harm done, or too apathetic, to raise any serious protest.

"Among the important agencies in bird-destruction is the 'bad small boy'—and in the ornithological sense his name is legion—of both town and country. Bird-nest robbing is one of the besetting sins—one of the marks 'of natural depravity'—of the average small boy, who fails to appreciate the cruelty of systematically robbing every nest within reach, and of stoning those that are otherwise inaccessible. To him the birds themselves, too, are also a fair target for a stone, a sling, a catapult, or a 'pea-shooter;' to the latter many a sparrow, a thrush or warbler falls a victim. Says a recent writer on the subject of bird-destruction, 'Two ten-year old lads in that quiet and moral hamlet [Bridgehampton, Long Island] confessed this autumn, that with pea-shooters they had killed during the season fifty robins and other birds which frequent the gardens, orchards and cemetery. Such boys exist all over the country, and war on birds as things made to be killed. . . . The pea-shooter gives no sound, and can be carried in the vest-pocket; but so destructive is it in the hands of a skillful child that the legislatures of some of the western states were obliged to pass laws making the sale of the thing a misdemeanor, and preventing the possession or use of it.

"The destruction of birds by taxidermists, and for alleged 'scientific purposes,' has justly attracted attention and has unjustly brought into disrepute the legitimate collecting of both eggs and birds for scientific use; but much of this alleged scientific collecting is illegitimate, being really done under false colors, or wrongly attributed to science. Of the birds killed or mounted by taxidermists, some, not unfrequently a large part, are for museums or private cabinets: another large share is put up for parlor or hall ornaments, either as groups or singly. All this by a little license, may be allowed as legitimate, or at least not seriously reprehensible. But, unfortunately, the average taxidermist has too often an unsavory alliance with the milliner, and in addition to his legitimate work, is allured into catering on a large scale to the 'hat-trade.' Although a few of them are too-high principled and too much the naturalist at heart, to thus prostitute their calling, taxidermists as a class are at present in deserved disrepute, and are to a large degree responsible for much of the public and mistaken criticism of scientific collecting. This critictsm is perhaps more especially directed against the 'egg-collector,' who ranges in calibre and purpose from the schoolboy, who gathers eggs as he gathers postage stamps or 'show-cards,—for the mere purpose of 'making a collection',—to the intelligent oologist or ornithologist, who gathers his eggs in sets, prepares them with great care, with the strictest regard to correct identification, and in series sufficient to show the range of variation —often considerable—in eggs of the same species, and takes a few additional sets for exchange. He may have in the aggregate a large collection, numbering hundreds of species, and thousands of specimens: but, in general, the same species is not laid under serious requisition, and the sets are gathered at considerable intervals of time and from a large area of country. A squad of street urchins set loose in the suburbs will often destroy as many nests in a single morning's foray as a collector, gathering for strictly scientific purposes, would take in a whole season, and with far more harmful results, because local and sweeping. Much of the egg-collecting by schoolboys should be stopped, and can be easily checked under proper statutory regulations."

Having called your attention to various agencies and objects affecting the decrease of birds, we now come to consider the most important—many-times exceeding all the others together—the most heartless and least defensible, namely, the sacrifice of birds to fashion, for hat and bonnet ornamentation and personal decoration. Startling as this assertion may seem, its demonstration is easy.

"In the United States of 50,000,000 inhabitants, half, or 25,000,000, may be said to belong to what some one has forcibly termed the 'dead-bird wearing gender,' of whom at least 10,000,000 are not only of the bird-wearing age, but—judging from what we see on our streets, in public assemblies and public conveyances—also of bird-wearing proclivities. Different individuals of this class vary greatly in their ideas of style and quantity in the way of what constitutes a proper decoration for that part of the person the Indian delights to ornament with plumes of various kinds of wild fowl. Some are content with a single bird, if a large one, mounted nearly entire: others prefer several small ones,—a group of three or four to half a dozen; or the heads and wings of even a greater number. Others, still, will content themselves with a few wings fancifully dyed and bespangled, or a wreath of grebe 'fur,' usually dyed, and not unfrequently set off with egret-plumes. In the average, however, there must be an incongruous assemblage made up of parts of various birds, or several entire birds, representing at least a number of individuals. But let us say that these 10,000,000 bird-wearers have but a single bird each, that these birds may be 'made over' so as to do service for more than a single season; and still what an annual sacrifice of bird-life is entailed! Can it be placed at less than 5,000,000?—ten times more than the number of specimens extant in all our scientific collections, private and public together, and probably a thousand times greater than the annual destruction of birds (including also eggs) for scientific purposes.

"Fortunately, perhaps, the supply of bird-skins for decorative purposes is not all drawn from a single country, the whole world being laid under tribute. The ornithologist recognizes in the heterogeneous groups of birds on women's hats, met with on every hand, a great preponderance of North American species; but with them are many of the common birds of Europe, and a far greater variety from South America, and many from Africa, Australia, New Guinea, and India. But, on the other hand, it is well known that our own birds are exported in immense numbers to Europe; but, whether the exportation exceeds the importation, it is impossible to determine, from lack of proper statistics.

"With the foregoing facts before us in regard to the annual destruction of birds, it is no longer surprising that many species, and even genera, of birds, are fast disappearing from our midst. Considering that this slaughter has been waged for years, but with rapid increase year by year, is it not rather a wonder that so many birds are still left?

"The destruction of 40,000 terns in a single season on Cape Cod for exportation, a million rails and reed-birds (bobolinks) killed in a single month near Philadelphia, are facts that may well furnish food for reflection. The swamps and marshes of Florida are well known to have recently become depopulated of their egrets and herons, while the State at large has been for years a favorite slaughter-ground of the milliner's emissaries. The present winter parties organized and equipped in this interest are said to be prosecuting the same wholesale warfare against the birds at various points along the whole gulf-coast.

"But why, some may be supposed to ask, should the slaughter be interfered with? Does it not yield profit to many an impecunious idler, who receives so much per head from the 'taxidermist' for the freshly killed birds? Do not their preparation and manufacture into the gaudy or otherwise untasteful hat-gear give employment to many a needy hand, and add materially to the milliner's gains? Why is not their use for personal decoration, *à la sauvage*, as legitimate and defensible as their use for food, with the added advantage of being able to utilize decoratively a great many species otherwise of no commercial value? Why should we be anxious to preserve our birds? Are they, when alive, of any practical value, or do they contribute in any way to our pleasure or well-being?

"In regard to the first of these inquiries, the men and boys really get little more in the average for the raw material than enough to pay them for their powder and shot: it is the 'sport' that affords them their real reward. The middlemen,—the skinners and manufacturers,—and an occasional professional gunner, make most of the profit, which must be more or less considerable to induce them to run the gauntlet of public opinion and the occasional risks of prosecution in their illegal enterprise. The milliner shares, of course, in the profits of the trade in such supplies; but, if birds were not used to such an extent, other and more fitting decorations would be adopted in their place, and their business would not suffer.

"Respecting the latter inquiries, birds may be said to have a practical value of high importance and an æsthetic value not easily overestimated. Birds in general are the friends of man, and it is doubtful whether a single species can be named which is not more beneficial than harmful. The great mass of our smaller birds, numbering hundreds of species, are the natural checks upon the undue multiplication of insect-pests. Many of them rarely make use of other than insect-food, while all, as shown by scientific investigations already made, depend largely or wholly, during considerable periods of the year, upon an insect-diet. Even the ill-reputed hawks and owls prey upon field-mice, grasshoppers, and other noxious insects or vermin, some never molesting the farmer's poultry, and others only exceptionally. In the present general summary of the subject, it may be sufficient to say, that, while the beneficial qualities of birds vary widely with the species, none can be set down as proven to be unmitigatedly injurious. With the decrease of birds at any point is noted an increase of insects, especially of kinds injurious to agriculture. The relation of birds to agriculture has been studied as yet but imperfectly; but results could be cited which would go far to substantiate the above statement of their general utility. The investigation of the subject has now been systematically entered upon by the department of agriculture at Washington, under the supervision of experts especially fitted for the work.

"Birds, considered æsthetically, are among the most graceful in movement and form, and the most beautiful and attractive in coloration, of nature's many gifts to man. Add to this their vivacity, their melodious voices and unceasing activity,—charms shared in only small degree by any other forms of life,—and can we well say that we are prepared to see them exterminated in behalf of fashion, or to gratify a depraved taste? Says a recent writer, 'A garden without flowers, childhood without laughter, an orchard without blossoms, a sky without color, roses without perfume, are the analogues of a country without song-birds. And the United States are going straight and swift into that desert condition.'

"Indeed, as previously noted, there is already an encouraging recognition of that fact. Here and there bird-protective associations are being formed, and more care is taken to secure proper bird-protective legislation; but the public at large is still too apathetic, or too ignorant of the real state of the case, to insist upon, and support by proper public sentiment, the enforcement of legislative acts already on our statute-books. The American ornithologists' union has moved in the matter by the appointment of a large and active committee on bird-protection, which is at present bending its energies toward the diffusion of information among the people, in the hope of awakening a healthy sentiment on the subject, and is also working to secure not only more effective and intelligent legislation, but the proper enforcement of the laws enacted in behalf of birds. This, too, notwithstanding a recent writer in a popular magazine characterized ornithologists as being among the worst enemies birds have, and to whose egg-collecting and bird-stuffing propensities was principally attributed the woful decrease of our song-birds!

"In England the same rage for hat decoration with dead birds has gone so far that anti-plumage-wearing societies have already been established by the more intelligent women of that country; and it has already been suggested, apparently independently of any similar action abroad, by ladies themselves, that the women of this country throw their influence in a similar way against the barbarous custom of using birds for personal decorations. Much could doubtless be done in behalf of the birds in this way; for, once let it come to be considered vulgar and in 'bad form' to thus decorate one's person, and the power of fashion would be a mighty weapon in defence of the birds.

"Of all the means that may be devised for checking the present wholesale bird-slaughter, the awakening of a proper public sentiment cannot fail of being the most powerful. Without this, all other means would prove, to a great degree, ineffectual. Laws, however good, cannot be enforced unless backed by public opinion. To arouse this, it seems only necessary to enlighten the community respecting the nature, the enormity, and the leading cause of this great evil."

It is with this object that the Union appeals to us as workers in Natural History—and asks for sympathy, encouragement and support; and to aid them to prevent the birds being exterminated by thoughtlessness, they ask us to endorse their work and to help them in drawing public attention to it, and thus to create a public sentiment in favor of the movement. Already in the larger cities of the United States, in New York, Boston, Philadelphia and Buffalo, and indeed all over the States, the movement is gaining rapidly, and people of all classes are becoming interested in it, and assisting to advance it.

Already the Natural History Society of Toronto have taken up the subject energetically and at their last meeting, it was moved by Mr. J. H. Pearce, and seconded by Dr. Brodie, the President, and carried:—

"That the President be authorized to issue a circular to the ministers of the various congregations of the city especially, and as far as possible of the Province, and ask them to bring to the notice of the ladies of their respective congregations, the subject of the slaughter of birds for millinery purposes, of which five to ten millions are ruthlessly and unnecessarily slaughtered every year to decorate their head-gear."

It would be an easy matter to cite instances of the extent of this bird decoration; as you walk in the streets you have only to look at the head-dress of the ladies and count the birds as you go along. Look in the milliner's windows, and you will be astonished, as I have been. A gentleman walking on Yonge street Toronto, last week, between Trinity Square and Wellesley street, counted no less than 38 whole birds on hats, not to mention all the wings &c. used as embellishments. "The assemblage of diverse and incongruous forms sometimes met with on the same hat is often striking in the extreme; birds from the opposite ends of the earth, and of the ornithological scale of classification, being brought into most inharmonious combination, viewed even from the artistic stand-point. Bearing on this subject, and illustrating the range of taste in such matters, as well as the extent to which birds are used for hat embellishment, may be given the following inventory, furnished by an ornithological friend, of what recently met his eye in a Madison Avenue horse-car in New York. The car contained thirteen women, of whom eleven wore birds, as follows: (1) heads and wing of three European starlings; (2) an entire bird (species unknown), of foreign origin: (3) seven warblers, representing four species; (4) a large tern; (5) the heads and wings of three shore-larks; (6) the wings of seven shore-larks, and grass-finches; (7) one-half of a gallinule; (8) a small tern; (9) a turtle-dove; (10) a vireo and a yellow-breasted chat; (11) ostrich-plumes. That this exhibition was by no means exceptional as to number or variety is obvious to any one who has given close attention to the ornithological displays one daily meets with in street-cars and elsewhere, wherever he may travel. Advertisements in newspapers, by milliners, of the stock in hand. also give some suggestions of the extent of the traffic in wings and bird-skins; it being not uncommon to see thousands of wings(plain or fancy, in natural colors or dyed), as well as thousands of bird-skins (mounted or made up) and thousands of plumes (dyed or plain), advertised by a single dealer, while the dealers themselves number hundreds, if not thousands, in each of our larger cities. Add to these the smaller shops, in country and city, throughout the land, and we get at least some comprehension of the extent of the traffic in birds by the milliners, and the support they receive from the ladies of our population.

"Take up any daily or fashion paper, and one can see such items as the following, clipped from a New York newspaper of recent date: '[Miss———] looked extremely well in white, with a whole nest of sparkling, scintillating birds in her hair, which it would have puzzled an ornithologist to classify,' and '[Mrs. —— ——] had her gown of unrelieved black, looped up with blackbirds; and a winged creature, so dusky that it could have been intended for nothing but a crow, reposed among the curls and braids of her hair.' It is said, 'Where ignorance is bliss, 'tis folly to be wise.' Perhaps, if the lady in question could have seen the crow during its lifetime perched upon and feeding on the decaying carcass of a horse, she might have objected to the association.

"Respecting the traffic abroad, there were sold in one auction-store in London, during the four months ending April, 1885, 404,464 West Indian and Brazilian bird-skins, and 356,389 East Indian, besides thousands of Impeyan pheasants and birds-of-paradise. On the other hand, London *Truth* publishes an item showing the humanity of England's Queen: 'I am glad to hear that the Queen contemplates issuing a ukase censuring the barbarous fashion which so many women have lately adopted, of wearing the bodies of birds, or parts of their bodies, in bonnets and hats and on dresses. Her Majesty strongly disapproves of this practice, which of late has greatly increased, which is daily increasing, and which most assuredly ought to be abolished.' As long as the ladies continue to demand bird-skins for ornamental purposes, so long will the gunners and taxidermists undertake to supply the market, therefore the initiative in the movement for the protection of birds must be with the 'wives, sweethearts, and mothers,' and not alone with the laws and lawmakers."

Time will not permit of my bringing before you for consideration more fully the questions of the destruction of the eggs of birds for food; the relation of birds to agriculture, (a most important consideration to Canadians) or the subject of bird laws, or laws for the protection of birds, or to make a more earnest appeal to the ladies in behalf of the birds, but before concluding I should like to call your attention to a society which has been formed in order to give an opportunity for definite and systematic effort by all those who believe that our birds ought to be protected. It is called "The Audubon Society" and is for the protection of American birds not used for food. To accomplish this purpose it will—

1. Secure and publlsh information to show the extent of the present enormous destruction of birds for millinery, decorative and other purposes.
2. Expose the outrageous and indefensible cruelty of such wanton taking of feathered life.
3. Point out the injury to the agricultural interests of the land which must certainly follow the decimation of the insectivores.
4. By thus presenting the subject in its ethical, humane and economic aspects enlist the sympathy and active personal co-operation of a large membership in the effort to check the evil.

Three forms of pledges have been adopted, viz.:—

1. To discourage the killing of any bird not used for food.
2. To discourage the robbing of any bird's nest or the destruction of its eggs.
3. To refrain from the use of any wild birds' plumage as an article of dress or ornament.

Certificates of membership are issued to those who subscribe to one or two or all of the pledges. There are no membership fees of any kind, the society being supported entirely by voluntary contributions.

In conclusion, I would re-echo the appeal of the American Ornithologists' Union, and say that so long as demand continues, supply will come. Law of itself can be of little, perhaps of no ultimate avail. It may give check, but this tide of destruction it is powerless to stay. The demand will be met; the offenders will find it worth while to dare the law. One thing only will stop this cruelty—the disapprobation of fashion. It is our women who hold this power. Let them say the word, and hundreds of thousands of birds' lives every year will be preserved, and, until they do use their influence, it is vain to hope that this nameless sacrifice will cease before it has worked out its own end, and the birds are gone.

Those who wear them and give countenance to the fashion, doubtless do it thoughtlessly and without one moment's reflection as to the results. It is earnestly hoped that the ladies of Montreal may be led to see this matter in its true light, and to take some pronounced stand in behalf of the birds, and against the fashion of wearing them.

On Montreal Drinking Water.

By Arthur Weir, B.A.Sc.

During the session of 1885-86, while a student at McGill University, I made a series of determinations of hardness, chlorine, solids and free albuminoid ammonia in the drinking water furnished to this city, with the view of ascertaining how and to what extent these fluctuated from month to month. The determinations were made from November 1885 to March 1886, inclusive, and comprised in all fifty-one determinations of hardness, forty-eight of chlorine, forty-six of solids, ten of free ammonia and eleven of albuminoid ammonia. The following were the results obtained :—

CHLORINE.

The average quantity of chlorine during the period in question was 0.26 grains per gallon, the maximum being 0.40 on November 4th and 5th, and the minimum being 0.175 on the 23rd of the same month. Calculated as sodium chloride, this gives,

Maximum	0.659 grain.
Mean for the period	0.428 "
Minimum	0.288 "

RESIDUE.

Both suspended and dissolved matter are included under this heading; for the water was not filtered or allowed to settle previous to evaporation. Yet, notwithstanding this, the results show the water to have been fairly free from solid impurities. The average residue, calculated from the daily determinations, was 6.55 grains per gallon, the maximum being 9.3 on March 11th and the minimum 4.06 on January 11th. Wanklyn gives 40 grains of solids per gallon as the extreme quantity permissible for a drinking water,[1] and ours is evidently well within this limit.

It is not necessary to dwell upon the effect on the proportion of solid matter in running water of the country through which it runs and the gases it holds in solution. The river Loka, in the north of Sweden, flows over granite and other hard rocks, and contains but 0.0566 grains of solid matter per gallon.[2] The other extreme is seen in brine wells or other mineral springs. The water furnished to Montreal is partly St. Lawrence, partly Ottawa water and partakes of the nature of both. "The Ottawa drains a region of crystalline rocks, and receives from these by far the greater part of its waters." "The St. Lawrence * * * flows through lakes whose basins are composed of palæozoic strata which abound in limestone rich in gypsum and salt."[3]

The influence of the rock upon the water brought into contact with it is well shown in the case of the spring at the back of McGill College, which, deriving its water from the reservoir, has a hardness of 12.5, or about double that of the water before its percolation through the walls of limestone.

HARDNESS.

The hardness of a water depends, as is well known, upon the proportion of calcium and magnesium salts it contains,

[1] The Jordan, however, is used for drinking, although it contains 73 grains of solids per gallon.—Chem. Com. Life.

[2] Johnston, Chem. Common Life.

[3] Hunt, Geol. Survey Report 1853.

carbonates giving temporary and sulphates permanent hardness. Where the hardness of a water is considerable, it is often important to distinguish between that which is permanent and that which is only temporary; but where the hardness is low, as in Montreal water, such a distinction is, from an economical or hygienic point of view unnecessary.

Like the chlorine and solids and usually with them, the hardness fluctuated, but, as necessitated by the small proportion of solids, it was never large. The average for the period covered by my determinations was 4.63, a low result and one showing our water to compare favorably with that of other towns. The maximum was 6.7 on Feb 11th and the minimum 3.2 on January 12th.

NITROGEN.

The average quantity of nitrogen, estimated as ammonia, during January, February and March 1886 was 0.0031[1] parts free and 0.0194 parts albuminoid ammonia per million, the maximum and minimum for free ammonia being respectively 0.004 on several occasions and 0.0009 on March 4th, and the corresponding figures for albuminoid ammonia 0.03 on January 18th and 0.01 on February 25th.

FLUCTUATIONS.

The analyses showed from day to day and week to week, as was to be expected, certain variations in hardness, chlorine, residue &c., dependent chiefly upon the dilution of the water by rain and snow and the relative heights of the Ottawa and St. Lawrence.

These fluctuations were noteworthy in that the maximum was in every case more than double the minimum.

	Maximum.	Minimum.	Ratios.
Chlorine....	0.40	0.175	2.28 to 1
Hardness...	6.70	3.20	2.09 to 1
Residue....	9.30	4.06	2.29 to 1

[1] Or 0.0035 if the doubtfully high result for Feb. 18th (0.0074) be considered in striking the average.

FLUCTUATIONS IN HARDNESS.

The average hardness for November was 4.70 degrees Wanklyn, a little higher (5.12) in December, but lowest in January, the average for that month being only 3.77 degrees. In February the hardness was about the same as in November, namely 4.72, while in March the maximum was attained, the average for that month being 6.07 degrees.

FLUCTUATIONS IN CHLORINE AND SOLIDS.

As regards chlorine, the average was 0.264 grains to the gallon in November, but instead of rising in December like the Hardness, it fell to 0.243, became 0.235 in January and rose in February and March to 0.28 and 0.325 respectively.

The solid residue varied in a similar manner, sinking from an average of 6.83 grains per gallon in November through 6.70 in December to 5.23 in January, and then rising as regularly through 7.12 in February to 8.82 in March. Thus we see that the average results for the opening and closing months of the period were high, while those for January, the central month, were the lowest.

SUMMARY.

To sum up the results, the following was the average proportion of foreign matters in Montreal water during the time covered by the analyses :—

Hardness......	Mean	of	51	Determinations	4.63°	Wanklyn
Chlorine.......	"	"	48	"	0.26	grs. per. gal.
Solids.........	"	"	46	"	6.55	part per gal.
Free Ammonia	"	"	9	"	0.0031	parts per mill.
Albuminoid Ammonia...	"	"	11	"	0.0194	" " "

These results are calculated from the actual analyses and differ somewhat from those given by computation from the monthly averages, for the reason that the same number of analyses was not made each month. The average obtained in the latter way is, perhaps, the more accurate, as it tends to neutralize the accidental advantage of the earlier over the later months. By this method alone can the four weekly determinations of March be made equal to the fifteen daily ones of November, as they should. The grand average corrected in accordance with this idea is given in the Table of Monthly Averages, which, with a Table of Daily Results, is hereto appended.

TABLE OF MONTHLY AVERAGES.

MONTHS.	Degrees of Hardness. Wanklyn.	Chlorine. Grs. per gal	Total Solids. Grs. per gal.	Free Ammonia. Per million.	Albuminoid Ammonia. Per million.
November	4.70	0.264	6.83	Not det.	Not det.
December.	5.12	0.243	6.70	"	"
January ..	3.77	0.235	5.23	0.0028	0.0250
February .	4.72	0.277	7.12	0.0040	0.0172
March....	6.07	0.325	8.82	0.00288	0.0155
Average.	4.876	0.269	6.94	0.00322	0.0192

TABLE OF ANALYSES OF MONTREAL WATER MADE BETWEEN NOV. 1st, 1885, AND APRIL 1st, 1886.

DAY.	DATE.	Hardness. Wanklyn.	Chlorine. Grs. per gal.	Residue. Grs. per gal.	Free H_3N. Per million.	Alb. H_3N. Per mill'n.
Monday ...	Nov. 2	4.66	—	—	Not deter	mined.
Tuesday ...	" 3	5.5	.40	—	"	"
Wedn'sday.	" 4	4.8	.25	7.1	"	"
Thursday ..	" 5	4 8	.40	7.3	"	"
Monday ...	Nov. 9	4.8	.25	7.1	"	"
Tuesday ...	" 10	4.75	.27	7.7	"	"
Wedn'sday.	" 11	4.63	.25	7.1	"	"
Monday ...	Nov. 16	4.7	.25	6.5	"	"
Tuesday ...	" 17	4.8	.20	6.6	"	"
Wedn'sday.	" 18	4.55	.30	6.1	"	"
Thursday ..	" 19	4.5	.30	—	"	"
Monday ...	Nov. 23	4.5	.175	6.9	"	"
Wedn'sday.	" 25	4.5	.20	6.9	"	"
Thursday ..	" 26	4.5	.25	6.3	"	"
Monday ...	Nov. 30	4.5	.20	6.4	"	"
Tuesday ...	Dec. 1	4.5	.25	6.3	"	"
Wedn'sday.	" 2	4.5	.20	6.4	"	"
Monday ..	Dec. 7	5.8	.20	6.4	"	"
Tuesday ...	" 8	5.7	.25	7.0	"	"
Wedn'sday.	" 9	6.1	.25	6.9	"	"
Thursday ..	" 10	4.6	.35	6.9	"	"

TABLE OF ANALYSES OF MONTREAL WATER.—(*Continued.*)

DAY.	DATE.	Hardness. Wanklyn.	Chlorine. Grs. per gal.	Residue. Grs. per gal.	Free H_3N. Per million.	Alb. H_3N. Per mill'n.
Monday	Dec. 14	5.0	Not det.	6.9	Not deter	mined.
Friday	" 18	4.8	.25	Not det.	"	"
Tuesday	Dec. 22	5.1	.20	Not det.	"	"
Tuesday	Jan. 5 '86	5.0	.25	5.9	"	"
Wedn'sday.	" 6	4.7	.25	5.7	"	"
Thursday ..	" 7	4.7	.25	5.7	"	"
Monday	Jan. 11	3.5	Not det.	4.06	Not det.	.028
Tuesday	" 12	3.2	.20	4.76	"	Not det.
Wedn'sday.	" 13	3.4	.25	6.3	"	"
Thursday ..	" 14	3.4	.20	6.3	.00266	.022
Monday	Jan. 18	3.6	.25	5.3	.00372	.030
Tuesday ..	" 19	3.5	.25	4.4	Not deter	mined.
Wedn'sday.	" 20	3.6	.20	4.5	.00200	.020
Thursday ..	" 21	3.6	.25	4.9	Not deter	mined.
Monday	Jan. 25	3.5	.20	5.1	"	"
Wedn'sday.	" 27	3.5	.25	4.7	"	"
Thursday ..	" 28	3.6	.25	5.7	"	"
Monday ..	Feb. 1	3.6	.20	5.7	"	"
Wedn'sday.	" 3	3.9	.30	6.7	"	"
Thursday ..	" 4	3.9	.25	6.7	.00400	.020
Monday	Feb. 8	4.5	.25	7.5	Not deter	mined.
Wedn'sday.	" 10	5.0	.30	7.5	"	"
Thursday ..	" 11	6.7	.35	7.8	"	"
Monday	Feb. 15	5.0	.30	7.1	"	"
Thursday ..	" 18	5.0	.30	7.2	.00746	.0216
Thursday ..	Feb. 25	4.9	.25	7.9	.00400	.010
Thursday ..	Mar. 4	5.5	.30	7.8	.00092	.016
Thursday ..	Mar. 11	6.0	.35	9.3	.00400	.020
Thursday ..	Mar. 18	6.4	.30	9.0	.00260	.012
Thursday ..	Mar. 25	6.4	.35	9.2	.00400	.014

NOTE.—On May 5th and 15th two determinations were made with the following results:—

Thursday ..	May 5	3.0	0.25	6.90	0·0035	0.015
Thursday ..	" 15	3.0	0.20	5.90	0.0040	0.018

Polyembryony.

By D. P. Penhallow, B.Sc.

According to Strasburger,[1] polyembryony, as it occurs in *Funkia, Allium, Nothoscordum*, oranges, &c., arises from adventitious outgrowths, which, originating in the nucleus external to the embryo-sac, ultimately penetrate the latter and then form true embryos, although independently of fecundation. They therefore represent, according to Gray, instances of true parthenogenesis. More recently, Guignard[2] has shown that polyembryony is not uncommon in the Mimoseæ; while B. Jönossn[3] points out a similar case in *Trifolium pratense*, which he ascribes to the development of several ovum cells in the same embryo-sac.

Although the common occurrence of polyembryony in oranges is well known, a very interesting instance of its frequency in certain varieties was recently brought to notice.

Among several hundred seeds planted, it was observed that in the Florida oranges of the more common sorts, and the ordinary Spanish oranges, polyembryony was comparatively of little frequency, but in the Tangierine, its occurrence was most marked. In transplanting some young trees on the 26th of April, then about three weeks old, opportunity was taken to note the number of plants to each seed. Of all those examined, only six were found to have produced a single plant, while all the others had produced from three to four plants each. The following is a summary of the results obtained :—

Whole number of Seeds	38	
Seeds producing one plant	6	= 15.8 p. c.
" " two plants	19	= 50 "
" " three "	9	= 23.7 "
" " four "	4	= 10.5 "

[1] Am. Jour. of Science, 1879. xvii, 334.

[2] Bull. Soc. Bot., 1881. xxviii. 177.

[3] Bot. Notiser, 1883. 135.

Proceedings of the Natural History Society.

The Fifth Monthly Meeting of the session took place on Monday evening, March 29th, 1886.

Sir William Dawson, the President, occupied the chair.

The minutes of the previous meeting and also those of the last council meeting were read and approved.

Donations to the Library were announced: from Dr. Wolfred Nelson, of Panama, of a book containing over a hundred photographs taken by him in Guatemala; from Thomas Macfarlane, Esq., of Ottawa, of a bound copy of his papers "On the primitive formations in Norway and Canada" and other subjects; and from E. T. Chambers, Esq., of a copy of "Lettres sur Les Roches du Jura," by Jules Marcou. For these donations votes of thanks were passed.

The President called attention to the rather unfavorable tenor of the Hon. J. G. Robertson's letter in response to the petition for a renewal of the Government grant.

The first paper of the evening was then read by A. T. Drummond, Esq., on "Our North-west Prairies, their Origin and their Forests," which elicited remarks from Sir William Dawson, Charles Gibb, Alex. McGibbon and others.

Professor Penhallow followed with Dr. Robert Bell's article on the Forests of Canada, when further criticism of both papers took place.

The thanks of the Society were tendered to both authors for their valuable communications.

The Sixth Monthly Meeting was held on Monday evening, May 3rd, 1886, Dr. Harrington occupying the chair.

The minutes of the meetings of 29th March and 26th April were read and confirmed. The minutes of council meeting of April 19th were also read.

Regarding the grant, Mr. J. A. U. Beaudry reported the receipt of a private communication from the Premier of the Province, intimating that the petition of the Society would have his personal attention and hoping to secure at least a portion of the sum asked for.

Alfred Henry Mason, Esq., was elected a delegate to represent the Society at the annual meeting of the "Royal Society of Canada" at Ottawa on May 25th, 1886.

John S. Shearer and Wm. T. Costigan were re-elected auditors.

It was resolved that the annual Field Day excursion should take place to Belœil Mountain, St. Hilaire, on the 5th or 12th of June, whichever day was considered the more suitable by the excursion committee.

A valuable donation of pottery from Dr. Wolfred Nelson, of Panama, was exhibited on the table, and on motion it was resolved that a hearty vote of thanks be conveyed to Dr. Nelson and that the corresponding Secretary should request him to favor the Society with a copy of his field notes on the collection.

Dr. T. Sterry Hunt presented a copy of each of his works entitled "Chemical and Geological Essays" and "Azoic Rocks of South Eastern Pennsylvania," the receipt of which were highly appreciated.

Mr. Charles Robb also presented a geological chart and several pamphlets to complete missing parts of serials belonging to the Society, for which a vote of thanks was passed.

Mr. Alfred Henry Mason then read a paper on the "Protection of North American Birds," at the close of which a vote of thanks was given to him.

The following resolution, prepared by Mr. Mason, was then unanimously adopted: "That the members of the Natural History Society of Montreal endorse the work of the 'American Ornithologists Union' for the protection of North American birds, and sympathize with their endeavours to prevent the destruction of birds for millinery and decorative purposes, and will use their best efforts to call public attention to the evil, and to bring about its suppression."

The chairman then read Mr. C. N. Bell's paper on the "Aboriginal Trade of the Canadian North-west" and a short communication from Prof. Penhallow on "Polyembryony."

The Annual Meeting of the Society took place on Monday evening, May 31st, 1886, the President, Sir J. William Dawson, in the chair.

The minutes of the last annual meeting and of the previous monthly meeting were read and approved. The minutes of the last council meeting were also read.

Rev. John Nichols was proposed as an ordinary member and Bertie Nichols as a junior member.

Dr. J. A. Beaudry was elected a member of the Society.

The President's annual address was next delivered.

ADDRESS OF THE PRESIDENT, SIR J. WILLIAM DAWSON, C.M.G., F.R.S.

We close, this evening, what may be regarded as a successful session of the Natural History Society of Montreal, which has now been pursuing its useful work for fifty-four years. In the past session our museum has been cared for and augmented. Our library has been arranged and catalogued. Our monthly meetings have been well sustained, with larger attendance than in some previous years, and with valuable and instructive papers. The RECORD OF SCIENCE has been regularly issued and circulated, and, as usual, has been truly a record of scientific progress and discovery. The Society has contributed to popular education by its course of free lectures, and financially we are in a solvent condition. Most of these matters will be brought under your notice in detail in the various reports to be presented this evening. The only one which it falls to me to discuss in this address is the scientific work of the Society. Before entering on this, however, I would pause to make two suggestions. One is to wealthy citizens disposed to aid in the diffusion of popular science. The Sommerville endowment has hitherto been the only one in Montreal intended to promote absolutely free popular scientific lectures. In this it has borne good fruit, since we have had on this endowment every year, for nearly half a century, a course of lectures of a high scientific character, many of them equal to those of any scientific course in the world, to which all of our citizens have had free access. It is not easy to estimate the amount of good which has thus been done. At the same time it is certain that an endowment of equal or greater amount added now would increase the number of lectures, improve the means of illustration and enable the Society to secure the services of eminent lecturers from abroad. There is here a good field for the exercise of enlightened liberality. My second suggestion has reference to our journal, the Record of Science. This is conducted under some difficulties. Even in older and richer countries such journals are rarely paying enterprises. Here they must necessarily be conducted at some loss, even though the work of writing and editing is done gratuitously; and but for the aid which we have received from the Provincial Government, in consideration of our circulating copies abroad, the publication must have been abandoned. I trust that some measure of public assistance will be continued to this useful work, and I would put it to the members of the Society and to all our citizens that they should at least be subscribers to this oldest and most important Record of Canadian Science. I have reason to know that this periodical has been the chief book of reference to naturalists abroad in relation to the natural history and geology of Canada. Its nineteen volumes are a mine of information on these subjects, and it is by no means inferior now to what it was in former times. But it is not sufficiently large to accommodate all the matter which deserves publication. It cannot afford sufficient illustrations, and its expense has to be curtailed in several undesirable ways. A larger subscription list would greatly tend to remedy these evils.

Turning now to the scientific work of the Society, I find that of thirteen papers contributed last session, five were on geological subjects, three ethnological, one chemical and the remainder biological.

Of our geological papers, three related to the more recent periods. Two of them directed our attention to the glacial phenomena and fossils of the Pleistocene beds of the Lower St. Lawrence and of Anticosti. We have, in the terraces and varied beaches of these districts, the evidences of a deep submergence, and extensive drift of boulders over the country at a time so recent that the existing shells, fishes and cetaceans were already living in our waters, and under a climate so severe that our hills were mantled with snow and ice. Such facts present to us a truly wonderful record of geological and climatic change. The communication of Col. Grant on Anticosti was of especial interest, both on account of the position of that island and of the comparative want of information respecting it. As might be expected, the appearances were altogether those of marine glacial deposits. Along with these papers I would place that of Mr. Drummond on the origin of prairies, at a time when the glacial subsidence and cold had passed away, and when swamps and forests were taking the place of ice-laden seas, and were themselves passing into the dry prairie condition of the present time. Under the same geological head we may also place Dr. Harrington's paper on new discoveries respecting Canadian minerals, which directed our attention to the fact that there are new chemical and crystallographic points to be ascertained by careful and accurate observation even with reference to well known mineral species, and which lead to interesting comparisons with the minerals of other countries.

Curiously enough, two of our ethnological papers were not on Canadian ethnology, but on the origin and physical characters of the Ainos of Japan, whom Prof. Penhallow had an opportunity to study during his residence in that remarkable country. The Ainos are a primitive race, allied apparently more nearly to the older European peoples than to the Turanians of eastern Asia, and suggesting that in Japan the order of succession of races seems to have been the reverse of that in Europe and western Asia, a fact which, if conclusively established, would have important bearings on our views of ethnology. We had also, however, a communication from a correspondent in the West, Mr. C. N. Bell, on the mounds of our North-western territory, which seem to show that these industrious races of primitive Indians who cultivated the valleys of the Mississippi and Ohio, and worked the copper mines of Lake Superior, were early colonists of the plains of the North-west. These mounds will furnish worthy objects of exploration to the archæologists of the western Provinces of Canada, whose special property they are, and on whom devolves the duty of their scientific study.

We are indebted to Dr. Edwards for a very full account of the various and insidious ways in which arsenic is introduced in injurious quantity into the human system, and to Prof. Penhallow for two important papers on new points of vegetable physiology. Dr. R. Bell gave us the results compiled from various sources as to the distribution of Canadian forest trees, so important to this country, in many practical ways, as well as the chief ornament of our hills and valleys. Mr. A. W. MacKay, of Pictou, Nova Scotia, has recently studied with much success the fresh-water sponges of that Province and other parts of Canada, some of which were described in our journal several years ago by Dr. Bowerbank and by Dr. G. M. Dawson, and Mr. MacKay has very properly favoured us with the very valuable and large additions which he has made to previous knowledge.

The subject of the destruction of small birds for purposes of ornament is one that has recently attracted much attention in the United States. Naturalists there seem indeed to be alarmed lest our feathered songsters should be altogether sacrificed to the exigencies of ladies' bonnets. The quantity of birds destroyed for such purposes seems to be enormous, though perhaps the fears which have been entertained may be somewhat exaggerated. The powers of multiplication of these creatures are great, but there can be little doubt that in some localities their numbers have been seriously thinned, and while we lose the pleasure derived from their beauty and their songs, we lose also the advantage of their services in the destruction of injurious insects. Our laws in the Province of Quebec provide for the protection of small birds, and in many places at least are fairly well enforced; but we are deeply interested in the question as it affects the United States. Our birds are migratory. They spend their winters in the South, and if they are not protected in the districts through which they pass in spring and autumn and in which they winter, our summer fields and woods will be slenderly peopled. It was well therefore that Mr. Mason directed our attention to this subject, and especially to the circular issued by the American Ornithologist's Union, with whose action in the matter we can cordially sympathize.

It is proper to add that much important matter has been published in the Record which has not been read, except by title, at our monthly meetings; but the subjects I have already treated of are sufficient to show that we have not been altogether idle. There is, however, still vast scope for our exertions, and a great many fields to be cultivated in which our younger members more particularly might benefit our country and distinguish themselves. In relation to this they should bear in mind that we do not exact lengthy and profound papers. Any notes, however short, relating to new facts in natural history or useful application of those already known, will be acceptable to the Society, since it often happens that important discoveries are overlooked and irretrievably lost to science, because no attention has been paid to the matter of bringing them under the notice of those who can appreciate their value. Our monthly meetings also are of much greater interest than one would infer from the moderate number of members usually present. We have in most of these meetings several subjects under discussion, some of them illustrated by specimens, and it not unfrequently happens that lively and interesting discussions follow the reading of our papers. Nor is the benefit of our regular meetings confined to members, since our rules allow members to introduce their friends, whether ladies or gentlemen, and we shall welcome any who think it proper to favour us with their presence at these meetings.

It has been suggested, and I hope this suggestion will receive the attention of the council, that next winter we should resume the practice of inviting our fellow-citizens to a conversazione in our rooms. These meetings have in former years been very attractive, and may, I think, be renewed with advantage to the Society and to the interests of science. They constitute a legitimate means of attracting to scientific pursuits, and more especially of imbuing the young with a taste for the study of nature, while they cultivate friendly relations between those who already take an interest in scientific subjects.

The report of the chairman of the council was next read by Mr. J. S. Shearer, as follows :—

REPORT OF CHAIRMAN OF COUNCIL.

The Council of the Natural History Society desires to submit the following report concerning the work done since the last annual meeting. There have been six meetings of the Society and twelve meetings of the Council held during the year just closed.

The Council is pleased to report satisfactory progress. Since the last annual meeting there have been elected one honorary, one corresponding, and sixteen ordinary members.

The Society has recognized the valuable services of Dr. Asa Gray, the celebrated botanist, by electing him an honorary member, and the Hon. Thos. White has been elected a corresponding member on the occasion of his departure from Montreal. The Council, however, whilst acknowledging the support that the Society has received in the past, believes that if its claims were more forcibly urged upon the citizens during the session of 1886-7, there would be a large increase in the membership. Such action, in fact, has become absolutely imperative, as it is upon increased memship that the welfare of the Society largely depends in the future.

The museum has been well patronized, having been visited by over 1,500 persons.

The proposal to improve the interior arrangements of the building has engaged attention during the year. A new light has been placed in the Hall, and other alterations made at considerable expense. The ventilation of the hall demands attention, and certain improvements in this connection will require to be made during the month of June.

The necessity of a complete re-arrangement and classification of the books in the library has long been felt, and with a view to having this accomplished, the Council took action in September last, and Mr. Chas. Robb was engaged to prepare a classified catalogue of all the books, periodicals and pamphlets in the library. This work is now completed, and it is the intention of the Council to publish the catalogue as the funds will permit. The Council would recommend, in the meantime, that works printed or purchased should be added to the list as soon as received, in order that when the catalogue is printed it will not be necessary to make a new classification.

The revision of the by-laws has also taken practical shape during the past session, and the Council at its last meeting appointed Sir William Dawson and Messrs. Geo. Sumner and P. S. Ross, a committee for this purpose. The committee at once entered upon its work with the utmost zeal, and in February a draft of the revised by-laws was submitted to the Society, and immediately adopted and ordered to be printed. The printed copies can now be obtained by subscribers.

The Editing Committee is to be congratulated on the efficient, prompt and admirable manner in which they have issued the RECORD, and the thanks of the Society are due to them for their arduous labours in the face of many difficulties.

The Council petitioned the Local Government again this year for a renewal of the grant to the Society, and is not without hope that the Government will soon see its way clear to a favorable consideration of the petition, so that the Editing Committee may be enabled to do its work efficiently.

The Field Day has always been one of the most enjoyable features of the Society, and this year proved no exception. Owing to the kind invitation of Mr. Chas. Gibb, of Abbottsford, Yamaska Mountain was this time selected, and on the fourth of June last, a party, numbering 120 persons, left the city by the South-eastern Railway to enjoy the day's outing. On their arrival, Mr. Gibb, who, with his characteristic hospitality, had invited the entire party to be his guests for the day, personally received and conducted them to his residence where ample refreshments were provided and partaken of. The party then divided into three portions and started for their respective pursuits. At half-past four they all re-assembled to partake of refreshments again, after which the prizes were awarded. There were eight entries in the botanical department, which was divided into two sections, one for "named" and one for "un-named" plants. The first prize in the "un-named" was awarded to Miss A. Van Horne, who succeeded in securing forty-six varieties of plants. Miss Ritchie took second prize with forty-three varieties. In the named section, Mr. E. H. P. Blackadder, who had collected forty-eight specimens, carried off the first prize, and Miss F. M. Girdwood took second prize with forty-five specimens. In the Entomological department Mr. R. C. Holden obtained first prize, and Miss Rose Edwards took second honours.

The proeeedings were brought to a close by addresses from from Sir J. W. Dawson, and Dr. Hunt. The party departed from Abbottsford at six o'clock, and arrived in the city at nine, after having passed one of the most enjoyable and instructive exploring days in the annals of the Natural History Society. The success of the event was largely due to Mr. Chas. Gibb, who was untiring in his exertions, and whose services were deservedly recognized by the Council in a special resolution of thanks at its meeting in June.

The Society has decided to hold its next Field Day at St. Hilaire, on the 5th of June, and it is hoped that it will be as successful as the last.

The Sommerville lectures—seven in number—were delivered in the following order:—Feb. 4th, "Antiseptics and Disinfectants," by Alfred H. Mason, Esq , F.C.S., F.S.Sc.; Feb. 11th, "The Chalk Formation," by Rev. W. J. Smyth, M.A., Ph. D.; Feb. 18th, "The Source of Igneous Rocks," by Thos. Macfarlane, Esq., F.R.S.C.; Feb. 25th, "The Chemistry of Bread and other Farinaceous Foods," by Casey A. Wood, C.M., M.D.,; March 4th, "Cotton and Cotton Manufactures," by William Hobbs, Esq.; March 11th, "Breathing and Ventilation," by J. B. McConnell, M.D.; March 18th, "The History of a Modern Volcano," by Sir William Dawson, LL.D., F.R.S.

The attendance at the lectures was large, and the thanks of the Society are due to the gentlemen who favoured the public with such an interesting series.

The Council takes great pride in being able to record the election of our worthy President, Sir J. William Dawson, to the Presidency of the British Association for the Advancement of Science, which meets in Birmingham this year, and whose session will therefore be watched with the greatest interest by Canadians.

The Council in conclusion ventures to express the earnest hope that the Society in the near future will receive the abundant support of the public.

The Report of tbe Honorary Curator, Mr. A. H. Mason, was then read.

REPORT OF HONORARY CURATOR.

The following donations have been made to the Museum during the session of 1885-86:—

Presented by	
John H. R. Molson, Esq.	Teeth of Carcharodon, " " Oxyrhina, and Vertebræ of Fishes, found in the Phosphate (Eocene) Beds near Charleston, South Carolina. Egg of an Alligator, from Jacksonville, Florida.
T. D. Watson, Esq., through Dr. T. Sterry Hunt.	Specimen of Walking-stick, *Spectrum femoranthum* (Say). A dipterous Insect, (*Pyrgota undata*) (Weidman).
Wm. G. Oswald, Esq.	A curiosity of vegetation in the form of a natural budding or grafting by the interlacing of Beech-root branches.
Dr. Wolfred Nelson.	A series of Photographs made in the Republic of Guatemala, in Central America. A Collection of Central American Pottery.

The work of re-arranging and classifying the American birds is nearly completed, the specimens being arranged, and only labelling requiring completion. The work has been done according to Ridgeway's American Classification, which is that adopted by the Smithsonian Institution.

It is proposed during the recess to complete a catalogue of the objects in the Museum, and to label the different departments in a more conspicuous manner. By this means it is hoped that greater interest will be taken in the museum by the general public and visitors to the city, it being a matter of regret to your Committee that so few avail themselves of the privilege offered.

If some arrangement could be arrived at by which the Janitor may present an appearance more in accordance with the idea that he is the person to show visitors over the museum, during the hours which it is open to them, than is now provided, it might add to the credit of the Society, or if a telephone was added to the building by which means the Hony. Curator could be communicated with in case any visitor of importance called, it might be one remedy. Such an addition would facilitate also the convenience of other officers, enabling them to spend more time on the premises, if they knew they were within call elsewhere.

I would also suggest that a visitor's book be provided, and every person visiting the Museum be required to sign it.

The report of the Library Committee was next read by Mr. J. A. U. Beaudry, being as follows:—

ANNUAL REPORT OF THE LIBRARY COMMITTEE.

Your committee have to report that although the meetings held during the session have not been very numerous, considerable progress has been made in improving the condition of the library. The meetings have been characterized by the utmost unanimity, mutual good-will and devotion to the interests of the Society, and although the work of arrangement is not yet complete, the results, so far, can scarcely fail to prove satisfactory.

Agreeably to instructions, and with the funds placed at our disposal for the purpose by the Council, a classified Catalogue of the books and pamphlets has been prepared by Mr. Charles Robb, who has been assiduously occupied during the last three or four months with this work, and is still engaged in the arrangement of the books on the shelves of the library. Unfortunately, owing to the great number of missing parts and of volumes not yet bound, this work has been greatly retarded; but steps have been taken to complete, as far as possible, and at the least expense, the sets of the more important scientific periodicals; and a contract was given out, at the last meeting of the committee, for binding such as can be completed, as well as some other volumes urgently requiring it.

The stipulated amount for preparing the catalogue has been paid; but that for arranging the books on the shelves &c., replacing the missing parts and superintending the binding has not yet been settled, as the work is still in progress. The committee have also called for tenders for printing the catalogue, and the proposals have been submitted to the Council.

Mr. Robb reports that the number of books in the library, including those about to be bound, is upwards of 3,000, and of pamphlets which it is not at present intended to bind, about half that number in addition. It is proposed to classify and deposit the unbound pamphlets in cases which have been ordered for the purpose.

Apart from the current scientific periodicals, which are very fairly represented, there is in the library a very considerable number of rare books, chiefly valuable for their antiquity, which have hitherto been, for the most part, buried in the lower cases, but are now transferred to the shelves and may prove an attractive feature.

A list of duplicates in the library, consisting of 43 volumes, bound or in boards, and 284 pamphlets and parts of periodicals has been printed; and a list of deficiencies has been prepared, so as to enable the Society to dispose of the duplicates and to fill up the deficiencies by purchase or exchange as the case may be. Mr. Robb is now engaged in distributing these lists.

Your committee have not yet prepared the regulations for the use of the books in the library, as their arrangement in the shelves is not yet complete; and it has been thought advisable to defer the matter until the new committee shall have assumed office, when they could probably be printed in their appropriate connection with the catalogue.

The following is a list of donations to the library during the session now coming to a close, not including, however, the parts or numbers of scientific periodicals, transactions &c., usually received in exchange for the "Record."

LIST OF DONATIONS.

From the U.S. Department of the Interior—Geological Survey,
Monographs Vols. III. V. VIII.
Two Atlases.
Third, Fourth and Fifth Annual Reports.
Mineral Resources for 1883-84.
Older Mesozoic Flora of Virginia.
International Polar Expedition to Alaska.
Smithsonian Institution.—Report for 1883.
Bulletin of U.S. Fish Commission 1885.
British Association.—Report of Montreal Meeting, 1884.
Montreal Committee.—Canadian Economics.
H. Carvell Lewis Esq.— "On Marginal Kames."
"On the discovery of a Mastodon's Remains."
"On the Progress of Mineralogy."
"On a great Trap Dyke in S. E. Pennsylvania."
Brookville Society of Nat. His.—Bulletin.
Dr. Perisfor Fraser. — "Archaean-Palæozoic contact near Philadelphia."
Dr. G. M. Dawson.— "Superficial Deposits in vicinity of Bow and Belly Rivers."
J. A. U. Beaudry Esq.— Cassil's Natural History and 3 vols. Engineering News.
28 Blue books, Reports of Goverment Departments &c.
Dr. T. S. Hunt.— "Chemical and Geological Essays."
"Azoic Rocks and Trap Dykes of S. E. Pennsylvania."
Thos. Macfarlane Esq.—A collection of Essays and Reports in bound volume.
E. T. Chambers Esq.—Marcou on the Rocks of the Jura. 2 vols.
J. H. Bartlett Esq.—"Manufacture and Statistics of Iron and Coal in Canada."
Charles Robb Esq.--Explorations and Surveys, Railroad Mississippi to Pacific. Vol. XI.
Figures and Descriptions, (Decades) Hall's Graptolites. 3 vols.
Transactions American Inst. Mining Engineers. 3 vols.
Mr. Walter Shanly's Report on Ottawa and French River Navigation.
Sir W. Logan's Esquisse Geologique du Canada. Full bound.
Chart of Geological Formations. Mounted on cloth.
Hind's Report on the Waverley Gold district, Nova Scotia.
Desor on the retrocession of Niagara Falls, with plates.
Newfoundland Geological Survey Reports.
Sir Wm. Dawson's Air-breathers of the Coal period and 4 other pamphlets.

Index and Maps to Pallisser's Report on the North West.
Cox's Report and Atlas of Geological Survey of Indiana.
David Dale Owen's do do Wisconsin.
Foster and Whitney's do Lake Superior.
Thomas Macfarlane "To the Andes."
Richard Brown "Coal Fields and Coal Trade of Cape Breton."
Walter Johnson on American and B. N. A. Coals. 2 vols.
Sandford Fleming's Intercolonial Railway Report.
T. C. Keefer's Miscellaneous Reports, Lectures &c. 2 vols.
Atlas to "Geology of Canada 1863."
Proceedings of Nova Scotia Institute. 6 parts.

Dr. Hingston.—On the Climate of Canada.
John Macoun Esq.—Catalogue of Canadian Plants.
Geological Survey.—Report of Progress for 1882-83-84, with maps of Canada.
Label List of Insects of the Dominion of Canada.
"Osteology of Alma Calvia."

The following Report of the Editing Committee was then submitted :—

REPORT OF THE EDITING COMMITTEE.

During the past year, the work of the Editing Committee has presented somewhat more than the uusal duties. Upon assuming office in May, 1885, the editors found the RECORD OF SCIENCE in a somewhat neglected condition, and showing a serious arrearage of regular issues.

During the summer, however, all the numbers of the first volume were brought up to date, and with the October number, the Journal began to appear at the proper time. Owing to the many changes required in the first four numbers, it was deemed wise to make the first volume contain four numbers only, and commence the second volume with the January issue of the present year. Several changes have been made in style and general appearance, all of which, it is hoped, will commend themselves to the Society and to subscribers.

Under arrangements with a new publisher, the work has been much more promptly and satisfactorily performed, and so long as equal satisfaction is given, the Committee would urge no further change in this direction. It was also found desirable to relieve the regular Committee of the burden of editorial work, for which purpose a paid editor has been employed. In most respects, this plan has proved satisfactory, though it will doubtless be well to further modify and improve the working of the Committee in this direction, particularly if additional funds become available.

An effort has been made to offset a certain portion of expense of publication, by the insertion of advertisements. Very little encouragement has been met with, or is to be hoped for in this direction, the three advertisements so far obtained, not returning very large profits.

One of the most important works of the Committee has been in extending the list of exchanges. Many former exchanges were found to have dropped off entirely. Most of these have once more been placed on our list and are regularly received, while a large number of new ones have been added, so that the list now embraces 178 regular exchanges in all parts of the world including some of the most important scientific journals published.

The work of the Society was chiefly represented in the publication of the Record of Science, and the Committee trust every effort will be made to continue its publication under competent management. It has been our endeavour to make it a representative Journal of Canadian Science, but the very many difficulties encountered, have often rendered it impossible to properly approach this ideal. One of the great difficulties is found in securing papers of a proper character. This might be overcome, to a large extent, were the incoming editorial committee to be composed of a paid editor, who should be primarily and chiefly responsible, and and four associate editors representing different branches of Science. The work of necessity falls upon one or two at most, before the printer is reached, and it is most desirable that every editor, or associate editor, should be capable of passing judgment upon articles in his particular department, as well as able to contribute original articles.

The Treasurer, Mr. P. S. Ross, then read the following Report :—

Report of Treasurer.

Annexed I beg to present a detailed statement of the financial affairs of the Society during the past year.

The year commenced with a balance on hand of $267.41 and ends with cash in hand amounting to $232.44, but there are outstanding accounts which will absorb this balance.

The subscriptions from members show a list of one hundred and thirty paying members.

The excursion of 1885 yielded a surplus of $35.50, besides a sum of $20 specially donated, to be distributed in prizes among the excursionists.

The rent from the rooms has been largely in excess of that obtained in previous years.

A special subscription list for binding books for library purposes has been opened, and so far about $55 have been subscribed, which, it is hoped, will be materially increased. It will be observed that the publication of the Record of Science makes a considerable draft on our funds, and in addition to the amount shown in the statement, there are outstanding claims against it of about $200.

Annual Statement of Treasurer (Mr. P. S. Ross) for 1885–6.

Receipts.

Balance from last year		$ 267 41
Rents	$ 919 00	
Subscriptions	515 00	
Excursions $160.50; less paid out $125.00	35 50	
Donations—Excursions, Joseph $5, Dawson $5, Molson $10 .... $20.00		
Less paid for prizes $20.00		
Do. Binding	10 00	
Do. Plumbing per Costigan	6 40	
Life membership, G. Sumner	50 00	
		$ 1,535 90
		$ 1,803 31

DISBURSEMENTS.

Printing and advertising	$ 181 98
Taxes	137 30
Repairs $170.81; less allowed by church $30	140 81
Tools	23 45
Fuel	110 40
Light	72 60
Insurance	15 00
Salaries, commissions and office charges, J. Potts $282.20, J. Foote $34.48, sundries $28	344 68
Record of Science, salary of editor	121 55
Do. printing	185 00
Catalogue for library per C. Robb	50 00
Furniture, chairs purchased	9 00
In hands of caretaker for petty expenses	25 00
Postage, stationery, &c	92 17
Cleaning, per caretaker's account	37 75
Sundry petty expenses	18 68
Freight on books	5 50
Balance on hand	232 44
	$ 1,803 31

Audited and found correct.

J. S. SHEARER,
W. T. COSTIGAN.

It was resolved that the foregoing reports be received, adopted and printed in the RECORD OF SCIENCE.

The President called upon Messrs. W. F. Ferrier and F. B. Caulfield to act as scrutineers.

On motion, the rules were suspended, and Sir J. William Dawson, re-elected President by acclamation.

The rules were further suspended when Alfred Hy. Mason was re-elected Honorary Curator, P. S. Ross, Honorary Treasurer, Professor Penhallow, Honorary Corresponding Secretary, and William T. Costigan, Honorary Recording Secretary.

On a ballot being taken for Vice-Presidents, the following gentlemen were declared elected:—

T. Sterry Hunt, LL.D., F.R.S., Sir D. A. Smith, J. H. R. Molson, J. H. Joseph, Edward Murphy, B. J. Harrington, Ph. D., F.R.S.C., W. H. Hingston, M.D., D.C.L., J. Baker Edwards, Ph. D., D.C.L., and Major L. H. Latour, M.A.

The ballot for members of Council resulted as follows:—

J. S. Shearer, Geo. Sumner, Joseph Bemrose, J. A. U. Beaudry, M. H. Brissette, A. T. Drummond, J. T. Donald. J. B. McConnell, M.D., and Rev. Robert Campbell, M.A.

The Library Committee was elected as follows:—

J. A. Beaudry, H. R. Ives, E. T. Chambers, F. B. Caulfield and J. H. Burland.

The President complimented the retiring officers on the efficient manner in which they had performed their duties.

On motion, an enthusiastic vote of thanks was passed to the President.

The chairman of the Excursion Committee roported the completion of arrangements for the Annual Field Day at Belœil Mountain on June 5th, 1886.

ANNUAL FIELD DAY.

The Annual Field Day of the Society was held on Saturday June 5th. The field days are always made the occasion of a very enjoyable outing for members and their friends, but that on Saturday was, in the opinion of those present, one of the most successful ever held under the auspices of the Society. The destination this year was Belœil Mountain, and about 150 ladies and gentlemen, including not only members of the Natural History Society, but also several members of the Montreal Microscopic Society availed themselves of the opportunity which the excursion and the delightful weather of Saturday afternoon afforded them of spending a pleasant day in the country, combining recreation with scientific research. The party left the Bonaventure depot shortly after nine o clock, among those present being Very Rev. Dean Carmichael, Dr. T. Sterry Hunt, Prof. B. J. Harrington, Dr. J. Baker Edwards, Prof Penhallow, Mr. A. H. Mason, Mr. P. S. Ross, Mr. J. S. Shearer, Mr. W. T. Costigan and Major Latour. After a pleasant hour's ride, St. Hilaire station was reached, where carriages were in waiting to convey the excursionist to the Iroquois House, which was made the headquarters for the day. After arrangements had been made for the collections and the day's programme generally, the excursionists dispersed in small parties, some to make collections and others to enjoy themselves in various ways. They most of them ultimately reached the summit of Belœil mountain, where lunch was partaken of, after which the Very Rev. Dean Carmichael delivered a short address, in the course of which he alluded to the peculiar associatious of the spot connected with the cross which was erected in 1841 by Bishop Forbin Jansen of Nancy, and to the interesting fact that on that occasion about ten thousand people assembled on the shores of the lake, and that the bishop entered a boat and from the waters of the lake preached a sermon to them. Dr. Edwards also made a few remarks, chiefly referring to the former excursion of the society in 1869, and calling attention to the address made by Sir William Dawson on that occasion, relating to the geology of the region.

The party returned to the hotel at three o'clock where they were provided with a hot lunch, after which the collections were examined and the prizes awarded. Dr. Hunt briefly addressed the party with reference to the peculiar geological features of the region. The mountain, he said, is of volcanic origin. It and its companion mountains were, so to speak, the roots of volcanoes that had been formed in a very early geological age. The mountains being of harder material than the strata which surrounded and covered them, resisted the action of the eroding agencies that levelled the plain and remained like bosses on its surface after the softer rocks had been worn and washed away. Their precise age could not be ascertained, but they were formed before there were any air breathing animals on the surface of the earth. By the slow and modifying action of the elements the beautiful region seen from the mountain's top was prepared for the habitation of man, who at last appeared upon the scene to enter into possession.

The prizes were awarded as follows:—

Named plants—1, Miss Van Horne.

Unnamed plants—1, Miss O. G. Ritchie; 2, Miss Burland.

Unnamed insects—1, Mr. R. C. Holden; 2, Miss Maud Brewster.

The following were deemed worthy of honorary mention for their collections :—Miss McLea, Miss Reid, Master Eric Harrington and Master W. H. Shearer.

Dr. Harrington took several readings of the barometer at the hotel and on the summit of the mountain, and from these it was estimated that the summit of the mountain was about 850 feet above the hotel, and nearly 1,300 above the railway at St. Hilaire station.

MISCELLANEOUS.

MINERALOGICAL NOTES.—At the February meeting of the Natural History Society, Dr. Harrington called attention to a number of points in connection with the forms, mode of occurrence, &c., of certain Canadian minerals. One of the species noticed was beryl, a mineral of somewhat rare occurrence in Canada. It was first found by the late Dr. Bigsby at the east side of Rainy Lake, 230 miles north of Lake Superior, occurring in well defined, pale green crystals in a porphyritic granite. †

According to the Rev. Prof. Laflamme, crystals of beryl as much as twelve to fifteen inches long and three inches or more in diameter occur in the township of Jonquières, on the Saguenay. ‡

Another locality more recently discovered and which it is worth while putting upon record is on lots 1 and 2 of the second range of Maisonneuve, Berthier county, P. Q. The specimens from this place are irregular masses and rough crystals, sometimes of considerable size. They evidently occur in a coarse granite vein containing quartz, orthoclase, a trichinic feldspar which shows play of colour in places, muscovite, garnet, tourmaline and samarskite? The locality is said to be the same as that from which the samarskite, analysed by Mr. Hoffmann, was derived §. The muscovite is said to occur in plates of considerable size and in quantity sufficient to be available for economic purposes.

Attention was also called to the remarkably fine crystals of molybdenite obtained by Mr. R. H. G. Chapman from the township of Aldfield, in Pontiac county, P.Q. They are short hexagonal crystals which, if regarded as belonging to the hexagonal system, consist of a hexagonal pyramid and the end face sometimes also with faces of the hexagonal prism. The angle between the end

† Geol. of Can. 1863, p. 492.

‡ Rep. Geol. Survey, 1882-84, D. p. 9.

§ Rept. Geol. Survey, 1880-82. H. p. 1.

face and pyramid in the case of several crystals was found to be approximately 112°. One of the crystals exhibited at the meeting was four inches across.

A list of about twenty localities in Canada where molybdenite has been found was given, many of them being taken from the reports of the Geological Survey.

Remarks were also made concerning octahedral crystals of fluor spar from the township of Hull and crystals of quartz from the township of Portland, P. Q. Some of the latter are interesting on account of their being terminated at one end by a single rhombohedron while at the other end both the plus and minus rhombohedrons are well developed.

Chemical—*Algin and Alginic Acid.*—After exposure to rain, the long fronds of *Laminaria stenophylla* are observed to be swollen and tumid, sacs of fluid being formed from endosmosis of water through the membrane, dissolving a peculiar glutinous body. If these sacs be cut, a neutral, glairy fluid escapes, which may be often seen partially evaporated on the frond as a colourless jelly. This substance, to which Mr. Ed. C. C. Stanford, F.C.S., has given the name *Algin*, contains calcium, magnesium, and sodium, in combination with a new acid which he has called *Alginic acid*.

Algin, when evaporated to dryness, becomes insoluble in water, but is very soluble in alkalies; it is so abundant in the plant that on maceration for twenty-four hours in cold sodium carbonate solution, the tissue is completely disintegrated, forming a thick solution having *fourteen times* the viscosity of starch and *thirty-seven times* that of gum arabic. It is coagulated by alcohol, acetone and collodion, but not by ether and precipitated by mineral acids, various salts, and by lime water and baryta water.

It differs from albumen in not being coagulated by heat and from gelose in not gelatizing on cooling, by containing nitrogen, by dissolving in weak alkaline solutions, and by its insolubility in boiling water. From gelatin it differs by not reacting with tannin, and from starch by giving no colour with iodine; whilst its insolubility in dilute alcohol and dilute mineral acids renders it unlike gum arabic, pectin, tragacanth, and dextrin. It precipitates the salt of the alkaline earths, with the exception of magnesium, and also the salts of the metals, but it gives no precipitates with mercuric chloride nor with potassic silicate.

The uses to which Mr. Stanford proposes to apply the Algin are, first—In sizing fabrics, a solution of sodium alginate imparting to cloth and paper an elastic feeling, without the stiffness of starch. 2nd: Containing about the same amount of nitrogen as Dutch cheese (3.77 per cent.), and having a pleasant, marine taste, it may form a useful addition to the means of thickening soups, etc., in the kitchen. 3rd. By mixing $\frac{1}{10}$ per cent. with the water supplied to boilers, a calcium deposit is formed, which may be easily blown off, thereby preventing troublesome incrustations. 4th. Mixed with gelatine it may replace gum arabic in the manufacture of lozenges and jujubes.

Alginic acid may be separated from its sodium salt by means of hydrochloric acid; a little bleach will render it white, and it may be separated by filtration and pressure and obtained in the form of a cake, in which state it can be kept for any length of time in a cool, dry place.

Analysis of the alginates shows that the formula of the acid is $C_{76}\ H_{80}\ N_2\ O_{22}$ which may be written thus:—

$$N_2 \begin{cases} H_2 \\ H_2 \\ C_{76}\ H_{76}\ O_{22} \end{cases}$$

as a diamide.

It is a nitrogenous acid, extremely retentive of water, taking up over 98 per cent. and it dries up to a horny substance resembling albumen, with a s. g. of 1.534 (the s. g. of ivory nut is only 1.376) in which state it can be turned and polished. It is easily obtained in thin transparent sheets, which possess considerable tenacity and in this form it is useful for tying over pots and jars. The sheets may be readily coloured blue, red, &c., resembling the coloured sheets of gelatine, but unlike them are not affected by water. Alginic acid is a moderately strong acid, displacing carbonic acid from the alkalies and earthy carbonates. The soluble alginates (sodium, potassium, ammonium, lithium and magnesium) have all an acid reaction. Some of the insoluble alginates are very soluble in ammonia, with which they seem to form double salts.

The aluminum alginate, for instance, is very soluble in ammonia, but becomes when dried again insoluble, and forms a cheap water varnish, and an efficient glaze for paper and cloth. It is quite neutral.

Shellac is dissolved by the alkaline alginates, the ammonium solution, when evaporated, forming a thin, tenaceous film, quite soluble in water, but which after being passed through a bath of dilute hydrochloric acid is insoluble. The compound then resembles sheet guttapercha, and it is thought might replace that substance for surgical dressings. Remembering the great brittleness of shellac, which destroys its value for many purposes, no one would suspect its presence in such quantity in this very pliable sheet.

Many other resinous bodies may also be incorporated in a similar manner with a soluble alginate and then rendered insoluble.

Alginic acid also combines with many alkaloids, forming soluble films, some of which may be useful in medicine, but none have as yet been fully investigated. Compounds have been obtained and exhibited by Mr. Stanford of alginic acid with quinine, chinoleine &c., about which he promises further reports.—*Journal Soc. Chem. Industry.*

THE

CANADIAN RECORD

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Presidential Address before the British Association for the Advancement of Science, Sept. 1886.

By Sir J. William Dawson,

C.M.G., M.A., LL.D., F.R.S., F.G.S., Principal and Vice-Chancellor of McGill University, Montreal, Canada.

Twenty-one years have passed away since the last meeting of the British Association in this great central city of England. At the third Birmingham meeting—that of 1865—I had the pleasure of being present, and had the honour of being one of the Vice-Presidents of the Geological Section. At that meeting, my friend John Phillips, one of the founders of the Association, occupied the Presidential chair, and I cannot better introduce what I have to say this evening than by quoting the eloquent words with which he then opened his address :—'Assembled for the third time in this busy centre of industrious England, amid the roar of engines and clang of hammers, where the strongest powers of nature are trained to work in the fairy chains of art, how softly and fittingly falls upon the ear the accent of science, the friend of that art, and the guide of that industry! Here where Priestley analysed the air, and Watt obtained the mastery over steam, it well becomes the students of nature to gather round the standard which they carried so far into the fields of knowledge. And when on other occasions we meet in quiet colleges and academic halls, how gladly welcome is the union of fresh discoveries and new inventions with the solid and venerable truths which are there treasured and taught. Long may such union last; the fair alliance of cultivated thought and practical skill; for by it, labour is dignified and science fertilised, and the condition of human society exalted.' These were the words of a man who, while earnest in the pursuit of science, was full of broad and kindly sympathy for his fellow-men and of hopeful confidence in the future. We have but to turn to the twenty Reports of this Association, issued since 1865, to see the realisation of that union of science and art to which he so confidently looked forward, and to appreciate the stupendous results which it has achieved. In one department alone—that to which my predecessor in this chair so eloquently adverted in Aberdeen, the department of education in science—how much has been accomplished since 1865. Phillips himself lived to see a great revolution in this respect at Oxford. But no one in 1865 could have anticipated that immense development of local schools of science of which your own Mason College and your admirable technical, industrial, and art schools are eminent examples. Based on the general education given by the new system of Board schools, with which the name of the late W. E. Forster will ever be honourably connected, and extending its influence upward to special training, and to the highest university examinations, this new scientific culture is opening paths of honourable ambition to the men and women of England scarcely dreamed of in 1865. I sympathise with the earnest appeal of Sir Lyon Playfair, in his Aberdeen address in favour of scientific education; but visiting England at rare intervals, I am naturally more impressed with the progress that has been made than with the vexatious delays which have occurred, and I am perhaps better able to appreciate the vast strides that have been taken in the direction of that complete and all-pervading culture in science which he has so ably advocated.

No one could have anticipated twenty years ago that a Birmingham manufacturer, in whose youthful days there were no schools of science for the people, was about to endow a college, not only worthy of this great city, but one of its brightest ornaments.[1] Nor could any-one have foreseen the great development of local scientific societies, like your Midland Institute and Philosophical Society, which are now flourishing in every large town and in many of those of less magnitude. The period of twenty-one years that has elapsed since the last Birmingham meeting has also been an era of public museums and laboratories for the teaching of science, from the magnificent national institutions at South Kensington and those of the great universities and their colleges down to those of the schools and field clubs in country towns. It has, besides, been an era of gigantic progress in original work, and in publication,—a progress so rapid that workers in every branch of study have been reluctantly obliged to narrow more and more their range of reading, and of effort to keep abreast of the advance in their several departments, Lastly, these twenty-one years have been characterised as the 'coming of age' of that great system of philosophy with which the names of three Englishmen, Darwin, Spencer, and Wallace, are associated as its founders. Whatever opinions one may entertain as to the sufficiency and finality of that philosophy, there can be no question as to its influence on scientific thought. On the one hand, it is inaccurate to compare it with things so entirely different as the discovery of the chemical elements and of the law of gravitation. On the other, it is scarcely fair to characterise it as a mere 'confused development' of the mind of the age. It is indeed a new attempt of science in its maturer years to

[1] It was in 1865 that Sir Josiah Mason was, quietly and without any public note, beginning to lay the foundation of his orphanage at Erdington.

grapple with those mysterious questions of origins which occupied it in the days of its infancy, and it is to be hoped that it may not, like the Titans of ancient fable, be hurled back from heaven, or like the first mother find the knowledge to which it aspires a bitter thing. In any case we should fully understand the responsibility which we incur when in these times of full-grown science we venture to deal with the great problem of origins, and should be prepared to find that in this field, the new philosophy, like those which have preceded it, may meet with very imperfect success. The agitation of these subjects has already brought science into close relations, sometimes friendly, sometimes hostile, it is to be hoped in the end helpful, with those great and awful questions of the ultimate destiny of humanity, and of its relations to its Creator, which must always be nearer to the human heart than any of the achievements of science on its own ground. In entering on such questions, we should proceed with caution and reverence, feeling that we are on holy ground; and that though, like Moses of old, we may be armed with all the learning of our time, we are in the presence of that which, while it burns, is not consumed; a mystery which neither observation, experiment, nor induction can ever fully solve.

In a recent address, the late President of the Royal Society called attention to the fact that within the lifetime of the older men of science of the present day, the greater part of the vast body of knowledge included in the modern sciences of physics, chemistry, biology, and geology, has been accumulated, and the most important advances made in its application to such common and familiar things as the railway, ocean navigation, the electric telegraph, electric lighting, the telephone, the germ theory of disease, the use of anæsthetics, the processes of metallurgy, and the dyeing of fabrics. Even since the last meeting in this city, much of this great work has been done, and has led to general results of the most marvellous kind. What at that time could have appeared more chimerical than the opening up, by the enterprise of one British colony, of a shorter road to the east by way of the extreme west, realizing what was happily called by Milton and Cheadle 'the new North-west Passage,' making Japan the next neighbour of Canada on the west, and offering to Britain a new way to her Eastern possessions; or than the possibility of this Association holding a successful meeting on the other side of the Atlantic? To have ventured to predict such things in 1865, would have appeared quite visionary, yet you are now invited to meet in Australia, and may proceed thither by the Canadian Pacific Railway and its new lines of steamers, returning by the Suez Canal.[1] To-day this is quite as feasible as the Canadian visit would have been in 1865. It is science which has thus brought the once widely separated parts of the world nearer to each other, and which is breaking down those geographical barriers which have separated the different portions of our widely extended British race. Its work in this is not yet complete. Its goal to-day is its starting-point to-morrow. It is as far as at any previous time from seeing the limit of its conquests; and every victory gained is but the opening of the way for a farther advance.

By its visit to Canada, the British Association has asserted its imperial character, and has consolidated the scientific interests of Her Majesty's dominions, in advance of that great gathering of the industrial products of all parts of the empire now on exhibition in London, and in advance of any political plans of imperial federation. There has even been a project before us for an international scientific convention, in which the great English republic of America shall take part, a project, the realisation of which was to some extent anticipated in the fusion of the members of the British and American Associations at Montreal and Philadelphia in 1884. As a Canadian, as a past President of the American Association, and now honoured with the Presidency of this Association, I may be held to represent in my own person the scientific union of the British Islands, of the various Colonies and of the great Republic, which, whatever the difficulties attending its formal accomplishment at present,

[1] It is expected that, on the completion of the connections of the Canadian Pacific Railway, the time from ocean to ocean may be reduced to 116 hours, and from London to Hong Kong to twenty-seven days.

is certain to lead to an actual and real co-operation in scientific work. In furtherance of this, I am glad to see here to-day influential representatives of most of the British Colonies, of India, and of the United States. We welcome here, also, delegates from other countries; and though the barrier of language may at present prevent a larger union, we may entertain the hope that Britain, America, India, and the Colonies, working together in the interest of science, may ultimately render our English tongue the most general vehicle of scientific thought and discovery, a consummation of which I think there are, at present, many indications.

But, while science marches on from victory to victory, its path is marked by the resting-places of those who have fought its battles and assured its advance. In looking back to 1865, there rise before me the once familiar countenances of Phillips, Murchison, Lyell, Forbes, Jeffreys, Jukes, Rolleston, Miller, Spottiswoode, Fairbairn, Gassiot, Carpenter, and a host of others, present in full vigor at that meeting, but no more with us. These were veterans of science; but, alas! many then young and rising in fame are also numbered with the dead. It may be that before another Birmingham meeting, many of us, the older members now, will have passed away. But these men have left behind them ineffaceable monuments of their work, in which they still survive, and we rejoice to believe that, though dead to us, they live in the company of the great and good of all ages who have entered into the unseen universe where all that is high and holy and beautiful, must go on accumulating till the time of the restitution of all things. Let us follow their example and carry on their work, as God may give us power and opportunity, gathering precious stores of knowledge and of thought, in the belief that all truth is immortal, and must go on for ever bestowing blessings on mankind. Thus will the memory of the mighty dead remain to us as a power which—

> "Like a star
> Beacons from the abode where the eternal are."

I do not wish, however, to occupy your time longer with general or personal matters, but rather to take the opportunity afforded by this address to invite your attention to some topics of scientific interest. In attempting to do this, I must have before me the warning conveyed by Professor Huxley, in the address to which I have already referred, that in our time, science, like Tarpeia, may be crushed with the weight of the rewards bestowed on her. In other words, it is impossible for any man to keep pace with the progress of more than one limited branch of science; and it is equally impossible to find an audience of scientific men of whom anything more than a mere fraction can be expected to take an interest in any one subject. There is, however, some consolation in the knowledge that a speaker who is sufficiently simple for those who are advanced specialists in other departments, will of necessity be also sufficiently simple to be understood by the general public who are specialists in nothing. On this principle, a geologist of the old school, accustomed to a great variety of work, may hope so to scatter his fire as to reach the greater part of the audience. In endeavouring to secure this end, I have sought inspiration from that ocean which connects rather than separates Britain and America, and may almost be said to be an English sea—the North Atlantic. The geological history of this depression of the earth's crust, and its relation to the continental masses which limit it, may furnish a theme at once generally intelligible and connected with great questions as to the structure and history of the earth, which have excited the attention alike of the physicists, geologists, biologists, geographers and ethnologists. Should I, in treating of these questions, appear to be somewhat abrupt and dogmatic, and to indicate rather than state the evidence of the general views announced, I trust you will kindly attribute this to the exigencies of a short address.

If we imagine an observer contemplating the earth from a convenient distance in space, and scrutinizing its features as it rolls before him, we may suppose him to be struck with the fact that eleven-sixteenths of its surface are covered with water, and that the land is so unequally distributed that from one point of view he would see a hemisphere almost exclusively oceanic, while nearly the whole of the dry land is gathered in the opposite hemisphere. He might observe that the great oceanic area of the Pacific and Antarctic Oceans is dotted with islands—like a shallow pool with stones rising above its surface—as if its general depth were small in comparison with its area. He might also notice that a mass or belt of land surrounds each pole, and that the northern ring sends off to the southward three vast tongues of land and of mountain chains, terminating respectively in South America, South Africa, and Australia, towards which feebler and insular processes are given off by the Antarctic continental mass. This, as some geographers have observed,[1] gives a rudely three-ribbed aspect to the earth, though two of the ribs are crowded together and form the Europ-asian mass or double continent, while the third is isolated in the single continent of America. He might also observe that the northern girdle is cut across, so that the Atlantic opens by a wide space into the Arctic Sea, while the Pacific is contracted toward the north, but confluent with the Antarctic Ocean. The Atlantic is also relatively deeper and less cumbered with islands than the Pacific, which has the higher ridges near its shores, constituting what some visitors to the Pacific coast of America have not inaptly called the 'back of the world,' while the wider slopes face the narrower ocean, into which, for this reason, the greater part of the drainage of the land is poured.[2] The Pacific and Atlantic, though both depressions or flattenings of the earth, are, as we shall find, different in age, character, and conditions; and the Atlantic, though the smaller, is the older, and, from the geological point of view, in some respects, the more important of the two.

If our imaginary observer had the means of knowing anything of the rock formations of the continents, he would notice that those bounding the North Atlantic are, in general, of great age—some belonging to the Laurentian system.

[1] Dana, *Manual of Geology*, introductory part. Green, *Vestiges of a Molten Globe*, has summed up these facts.

[2] Mr. Mellard Reade, in two Presidential addresses before the Geological Society of Liverpool, has illustrated this point and its geological consequences.

On the other hand, he would see that many of the mountain ranges along the Pacific are comparatively new, and that modern igneous action occurs in connection with them. Thus he might be led to believe that the Atlantic, though comparatively narrow, is an older feature of the earth's surface; while the Pacific belongs to more modern times. But he would note, in connection with this, that the oldest rocks of the great continental masses are mostly toward their northern ends; and that the borders of the northern ring of land, and certain ridges extending southward from it, constitute the most ancient and permanent elevations of the earth's crust, though now greatly surpassed by mountains of more recent age nearer the equator.

Before leaving this general survey we may make one further remark. An observer, looking at the earth from without, would notice that the margins of the Atlantic and the main lines of direction of its mountain chains are north-east and south-west, and north-west and south-east, as if some early causes had determined the occurrence of elevations along great circles of the earth's surface tangent to the polar circles.

We are invited by the preceding general glance at the surface of the earth to ask certain questions respecting the Atlantic. (1) What has at first determined its position and form? (2) What changes has it experienced in the lapse of geological time? (3) What relations have these changes borne to the development of life on the land and in the water? (4) What is its probable future?

Before attempting to answer these questions, which I shall not take up formally in succession, but rather in connection with each other, it is necessary to state, as briefly as possible, certain general conclusions respecting the interior of the earth. It is popularly supposed that we know nothing of this beyond a superficial crust perhaps averaging 50,000 to 100,000 feet in thickness. It is true we have no means of exploration in the earth's interior, but the conjoined labours of physicists and geologists have now proceeded sufficiently far to throw much inferential light on the subject, and to enable us to make some general affirmations with certainty; and these it is the more necessary to state distinctly, since they are often treated as mere subjects of speculation and fruitless discussion.

(1) Since the dawn of geological science, it has been evident that the crust on which we live must be supported on a plastic or partially liquid mass of heated rock, approximately uniform in quality under the whole of its area. This is a legitimate conclusion from the wide distribution of volcanic phenomena, and from the fact that the ejections of volcanoes, while locally of various kinds, are similar in every part of the world. It led to the old idea of a fluid interior of the earth, but this is now generally abandoned, and this interior heated and plastic layer is regarded as merely an under-crust.

(2) We have reason to believe, as the result of astronomical investigations, [1] that, notwithstanding the plasticity or liquidity of the under-crust, the mass of the earth—its nucleus as we may call it—is practically solid and of great density and hardness. Thus we have the apparent paradox of a solid yet fluid earth; solid in its astronomical relations, liquid or plastic for the purposes of volcanic action and superficial movements. [2]

(3) The plastic sub-crust is not in a state of dry igneous fusion, but in that condition of aqueo-igneous or hydrothermic fusion which arises from the action of heat on moist substances, and which may either be regarded as a fusion or as a species of solution at a very high temperature. This we learn from the phenomena of volcanic action, and from

[1] Hopkins, Mallet, Sir William Thomson, and Prof. G. H. Darwin maintain the solidity and rigidity of the earth on astronomical grounds; but different conclusions have been reached by Hennesey, Delaunay, and Airy. In America, it was taught from 1858 by Sterry Hunt, and later by Shaler and Le Conte.

[2] An objection has been taken to the effect that the supposed ellipsoidal form of the equator is inconsistent with a plastic subcrust. But this ellipsoidal form is not absolutely certain, or, if it exists, is very minute. Bonney has, in a recent lecture, suggested the important consideration that a mass may be slowly mobile under long-continued pressure, while yet rigid with reference to more sudden movements.

the composition of the volcanic and plutonic rocks, as well as from such chemical experiments as those of Daubrée and of Tilden and Shenstone.[1]

(4) The interior sub-crust is not perfectly homogeneous, but may be roughly divided into two layers or magmas, as they have been called: an upper, highly siliceous or acidic, of low specific gravity and light-coloured, and corresponding to such kinds of plutonic and volcanic rocks as granite and trachyte; and a lower, less siliceous or more basic, more dense, and more highly charged with iron, and corresponding to such igneous rocks as the dolerites, basalts, and kindred lavas. It is interesting here to note that this conclusion, elaborated by Durocher and von Waltershausen, and usually connected with their names, appears to have been first announced by John Phillips, in his 'Geological Manual,' and as a mere common sense deduction from the observed phenomena of volcanic action and the probable results of the gradual cooling of the earth.[2] It receives striking confirmation from the observed succession of acidic and basic volcanic rocks of all geological periods and in all localities. It would even seem, from recent spectroscopic investigations of Lockyer, that there is evidence of a similar succession of magmas in the heavenly bodies, and the discovery by Nordenskiöld of native iron in Greenland basalts, affords a probability that the inner magma is in part metallic.[3]

(5) Where rents or fissures form in the upper crust, the material of the lower crust is forced upward by the pressure of the less supported portions of the former, giving rise to

[1] *Phil. Trans.* 1884. Also Crosby in *Proc. Boston Soc. Nat. Hist.* 1883.

[2] Phillips, *Manual of Geology*, 1855, p. 493. Dr. Sterry Hunt has kindly directed my attention to the fact of Phillip's right of priority in this matter. Durocher in 1857 elaborated the theory of magmas in the *Annales des Mines*, and we are indebted to Dutton, of the United States Geological Survey, for its detailed application to the remarkable volcanic outflows of Western America.

[3] These basalts occur at Ovifak, Greenland. Andrews has found small particles of iron in British basalts. Prestwich and Judd have referred to the bearing on general geology of these facts, and of Lockyer's suggestions.

volcanic phenomena either of an explosive or quiet character, as may be determined by contact with water. The underlying material may also be carried to the surface by the agency of heated water, producing those quiet discharges which Hunt has named crenitic. It is to be observed here that explosive volcanic phenomena, and the formation of cones, are, as Prestwich has well remarked, characteristic of an old and thickened crust ; quiet ejection from fissures and hydro-thermal action may have been more common in earlier periods and with a thinner over-crust.

(6) The contraction of the earth's interior by cooling and by the emission of material from below the over-crust, has caused this crust to press downward, and therefore laterally, and so to effect great bends, folds, and plications ; and these, modified subsequently by surface denudation, constitute mountain chains and continental plateaus. As Hall long ago pointed out,[1] such lines of folding have been produced more especially where thick sediments had been laid down on the sea bottom. Thus we have here another apparent paradox, namely, that the elevations of the earth's crust occur in the places where the greatest burden of detritus has been laid down upon it, and where consequently the crust has been softened and depressed. We must beware, in this connection, of exaggerated notions of the extent of contraction and of crumpling required to form mountains. Bonney has well shown, in lectures delivered at the London Institution, that an amount of contraction, almost inappreciable in comparison with the diameter of the earth, would be sufficient ; and that as the greatest mountain chains are less than $\frac{1}{600}$th of the earth's radius in height, they would, on an artificial globe a foot in diameter, be no more important than the slight inequalities that might result from the paper gores overlapping each other at the edges.

(7) The crushing and sliding of the over-crust implied in these movements raise some serious questions of a physical

[1] Hall, (American Association Address, 1857, subsequently republished, with additions, as *Contributions to the Geological History of the American Continent,*) Mallet, Rogers, Dana, Le Conte, &c.

character. One of these relates to the rapidity or slowness of such movements, and the consequent degree of intensity of the heat developed, as a possible cause of metamorphism of rocks. Another has reference to the possibility of changes in the equilibrium of the earth itself as resulting from local collapse and ridging. These questions in connection with the present dissociation of the axis of rotation from the magnetic poles, and with changes of climate, have attracted some attention,[1] and probably deserve further consideration on the part of physicists. In so far as geological evidence is concerned, it would seem that the general association of crumpling with metamorphism indicates a certain rapidity in the process of mountain-making, and consequent development of heat; and the arrangement of the older rocks around the Arctic basin forbids us from assuming any extensive movement of the axis of rotation, though it does not exclude changes to a limited extent. I hope that Professor Darwin will discuss these points in his address to the Physical Section.

I wish to formulate these principles as distinctly as possible, and as the result of all the long series of observations, calculations, and discussions since the time of Werner and Hutton, and in which a vast number of able physicists and naturalists have borne a part, because they may be considered as certain deductions from our actual knowledge, and because they lie at the foundation of a rational physical geology.

We may popularise these deductions by comparing the earth to a drupe or stone-fruit, such as a plum or peach, somewhat dried up. It has a large and intensely hard stone and kernel, a thin pulp made up of two layers, an inner more dense and dark-coloured, and an outer less dense and lighter-coloured. These constitute the under-crust. On the outside it has a thin membrane or over-crust. In the process of drying it has slightly shrunk, so as to produce ridges and hollows of the outer crust, and this outer crust has

[1] See recent papers of Oldham and Fisher, in *Geological Magazine* and *Philosophical Magazine*, July 1886. Also Péroche, *Revol. Polaires.* Paris, 1886.

cracked in some places, allowing portions of the pulp to ooze out—in some of these its lower dark substance, in others its upper and lighter material. The analogy extends no farther, for there is nothing in our withered fruit to represent the oceans occupying the lower parts of the surface or the deposits which they have laid down.

Keeping in view these general conclusions, let us now turn to their bearing on the origin and history of the North Atlantic.

Though the Atlantic is a deep ocean, its basin does not constitute so much a depression of the crust of the earth as a flattening of it, and this, as recent soundings have shown, with a slight ridge or elevation along its middle, and banks or terraces fringing the edges, so that its form is not so much that of a basin as that of a shallow plate with its middle a little raised. Its true permanent margins are composed of portions of the over-crust folded, ridged up and crushed, as if by lateral pressure emanating from the sea itself. We cannot, for example, look at a geological map of America without perceiving that the Appalachian ridges, which intervene between the Atlantic and the St. Lawrence valley, have been driven bodily back by a force acting from the east, and that they have resisted this pressure only where, as in the Gulf of St. Lawrence and the Catskill region of New York, they have been protected by outlying masses of very old rocks, as, for example, by that of the island of Newfoundland and that of the Adirondack Mountains. The admirable work begun by my friend and fellow-student Professor James Nicol, followed up by Hicks, Lapworth, and others, and now, after long controversy, fully confirmed by the recent observations of the geological survey of Scotland, has shown the most intense action of the same kind on the east side of the ocean in the Scottish highlands; and the more widely distributed Eozoic rocks of Scandinavia may be appealed to in further evidence of this. [1]

[1] Address to the Geological Section, by Prof. Judd, Aberdeen Meeting, 1885. According to Rogers, the crumpling of the Appalachians has reduced a breadth of 158 miles to about 60.

If we now inquire as to the cause of the Atlantic depression, we must go back to the time when the areas occupied by the Atlantic and its bounding coasts were parts of the shoreless sea in which the earliest gneisses or stratified granites of the Laurentian age were being laid down in vastly extended beds. These ancient crystalline rocks have been the subject of much discussion and controversy, and as they constitute the lowest and probably the firmest part of the Atlantic sea-bed, it is necessary to inquire as to their origin and history. Dr. Bonney, the late President of the Geological Society, in his Anniversary address, and Dr. Sterry Hunt, in an elaborate paper communicated to the Royal Society of Canada, have ably summed up the hypotheses as to the origin of the oldest Laurentian beds. At the basis of these hypotheses lies the admission that the immensely thick beds of orthoclase gneiss, which are the oldest stratified rocks known to us, are substantially the same in composition with the upper or silicious magma or layer of the undercrust. They are, in short, its materials either in their primitive condition or merely re-arranged. One theory considers them as original products of cooling, owing their lamination merely to the successive stages of the process. Another view refers them to the waste and re-arrangement of the materials of a previously massive granite. Still another holds that all our granites really arise from the fusion of old gneisses of originally aqueous origin, while a fourth refers the gneisses themselves to molecular changes effected in granite by pressure. These several views, in so far as they relate to the oldest or fundamental Laurentian gneiss, may be arranged under the following heads: (1) *Endoplutonic*, or that which regards all the old gneisses as molten rocks cooled from without inward, in successive layers.[1] (2) *Exoplutonic*, or that which considers them as made up of matter ejected from below the upper crust in the manner of volcanic action[2]. (3) *Metamorphic*, which supposes the old gneisses to arise from the crystallisation of detrital matter spread over the sea-bottom, and either igneous or derived from the decay of

[1] Naumann, Phillips, Durocher, Macfarlane, &c.

[2] Clarence King, Tornebohm, Marr. &c.

igneous rocks.[1] (4) *Chaotic* or *Thermo-chaotic*, or the theory of deposit from the turbid waters of a primeval ocean either with or without the aid of heat. In one form this was the old theory of Werner.[2] (5) *Crenitic* or Hydro-thermic, which supposes the action of heated waters, penetrating below the crust, to be constantly bringing up to the surface mineral matters in solution and depositing these so as to form felspathic and other rocks.[3]

It will be observed, in regard to these theories, that they do not suppose that the old gneiss is an ordinary sediment, but that all regard it as formed in exceptional circumstances, these circumstances being the absence of land and of subaërial decay of rock, and the presence wholly or principally of the material of the upper surface of the recently hardened crust. This being granted, the question arises, ought we not to combine these several theories and to believe that the cooling crust has hardened in successive layers from without inward; that at the same time fissures were locally discharging igneous matter to the surface; that matter held in suspension in the ocean and matter held in solution by heated waters rising from beneath the outer crust were mingling their materials in the deposits of the primitive ocean? It would seem that the combination of all these agencies may safely be evoked as causes of the pre-Atlantic deposits. This is the eclectic position which I endeavoured to maintain in my address before the Minneapolis Meeting of the American Association in 1883, and which I still hold to be in every way probable.

A word here as to metamorphism, a theory which, like many others, has been first run to death and then discredited, but which, owing to the moderate degree in which it was originally held by Lyell, is still valid. Nothing can be more certain than that the composition of the Laurentian gneisses forbids us to suppose that they can be ordinary sediments metamorphosed. They are rocks peculiar in their origin, and not paralleled, unless exceptionally, in

[1] Lyell, Kopp, Reusch, Judd, &c.

[2] Scrope, De LaBeche, Daubrée.

[3] Hunt, Transactions Royal Society of Canada, 1885.

later times. On the other hand, they have undoubtedly experienced very important changes, more especially as to crystallization, the state of combination of their ingredients, and the development of disseminated minerals;[1] and while this may in part be attributed to the mechanical pressure to which they have been subjected, it requires also the action of hydrothermic agencies. Any theory which fails to invoke both of these kinds of force must necessarily be partial and imperfect.

But all metamorphic rocks are not of the same character with the gneisses of the Lower Laurentian. Even in the Middle and Upper Laurentian, we have metamorphic rocks, *e. g.* quartzite and limestone, which must originally have been ordinary aqueous deposits. Still more, in the succeeding Huronian and its associated series of beds, and in the Lower Palæozoic, local metamorphic change has been undergone by rocks quite similar to those which in their unaltered state constitute regular sedimentary deposits. In the case of these later rocks it is to be borne in mind that, while some may have been of volcanic origin, others may have been sediments rich in undecomposed fragments of silicates. It is a mistake to suppose that the ordinary decay of stratified siliceous rocks is a process of kaolinization so perfect as to eliminate all alkaline matters. On the contrary, the fact, which Judd has recently well illustrated in the case of the mud of the Nile, applies to a great number of similar deposits in all parts of the world, and shows that the finest sediments have not always been so completely lixiviated as to be destitute of the basic matters necessary for their conversion into gneiss, mica-schist, and similar rocks, when the necessary agencies of metamorphism are applied to them, and this quite independently of any other extraneous matters introduced into them by water or otherwise. Still it must

[1] The first of these is what Bonney has called *Metastasis.* The second and third come under the name *Metacrasis.* *Methylosis,* or change of substance, is altogether exceptional, and not to be credited, except on the best evidence, or in cases where volatile matters have been expelled, as in the change of hæmatite into magnetite, or of bituminous coal into anthracite.

be steadily kept in view that many of the old pre-Cambrian crystalline rocks must have been different originally from those succeeding them, and that, consequently, these last, even when metamorphosed, present different characters.

I may remark here that, though a palæontologist rather than a lithologist, it gives me great pleasure to find so much attention now given in this country to the old crystalline rocks, and to their study microscopically and chemically as well as in the field, a work in which Sorby and Allport were pioneers. As a pupil of the late Professor Jameson of Edinburgh, my own attention was early attracted to the study of minerals and rocks as the stable foundations of geological science; and so far back as 1841 I had learnt of the late Mr. Sanderson, of Edinburgh, who worked at Nicol's sections,[1] how to slice rocks and fossils; and since that time I have been in the habit of examining everything with the microscope. The modern developments in this direction are therefore very gratifying to me, even though, as is natural, they sometimes appear to be pushed too far or their value over-estimated.

That the older gneisses were deposited, not only in what is now the bed of the Atlantic, but also on the great continental areas of America and Europe, anyone who considers the wide extent of these rocks represented on the map recently published by Professor Hull can readily understand.[2] It is true that Hull supposes that the basin of the Atlantic itself may have been land at this time, but there is no necessity for holding this view, more especially as the material of the gneiss could not have been detritus derived from sub-aërial decay of rock.

Let us suppose, then, the floor of old ocean covered with a flat pavement of gneiss, or of that material which is now gneiss, the next question is how and when did this original bed become converted into sea and land. Here we have some things certain, others most debateable. That the cooling mass, especially if it was sending out volumes of softened rocky material, either in the exoplutonic or in the crenitic

[1] *Trans. Royal Irish Academy.* [2] And I believe at Witham's also.

way, and piling this on the surface, must soon become too small for its shell, is apparent; but when and where would the collapse, crushing, and wrinkling inevitable from this cause begin? When they began is indicated by the lines of mountain-chains which traverse the Laurentian districts; but the reason why is less apparent. The more or less unequal cooling, hardening and conductive power of tbe outer crust we may readily assume. The driftage unequally of water-borne detritus to the south-west by the bottom currents of the sea is another cause, and, as we shall soon see, most effective. Still another is the greater cooling and hardening of the crust in the polar regions, and the tendency to collapse of the equatorial protuberance from the slackening of the earth's rotation. Besides these, the internal tides of the earth's substance at the times of solstice would exert an oblique pulling force on the crust, which might tend to crack it along diagonal lines. From whichever of these causes or the combination of the whole, we know that, within the Laurentian time, folded portions of the earth's crust began to rise above the general surface, in broad belts running from N.E. to S.W., and from N.W. to S.E., where the older mountains of Eastern America and Western Europe now stand, and that the subsidence of the oceanic areas, allowed by this crumpling of the crust, permitted other areas on both sides of the Atlantic to form limited table-lands.[1] This was the commencement of a process repeated again and again in subsequent times,and which began in the middle Laurentian, when for the first time we find beds of quartzite, limestone, and iron ore,and graphitic beds, indicating that there was already land and water, and that the sea, and perhaps the land, swarmed with forms of animal and plant life, unknown, for the most part, now. Independently of the questions as to the animal nature of Eozoon, I hold that we know, as certainly as we can know anything

[1] Daubrée's curious experiments on the contraction of caoutchouc balloons, partially hardened by coating with varnish, show how small inequalities of the crust, from whatever cause arising, might effect the formation of wrinkles, and also that transverse as well as longitudinal wrinkling might occur.

inferentially, the existence of these primitive forms of life. If I were to conjecture what were the early forms of plant and animal life, I would suppose that, just as in the Palæozoic, the acrogens culminated in gigantic and complex forest trees, so in the Laurentian, the algæ, the lichens, and the mosses grew to dimensions and assumed complexity of structure unexampled in later times, and that, in the sea, the humbler forms of Protozoa and Hydrozoa were the dominant types, but in gigantic and complex forms. The land of this period was probably limited, for the most part, to high latitudes, and its aspect, though more rugged and abrupt, and of greater elevation, must have been of that character which we still see in the Laurentian hills. The distribution of this ancient land is indicated by the long lines of old Laurentian rock extending from the Labrador coast and the north shore of the St. Lawrence, and along the eastern slopes of the Appalachians in America, and the like rocks of the Hebrides, the Western Highlands, and the Scandinavian mountains. A small but interesting remnant is that in the Malvern Hills, so well described by Holl. It will be well to note here and to fix on our minds, that these ancient ridges of Eastern America and Western Europe have been greatly denuded and wasted since Laurentian times, and that it is along their eastern sides that the greatest sedimentary accumulations have been deposited.

From this time dates the introduction of that dominance of existing causes which forms the basis of uniformitarianism in geology, and which had to go on with various and great modifications of detail, through the successive stages of the geological history, till the land and water of the northern hemisphere attained to their present complex structure.

So soon as we have a circumpolar belt or patches of Eozoic[1] land and ridges running southward from it, we enter on new and more complicated methods of growth of the continents and seas. Portions of the oldest crystalline rocks, raised out of the protecting water, were now eroded by atmospheric agents, and especially by the car-

[1] Or Archæan, or pre-Cambrian, if these terms are preferred.

bonic acid, then existing in the atmosphere perhaps more abundantly than at present, under whose influence the hardest of the gneissic rocks gradually decay. The Arctic lands were subjected in addition to the powerful mechanical force of frost and thaw. Thus every shower of rain and every swollen stream would carry into the sea the products of the waste of land, sorting them into fine clays and coarser sands ; and the cold currents which cling to the ocean bottom, now determined in their courses, not merely by the earth's rotation, but also by the lines of folding on both sides of the Atlantic, would carry south-westward, and pile up in marginal banks of great thickness, the *débris* produced from the rapid waste of the land already existing in the Arctic regions. The Atlantic, opening widely to the north, and having large rivers pouring into it, was, especially, the ocean characterised, as time advanced, by the prevalence of these phenomena. Thus throughout the geological history it has happened that, while the middle of the Atlantic has received merely organic deposits of shells of Foraminifera and similar organisms, and this probably only to a small amount, its margins have had piled upon them beds of detritus of immense thickness. Professor Hall, of Albany, was the first geologist who pointed out the vast cosmic importance of these deposits, and that the mountains of both sides of the Atlantic owe their origin to these great lines of deposition, along with the fact, afterwards more fully insisted on by Rogers, that the portions of the crust which received these masses of *débris* became thereby weighted down and softened, and were more liable than other parts to lateral crushing.[1]

[1] The connection of accumulation with subsidence was always a familiar consideration with geologists ; but Hall seems to have been the first to state its true significance as a geological factor, and to see that those portions of the crust, which are weighted down by great detrital accumulations, are necessarily those which, in succeeding movements, were elevated into mountains. Other American geologists, as Dana, Rogers, Hunt, Le Conte, Crosby, &c., have followed up Hall's primary suggestion, and in England, Hicks, Fisher, Starkie Gardiner, Hull, and others, have brought it under notice, and it enters into the great generalisations of Lyell on these subjects.

Thus in the later Eozoic and early Palæozoic times, which succeeded the first foldings of the oldest Laurentian, great ridges were thrown up, along the edges of which were beds of limestone, and on their summits and sides, thick masses of ejected igneous rocks. In the bed of the central Atlantic, there are no such accumulations. It must have been a flat, or slightly ridged, plate of the ancient gneiss, hard and resisting, though perhaps with a few cracks, through which igneous matter welled up, as in Iceland and the Azores in more modern times. In this condition of things we have causes tending to perpetuate and extend the distinctions of ocean and continent, mountain and plain, already begun; and of these we may more especially note the continued subsidence of the areas of greatest marine deposition. This has long attracted attention, and affords very convincing evidence of the connection of sedimentary deposit as a cause with the subsidence of the crust.[1]

We are indebted to a French physicist, M. Faye,[2] for an important suggestion on this subject. It is that the sediment accumulated along the shores of the ocean presented an obstacle to radiation, and consequently to cooling of the crust, while the ocean floor, unprotected and unweighted, and constantly bathed with currents of cold water having great power of convection of heat, would be more rapidly cooled, and so would become thicker and stronger. This suggestion is complementary to the theory of Professor Hall, that the areas of greatest deposit on the margins of

[1] Dutton in *Report of U.S. Geological Survey*, 1881. From facts stated in this report and in my *Acadian Geology*, it is apparent that in the Western States and in the coalfields of Nova Scotia, shallow-water deposits have been laid down, up to thicknesses of 10,000 to 20,000 feet in connection with continuous subsidence. See also a paper by Ricketts in the *Geol. Mag.* 1883. It may be well to add here that this doctrine of the subsidence of wide areas being caused by deposition, does not justify the conclusion of certain glacialists that snow and ice have exercised a like power in glacial periods. In truth, as will appear in the sequel, great accumulations of snow and ice require to be preceded by subsidence, and wide continental areas can never be covered with deep snow, while, of course, ice can cause no addition of weight to submerged areas.

[2] *Revue Scientifique*, 1886.

the ocean are necessarily those of greatest folding and consequent elevation. We have thus a hard, thick, resisting ocean-bottom which, as it settles down toward the interior, under the influence of gravity, squeezes upward and folds and plicates all the soft sediments deposited on its edges. The Atlantic area is almost an unbroken cake of this kind. The Pacific area has cracked in many places, allowing the interior fluid matter to exude in volcanic ejections.

It may be said that all this supposes a permanent continuance of the ocean-basins, whereas many geologists postulate a mid-Atlantic continent[1] to give the thick masses of detritus found in the older formations both in Eastern America and Western Europe, and which thin off in proceeding into the interior of both continents. I prefer, with Hall, to consider these belts of sediment as, in the main, the deposits of northern currents, and derived from Arctic land, and that like the great banks of the American coast at the present day, which are being built up by the present Arctic current, they had little to do with any direct drainage from the adjacent shore. We need not deny, however, that such ridges of land as existed along the Atlantic margins were contributing their quota of river-borne material, just as on a still greater scale the Amazon and Mississippi are doing now, and this especially on the sides toward the present continental plateaus, though the greater part must have been derived from the wide tracts of Laurentian land within the Arctic Circle or near to it. It is further obvious that

[1] Among American geologists, Dana and Le Conte, though from somewhat different premises, maintain continental permanence. Crosby has argued on the other side. In Britain, Hull has elaborated the idea of interchange of oceanic and continental areas in his memoir in *Trans. Dublin Society*, and in his work entitled *The Physical History of the British Islands*. Godwin-Austin argues powerfully for the permanence of the Atlantic basin, *Q. J. Geol. Society*, vol. xii. p. 42. Mellard Reade ably advocates the theory of mutation. The two views require, in my judgment, to be combined. More especially it is necessary to take into the account the existence of an Atlantic ridge of Laurentian rock on the west side of Europe, of which the Hebrides and the oldest rocks of Wales, Ireland, Western France, and Portugal are remnants.

the ordinary reasoning respecting the necessity of continental areas in the present ocean basins would actually oblige us to suppose that the whole of the oceans and continents had repeatedly changed places. This consideration opposes enormous physical difficulties to any theory of alternations of the oceanic and continental areas, except locally at their margins. I would, however, refer you for a more full discussion of these points to the address to be delivered to-morrow by the President of the Geological Section.

But the permanence of the Atlantic depression does not exclude the idea of successive submergences of the continental plateaus and marginal slopes, alternating with periods of elevation, when the ocean retreated from the continents and contracted its limits. In this respect, the Atlantic of to-day is much smaller than it was in those times when it spread widely over the continental plains and slopes, and much larger than it has been in times of continental elevation. This leads us to the further consideration that, while the ocean-beds have been sinking, other areas have been better supported, and constitute the continental plateaus; and that it has been at or near the junctions of these sinking and rising areas that the thickest deposits of detritus, the most extensive foldings, and the greatest ejections of volcanic matter have occurred. There has thus been a permanence of the position of the continents and oceans throughout geological time, but with many oscillations of these areas, producing submergences and emergences of the land. In this way, we can reconcile the vast vicissitudes of the continental areas in different geological periods with that continuity of development from north to south, and from the interiors to the margins, which is so marked a feature. We have, for this reason, to formulate another apparent geological paradox, namely, that while, in one sense, the continental and oceanic areas are permanent, in another, they have been in continual movement. Nor does this view exclude extension of the continental borders or of chains of islands beyond their present limits, at certain periods; and indeed the general principle already stated, that subsidence of the ocean-bed has produced elevation of the land, implies in earlier periods a shallower ocean and many possibilities as to volcanic islands, and low continental margins creeping out into the sea; while it is also to be noted that there are, as already stated, bordering shelves, constituting shallows in the ocean, which at certain periods have emerged as land.

We are thus compelled to believe in the contemporaneous existence in all geological periods, except perhaps the earliest of them, of three distinct conditions of areas on the surface of the earth. (1) Oceanic areas of deep sea, which always continued to occupy in whole or in part the bed of the present ocean. (2) Continental plateaus and marginal shelves, existing as low flats or higher table-lands liable to periodical submergence and emergence. (3) Lines of plication and folding, more especially along the borders of the oceans, forming elevated portions of land, rarely altogether submerged and constantly affording the material of sedimentary accumulations, while they were also the seats of powerful volcanic ejections.

In the successive geological periods, the continental plateaus, when submerged, owing to their vast extent of warm and shallow sea, have been the great theatres of the development of marine life and of the deposition of organic limestones, and when elevated, they have furnished the abodes of the noblest land faunas and floras. The mountain belts, especially in the north, have been the refuge and stronghold of land life in periods of submergence; and the deep ocean basins have been the perennial abodes of pelagic and abyssal creatures, and the refuge of multitudes of other marine animals and plants in times of continental elevation. These general facts are full of importance with reference to the question of the succession of formations and of life in the geological history of the earth.

So much time has been occupied with these general views, that it would be impossible to trace the history of the Atlantic in detail through the ages of the Palæozoic, Mesozoic, and Tertiary. We may, however, shortly glance at the changes of the three kinds of surface already referred to. The bed of the ocean seems to have remained, on the whole, abyssal, but there were probably periods when those shallow reaches of the Atlantic which stretch across its most northern portion, and partly separate it from the Arctic basin, presented connecting coasts or continuous chains of islands sufficient to permit animals and plants to pass over.[1] At certain periods also there were, not unlikely, groups of volcanic islands, like the Azores, in the temperate or tropical Atlantic. More especially might this be the case in that early time when it was more like the present Pacific; and the line of the great volcanic belt of the Mediterranean, the mid Atlantic banks, the Azores and the West India Islands point to the possibility of such partial connections. These were stepping-stones, so to speak, over which land organisms might cross, and some of these may be connected with the fabulous or pre-historic Atlantis.[2]

In the Cambrian and Ordovician periods, the distinctions, already referred to, into continental plateaus, mountain ridges, and ocean depths, were first developed, and we find, already, great masses of sediment accumulating on the seaward sides of the old Laurentian ridges, and internal deposits thinning away from these ridges over the submerged continental areas, and presenting dissimilar conditions of sedimentation. It would seem also that, as Hicks has argued for Europe, and Logan and Hall for America, this Cambrian age was one of slow subsidence of the land previously elevated, accompanied with or caused by thick deposits of detritus

[1] It would seem, from Geikie's description of the Faroe Islands, that they may be a remnant of such connecting land, dating from the Cretaceous or Eocene period.

[2] Dr. Wilson has recently argued that the Atlantis of tradition was really America, and Mr. Hyde Clarke has associated this idea with the early dominance in western Europe of the Iberian race, which Dawkins connects with the Neolithic and Bronze ages of archæology. My own attention has recently been directed, through specimens presented to the McGill College Museum, by Mr. R. S. Haliburton, to the remarkable resemblance in cranial characters, wampum, and other particulars of the Guanches of the Canaries with aborigines of Eastern America—resemblances which cannot be accidental.

along the borders of the subsiding land, which was probably covered with the decomposing rock arising from long ages of sub-aerial waste.

In the coal-formation age, its characteristic swampy flats stretched in some places far into the shallower parts of the ocean.[1] In the Permian, the great plicated mountain margins were fully developed on both sides of the Atlantic. In the Jurassic, the American continent probably extended further to the sea than at present. In the Wealden age, there was much land to the west and north of Great Britain, and Professor Bonney has directed attention to the evidence of the existence of this land as far back as the Trias, while Mr. Starkie Gardiner has insisted on connecting links to the southward as evidenced by fossil plants. So late as the Post-glacial, or early human period, large tracts, now submerged, formed portions of the continents. On the other hand, the interior plains of America and Europe were often submerged. Such submergences are indicated by the great limestones of the Palæozoic, by the chalk and its representative beds in the Cretaceous, by the Nummulitic formation in the Eocene, and lastly by the great Pleistocene submergence, one of the most remarkable of all, one in which nearly the whole northern hemisphere participated, and which was probably separated from the present time by only a few thousands of years.[2] These submergences and elevations were not always alike on the two sides of the Atlantic. The Salina period of the Silurian, for example, and the Jurassic, show continental elevation in America not shared by Europe. The great subsidences of the Cretaceous and the Eocene were proportionally deeper and wider on the eastern continent, and this and the direction of the land being from north to south, cause more ancient forms of life to survive in America.

[1] I have shown the evidence of this in the remnants of Carboniferous districts once more extensive on the Atlantic coast of Nova Scotia and Cape Breton (*Acadian Geology.*)

[2] The recent surveys of the Falls of Niagara coincide with a great many evidences to which I have elsewhere referred in proving that the Pleistocene submergence of America and Europe came to an end not more than ten thousand years ago, and was itself not of very great duration. Thus in Pleistocene times the land must have been submerged and re-elevated in a very rapid manner.

These elevations and submergences of the plateaus alternated with the periods of mountain-making plication, which was going on at intervals at the close of the Eozoic, at the beginning of the Cambrian, at the close of the Siluro-Cambrian, and in Europe and Western America in the Tertiary. The series of changes, however, affecting all these areas was of a highly complex character, and embraces the whole physical history of the geological ages.

We may here note that the unconformities caused by these movements and by subsequent denudation constitute what Le Conte has called 'lost intervals,' and one of the most important of which is supposed to have occurred at the end of the Eozoic. It is to be observed, however, that as every such movement is followed by a gradual subsidence, the seeming loss is caused merely by the overlapping of the successive beds deposited.

(*To be Continned.*)

Relations of the Earth's Rocks to Meteorites.

By H. A. Newton,

Retiring President of the American Association for the Advancement of Science.

[ABSTRACT.]

After briefly recounting the various superstitions and popular views respecting the origin of meteorites and their influence upon the earth, the President reviewed the various views advanced by scientists and reduced them to the following generally accepted propositions:—

1. The luminous meteor tracks are in the upper part of the earth's atmosphere. Few meteors, if any, appear at a height greater than one hundred miles, and few are seen below a height of thirty miles from the earth's surface, except in rare cases, when stones and irons fall to the ground. All these meteor tracks are caused by bodies which come into the air from without.

2. The velocities of the meteors in the air are comparable with that of the earth in its orbit about the sun. It is not easy to determine the exact values of those velocities, yet they may be roughly stated as from fifty to two hundred and

fifty times the velocity of sound in the air, or of a cannon ball.

3. It is a necessary consequence of these velocities that the meteors move about the sun, and not about the earth, as the controlling body.

4. There are four comets related to four periodic star-showers, that have occurred on the dates April 20th, August 10th, November 14th and November 27th. The meteoroides which have given us any of these star-showers constitute a group, each individual of which moves in a path which is like that of the corresponding comet. The bodies are, however, now too far from one another to influence appreciably each other's motions.

5. The ordinary shooting stars in their appearance and phenomena, do not differ essentially from the individuals in star-showers.

6. The meteorites of different falls differ from one another in their chemical composition, in their mineral forms and in their tenacity. Yet through all these differences they have peculiar common properties which distinguish them entirely from all terrestrial rocks..

7. The most delicate researches have failed to detect any trace of organic life in meteorites.

8. These propositions have practically universal acceptance among scientific men. We go on to consider others which have been received with hesitation, or in some cases have been denied.

With a very great degree of confidence we may believe that shooting stars are solid bodies. As we see them they are discrete bodies, separated even in prolific star-showers by large distances one from another. We see them penetrate the air many miles, that is, many hundred times their own diameters at the very least. They are sometimes seen to break in two. They are sometimes seen to glance in the air. There is good reason to believe that they glance before they become visible. Now, these are not the phenomena which may be reasonably expected from a mass of gas.

A spherical mass of gas, at the earth's distance from the sun, must exceed in density air at one-sixth millimetre pressure, or else the sun will scatter it. Such a mass would hardly have a possible existence. The surface of solid meteorites is burned or melted away when brought in contact with the air at a similar velocity, while the experiments of M. Daubrée and the well known effects of dynamite well show the enormous resistance such gaseous bodies would have to encounter, and only a solid body could be conceived of under such conditions as obtain in the flight of a meteorite.

Again, we may reasonably believe that the bodies that cause the shooting stars, the large fireballs and the stone-producing meteor, all belong to one class. They differ in kind of material, in density, in size. But from the faintest shooting star to the largest stone-meteor, we pass by such small gradations that no clear dividing lines can separate them into classes.

See wherein they are alike.

1. Each appears as a ball of fire traversing the apparent heavens, just as a single solid, but glowing or burning mass would do.

2. Each is seen in the same part of the atmosphere and moves through its upper portion. The stones come to the ground, it is true, but the brightly luminous portion of their paths generally ends high up in the air.

3. Each has a velocity which implies an orbit about the sun.

4. The members of each class have apparent motions which imply common relations to the horizon, to the ecliptic, and to the line of the earth's motion.

5. A cloudy train is sometimes left along the track both of the stone-meteor and of the shooting star.

6. "They have like varieties of colors, though in the small meteors the colors are naturally less intense and are not so variously combined as in the large ones.

In short, if the bodies that produce the various kinds of fireballs had just the difference in size and material which we find in meteorites, all the differences in the appearances would be explained; while, on the other hand, a part of the likenesses that characterize the flights, point to something common in the astronomical relations of the bodies that produce them.

This likeness of the several grades of luminous meteors has not been admitted by all scientific men. Especially it was not accepted by your late President, Prof. J. Lawrence Smith, who by his studies added so much to our knowledge of the meteorites.

The only objection of apparent force, that has been urged against the relationship of meteorites and star-showers, is the fact that no meteorites have been secured that are known to have come from star-showers. Within the last one hundred years there have been five or six star-showers of considerable intensity, and the objection assumes that a large number of stones must have come to the ground from them, and have been picked up. But a reasonable estimate of the total number of meteors in all of these five or six star-showers combined, makes it about equal to the number of ordinary meteors which come into the air in six or eight months, and the average annual number of stone-meteors of known date, from which we have secured specimens, has during this hundred years been about two and a half.

Supposing the luminous meteors to be of the same origin and astronomical nature, and that the proportion of those fitted to come through the air without destruction is the same among the star-shower meteors as among the other meteors, a hundred years of experience would lead us to expect two, or perhaps three, stone-falls, from which we secure specimens during the half dozen showers put together. To ask for more than two or three, is to demand of star-shower meteors more than other meteors give us. The failure to get these two or three may have resulted from chance, or from some peculiarity in the nature of the rocks of Biela's and Pempel's comets.

It may be assumed, then, as reasonable, that the shooting stars and the stone-meteors, together with all the intermediate forms of fireballs, are like phenomena. What we know about the one may with due caution be used to teach facts about the other. From the mineral and physical nature of the different meteorites, we may reason to the shooting stars, and from facts established about the shooting stars we may infer something about the origin and history of the meteorites. Thus it is reasonable to suppose that the shooting stars are made of such matter and such varieties of matter as are found in meteorites. On the other hand, since star-showers are surely related to comets, it is reasonable to look for some relation of the meteorites to the astronomical bodies and systems of which the comets form a part.

This common nature of the stone-meteor and the shooting stars enables us to get some idea, indefinite, but yet of great value, about the masses of the shooting stars. Few meteoric stones weigh more than one hundred pounds. The most productive stone-falls have furnished only a few hundred pounds each, though the irons are larger. Allowing for fragments not found, and for portions scattered in the air, such meteors may be regarded as weighing a ton, or it may be several tons, on entering the air. The explosion of such a meteor is heard a hundred miles around, shaking the air and the houses over the whole region like an earthquake. The size and brilliancy of the flame of the ordinary shooting star are so much less than that of the stone-meteor that it is reasonable to regard the ordinary meteoroid as weighing pounds or even ounces, rather than tons.

Determinations of mass have been made by measuring the light and computing the energy needed to produce the light. These are to be regarded as lower limits of size, because a large part of the energy of the meteor is changed into heat and motion of the air. The smaller meteors visible to the naked eye may be thought of without serious error as being of the size of gravel stones, allowing, however, not a little latitude to the meaning of the indefinite word gravel.

These facts about the masses of shooting stars have important consequences.

The meteors, in the first place, are not the fuel of the sun. We can measure and compute within certain limits of error, the energy emitted by the sun. The meteoroides, large enough to give shooting stars visible to the naked eye, are scattered very irregularly through the space which the earth traverses, but in the mean, each is distant two or three hundred miles from its near neighbors. If these meteoroides supply the sun's radiant energy, a simple computation shows that the average shooting star ought to have a mass enormously greater than is obtained from the most prolific stone-fall.

Moreover, if these meteoroides are the source of the solar heat, their direct effect upon the earth's heat by their impact upon our atmosphere ought also to be very great; whereas the November star-showers, in some of which a month's supply of meteroids was received in a few hours, do not appear to have been followed by noticeable increase of heat in the air.

Again, the meteoroides do not cause the acceleration of the moon's mean motion. In various ways the meteors do shorten the month as measured by the day. By falling on the earth and on the moon they increase the masses of both, and so make the moon move faster. They check the moon's motion, and so, bringing it nearer to the earth, shorten the month. They load the earth with matter which has no momentum of rotation, and so lengthen the day. The amount of matter that must fall upon the earth, in order to produce in all these ways the observed acceleration of the moon's motion, has been computed by Prof. Oppolzer. But his result would require for each meteroid an enormous mass, one far too great to be accepted as possible.

The power of such small bodies to break up comets or other heavenly bodies is insignificant, and their effect in producing geologic changes by adding to the earth's strata has been much over-estimated. To assume a sufficient abundancy of meteors in ages past to accomplish any of these purposes, is to reason from hypothetical and not from known causes.

The same may be said of the suggestion that the mountains of the moon are due to the impact of meteorites. Enormously large meteoroides in ages past must be arbitrarily assumed, and, in addition, a very peculiar plastic condition of the lunar substance in order that the impact of a meteoroid can make in the moon depressions ten, or fifty, or a hundred miles in diameter, surrounded by abrupt mountain walls two, and three, and four miles high, and yet the mountain walls not sink down again.

The known visible meteors are not large enough nor numerous enough to do the various kinds of work which I have named. May we not assume that an enormous number of exceedingly small meteoroides are floating in space, are falling into the sun, are coming into our air, are swept up by the moon? May we not assume that some of these various forms of work which cannot be done by meteoroids large enough for us to see them as they enter the air, are done by this finer impalpable cosmic dust? Yes, we may make such an assumption. There exist, no doubt, multitudes of these minute particles travelling in space. But science asks not only for a true cause but a sufficient cause. There must be enough of this matter to do the work assigned to it. At present, we have no evidence that the total existing quantity of such fine material is very large. It is to be hoped that through the collection and examination of meteoric dust, we may soon learn something about the amount which our earth receives. Until that shall be learned we can reason only in general terms. So much matter coming into our atmosphere as these several hypotheses require would, without doubt, make its presence known to us in the appearance of our sunset skies and in a far greater deposit of meteoric dust than has ever yet been proven.

A meteoroid origin has been assigned to the light of the solar corona. It is not unreasonable to suppose that the amount of the meteoroid matter should increase toward the sun, and the illumination of such matter would be much greater as we approach the solar surface. But it is difficult to explain upon such an hypothesis the radial structure, the rifts, and the shape of the curved lines that are marked features of the corona. These seem to be inconsistent with any conceivable arrangement of meteoroids in the vicinity of the sun. If the meteoroids are arranged at random, there should be a uniform shading away of light as we go from the sun. If the meteoroides are in streams along cometary orbits, all lines bounding the light and shade in the coronal light should evidently be approximated by projections of conic sections of which the sun's centre is the focus.

There are curved lines in abundance in the coronal light, but as figured by observers and in the photographs, they seem to be entirely unlike any such projections of conic sections. Only by a violent treatment of the observations can the curves be made to represent such projections. They look more as though they were due to forces at the sun's surface than at his centre. If these complicated lines have any meteoroid origin (which seems very unlikely), they suggest rather the phenomena of comets' tails than meteoroide streams or sporadic meteors.

The hypothesis that the long rays of light which sometimes have been seen to extend several degrees from the sun at the time of the solar eclipse, are meteor streams seen edgewise seems possibly true, but not at all probable.

The observed life of a meteor, with few exceptions, is only a second, or at most a few seconds. Near the beginning of this century, small meteors were looked upon as some form of electricity; while the view that they originate in the earth's volcanoes even gains support from a few men of science at the present day, among whom is the distinguished Astronomer Royal of Ireland. The difficulties of this hypothesis, however, are exceedingly great.

No one claims that the meteors of the star-showers nor that their accompanying comets come from the earth's volcanoes. To ascribe a terrestrial origin to meteorites is then to deny the relationship of the shooting star and the stone-meteor. Every reason for their likeness is an argument against the terrestrial origin of the stones.

To suppose that the meteors came from any planets that have atmospheres, involves difficulties not unlike to, and equally serious with, those of a terrestrial origin.

The solar origin of meteorites has been seriously urged, and deserves a serious answer.

The first difficulty which this hypothesis meets is, that solid bodies should come from the hot sun. Besides this, they must have passed without destruction through an atmosphere of immense thickness, and must have left the sun with an immense velocity.

Then there is a geometric difficulty. The meteorite shot out from the sun would travel under the law of gravitation nearly in a straight line outward and back again into the sun. If in its course it enters the earth's atmosphere, its relative motion, that which we see, should be in a line parallel to the ecliptic, except as slightly modified by the earth's attraction. A large number of these meteors, that is most, if not all, well observed fireballs, have certainly not travelled in such paths. These did not come from the sun.

It has been a favorite hypothesis that the meteorites came from some planet broken in pieces by an internal catastrophe. There is much which mineralogists can say in favor of such a view. The studies of M. Stanislas Meunier and others, into the structure of meteorites have brought out many facts which make their hypothesis plausible. It requires, however, that the stone-meteor be not regarded as of the same nature as the star-shower meteor, for no one now seriously claims that the comets are fragments of a broken planet. The hypothesis of the existence of such a planet is itself arbitrary; and it is not easy to understand how any mass that has become collected by the action of gravity and of other known forces should by internal forces be broken in pieces, and these pieces rent asunder. The disruption of such a planet by internal forces after it has by cooling largely lost its original energy, would be specially difficult to explain.

We cannot then look to the moon, nor to the earth, nor to the sun, nor to any of the large planets, nor to a broken planet as the first home of the meteoroides, without seeing serious if not insuperable objections. But since some of the meteoroides were in time past certainly connected with comets, and since we can draw no line separating shooting stars from stone-meteors, it is most natural to assume that all of them are of a cometary origin.

And if the cometary origin of meteorites is inadmissible, the objections must mainly come from the nature and structure of meteoric stones and iron.

What that structure is, and to some extent what conditions must have existed at the time and place of its first formation and during its subsequent transformations, mineralogists rather than astronomers must tell us. For a long time it was accepted without hesitation that these bodies required great heat for their first consolidation. Their resemblance to the earth's volcanic rocks was insisted on by mineralogists. Professor J. Lawrence Smith in 1855 asserted, without reserve, that "they have all been subject to a more or less prolonged igneous action corresponding to that of terrestrial volcanoes." Director Haidinger, in 1861, said:—"With our present knowledge of natural laws, these characteristically crystalline formations could not possibly have come into existence except under the action of high temperature combined with powerful pressure." The likeness of these stones to the deeper igneous rocks of the earth, as shown by the experiments of M. Daubrée, strengthened this conviction.

Mr. Sorby, in 1877, said:—"It appears to me that the conditions under which meteorites were formed must have been such that the temperature was high enough to fuse stony masses into glass; the particles could exist independently one of the other in an incandescent atmosphere, subject to violent mechanical disturbances; that the force of gravitation was great enough to collect these fine particles together into solid masses, and that these were in such a situation that they could be metamorphosed, further broken up into fragments, and again collected together."

Now if meteorites could come into being only in a heated place, then the body in which they were formed ought, it would seem, to have been a large one. But the comets, on the contrary, appear to have become aggregated in small masses.

The idea that heat was essential to the production of these minerals was at first a natural one. All other known rock formations are the result of processes that involved water or fire or metamorphism. All agree that the meteorites could not have been formed in the presence of water or free oxygen. What conclusion was more reasonable than that heat was present in the form of volcanic or of metamorphic action?

The more recent investigations of the meteorites and kindred stones, especially the discussions of the Greenland native irons and the rocks in which they are imbedded, are leading mineralogists, if I do not mistake, to modify their views. Great heat at the first consolidation of the meteoric matter is not considered so essential. In a late paper, Mr. Daubrée says:—" It is extremely remarkable that in spite of their great tendency to a sharply defined [*nette*] crystallization, the silicate combinations which make up the meteorites are there only in the condition of very small crystals all jumbled together as if they had not passed through fusion. If we may look for something analogous about us, we should say that instead of calling to mind the long needles of ice which liquid water forms as it freezes, the fine grained texture of meteorites resembles rather that of hoar frost and that of snow, which is due, as is known, to the immediate passage of the atmospheric vapor of water into the solid state."

So Dr. Reusch, from the examination of the Scandinavian meteorites, concludes that "there is no need to assume volcanic and other processes taking place upon a large heavenly body formerly existing but since gone to pieces."

The meteorites resemble the lavas and slags on the earth. These lavas and slags are formed in the absence of water, and with a limited supply of oxygen, and heat is present in the process. But is heat necessary for the making of the meteorites? Some crystallizations do take place in the cold; some are direct changes from gaseous to solid forms. We cannot in the laboratory reproduce all the conditions of crystallization in the cold of space. We cannot easily determine whether the mere absence of oxygen will not account fully for the slag-like character of the meteoric minerals.

Wherever crystallization can take place at all, if there are present silicon and magnesium and iron and nickel with a limited supply of oxygen, there silicates ought to be expected in abundance, and the iron and nickel in their metallic form. Except for the heat, the process should be analogous to that of the reduction of iron in the Bessemer cupola, where the limited supply of oxygen combines with the carbon and leaves the iron free. The smallness of the comets should not then be an objection to considering the meteoric stones and irons as pieces of comets. There is no necessity of assuming that they were parts of a large mass in order to provide an intensely heated birth-place.

But although great heat was not needed at the first formation, there are many facts about these stones which imply that violent forces have in some way acted during the meteorite's history. The brecciated appearance of many specimens, the fact that the fragments in a breccia are themselves a finer breccia, the fractures, infiltrations and apparent faultings seen in microscopic sections and by the naked eye—these all imply the action of force

M. Daubrée supposes that the union of oxygen and silicon furnishes sufficient heat for making these minerals. If this be possible, those transformations may have taken place in their first home. Dr. Reusch argues that the repeated heating and cooling of the comet as it comes down to the sun and goes back again into the cold, is enough to account for all the peculiarities of structure of the meteorites. These two modes of action do not, however, exclude each other.

It has been assumed that the cometic fragments go continuously away from the parent mass so as to form, in due time, a ringlike stream of varying density, but stretched along the entire elliptic orbit of the comet. The epochs of the Leonid star-showers in November, which have been coming at intervals of thirty-three years since the year 902, have led us to believe that this departure of the fragments from Tempel's comet (1866, I) and the formation of the ring was a very slow process. The meteors which we met near 1866 were, therefore, thought to have left the comet many thousand years ago. The extension of the group was presumed to go on in the future, until, perhaps, tens of thousands of years hence, the earth shall meet the stream every year.

Whatever may be the case with Tempel's comet and its meteors, this slow development is not found to be true for the fragments of Biela's comet. It is quite certain that the meteors of the splendid displays of 1872 and 1885 left the immediate vicinity of that comet later than 1840, although at the time of those showers they had become separated two hundred millions of miles from the computed place of the comet. The process then has been an exceedingly rapid one, requiring, if continued at the same rate, only a small part of a millennium for the completion of an entire ring, if a ring is to be the finished form of the group.

It may be thought reasonable, in view of this fact about Biela's comet, established by the star-showers of 1872 and 1885, to revise our conception of the progress of disintegration of Tempel's comet also. The more brilliant of the star-showers from this comet have always occurred very near the end of the thirty-three year period. Instead of there being a slow process which is ultimately to produce a ring along the orbit of the comet, it certainly seems more reasonable to suppose that the compact lines of meteors which we met in 1866, 1867 and 1868 left the comet at a recent date. A thousand years ago this shower occurred in the middle of October. By the precession of the equinoxes and the action of the planets, the shower has moved to the middle of November. One-half of this motion is due to the precession of the equinoxes, the other half to the perturbing action of the planets. Did the planets act upon the comet before the meteoroids left it, or upon the meteoroid stream? Until one has reduced the forces to numerical values, he may not give to this question a positive answer. But I strongly suspect that computations of the forces will show that the perturbations of Jupiter and Saturn upon that group of meteoroids hundreds of millions of miles in length, perturbations strong enough to change the node of the orbit fifteen degrees along the ecliptic, would not leave the group such a compact train as we found it in 1866. If this result is at all possible, it is because the total action is scattered over so many centuries. But it seems more probable that the perturbation was of the comet itself, that the fragments are parting more rapidly from the comet than we have assumed, and that long before the complete ring is formed the groups become so scattered that we do not recognize them, or else are turned away so as not to cross the earth's orbit.

Comets, by their strange behavior and wondrous trains, have given to timid and superstitious men more apprehensions than have any other heavenly bodies. They have been the occasion of an immense amount of vague and wild and worthless speculation by men who knew a very little science. They have furnished a hundred as yet unanswered problems which have puzzled the wisest. A world without water, with a strange and variable envelope which takes the place of an atmosphere, a world that travels repeatedly out into the cold and back to the sun and slowly goes to pieces in the repeated process, has conditions so strange to our experience and so impossible to reproduce by experiment that our physics cannot as yet explain it. Yet we may confidently look forward to the answer of many of these problems in the future. Of those strange bodies, the comets, we shall have far greater means of study than of any other bodies in the heavens. The comets alone give us specimens to handle and analyze. Comets may be studied, like the planets, by the use of the telescope, the polariscope and the spectroscope. The utmost refinements of physical astronomy may be applied to both. But the cometary worlds will also be compelled, through these meteorite fragments with their included gases and peculiar minerals, to give up some additional secrets of their own life and of the physics of space to the blowpipe, the microscope, the test-tube aud the crucible.

Additional Notes upon the Tendrils of Cucurbitaceæ.[1]

By D. P. Penhallow.

During the past summer, opportunity was presented for the extension of previous observations upon tendril movements in several important particulars, and the results

[1] The facts contained in this paper were nearly all obtained at the Botanic Gardens of Harvard University. For the facilities there placed at my disposal, and for many courtesies extended, the author is under deep obligations to Dr. Gray and Dr. Goodale.

obtained are now presented as supplementary to those already recorded.[1] The leading subjects for inquiry, not previously dealt with, concerned (1) a determination of the force developed during the formation of tendril spirals, *i.e.*, to what extent, if any, does the formation of the double spirals involve a direct and measurable strain? Owing to circumstances developed during the progress of the experiments, and to be detailed later, this consideration could not be dealt with in any extended series of observations, and the question had to be approached from another standpoint, the proposition then resolving itself into a consideration of the tensile strength of already formed spirals at different stages of maturity.

Owing to the abundant facilities most courteously placed at our disposal, both in the Physiological Laboratory and the Botanic Garden of Harvard University, it has been possible to collect a large amount of evidence, which goes far to settle the questions involved, of which the following is a condensed summary.

For the determination of the various considerations presented, as large a number of representattves of the order was selected as could conveniently be brought under observation. The genera represented, as also the total number of species observed, are as follows:—

	Species.		Species.
Benincasa	1	Megarrhiza	1
Citrullus	1	Rhynchocarpa	1
Cucumis	1	Sicyos	2
Cucurbita	3		—
Lagenaria	8	Totals, 9	22
Luffa	4		

All of these species were employed in determining the tendril type, and most of them were used for observations relating to tensile strength and other considerations. One genus (*Lagenaria*) was studied under glass, while all the genera were studied out of doors, several of them under different conditions of exposure and training.

General considerations seemed to render it highly probable that, if the tendril of *Cucurbita* were not the true type

[1] Trans. R. Soc. Can., IV.

of the family, there would at least be but few and unimportant structural differences as observed in the various genera. No exact comparison having been instituted, however, it has been impossible to give definite expression to any settled view on this point, up to the present time. Our recent observations, however, enable us to supply this deficiency. As we have already detailed the structure of the tendril in *Cucurbita*, it may be well to institute our comparisons with it, more especially as we are to demonstrate how far it may be considered the type, and reference should be made to our description for comparison.[1]

All the tendrils of the family, so far as observed, present the same general features of internal structure, at least so far as the more important mechanical elements are concerned, *e.g.*, the distribution of the tissues, particularly with reference to the strong localization of bast and the development of vibrogen bands. Externally, the form varies somewhat, though in most cases in no essential particular. All are more or less well rounded at the base and flattened toward the tip, usually before the middle section is reached, but, with one or two exceptions, the lower or sensitive surface is rounded. In *Sicyos*, an exception appears in the strong flattening of both sides for some distance back from the tip. *Citrullus* and *Lagenaria* are flattened only on the upper side, but show no channel, or mere rudiments of one, while *Cucumis* is not only channelled above, but shows several longitudinal furrows in other parts of the circumference. *Citrullus*, *Lagenaria*, *Luffa*, *Benincasa* and *Cucumis* are more or less hairy all over the base; *Rhynchocarpa* is hairy throughout, while *Sicyos* is equally smooth throughout its entire length. It is a noticeable fact, however, that in nearly all the genera the hairs disappear at a short distance from the base, over the entire region of the collenchyma tissue of the lower side, and even in *Rhynchocarpa*, where the hirsuteness is so strongly defined, there are comparatively few hairs in this region. The same is true of the two collenchyma regions lying laterally

[1] Trans. R. Soc. Can., IV.

upon the upper side of the tendril. It thus appears that the hairs are chiefly developed in the regions where the sensitiveness of the tendril is least, that where this latter is most acute the surface is the smoothest.

In the distribution of the vibrogen bands, there is probably greater variation than in any other particular noted. While in *Cucurbita pepo*, we have noted three bands of this tissue, we cannot consider this strictly true of the whole genus, since in *C. pyxidaris* there are four such at the tip. This is also true of other genera. In *Sicyos* and *Cucumis* there are more than four bands at the base, but, by absorption or merging, they become two at the tip. In *Lagenaria* four bands are distinct throughout, but in *Citrullus*, *Cucurbita* and *Megarrhiza* they become reduced from four, at the base, to three or (*Citrullus*) two. On the other hand, in *Luffa*, *Rhynchocarpa*, *Benincasa*, *Megarrhiza* and *Cucurbita*, the three bands at the base become four at the tip. The general tendency appears to be toward the development of three principal bands at the base, together with several subordinate bands which soon disappear. The former become divided into four at about the middle section of the arm. In all such cases, the lateral bands remain intact, while the division occurs in the central band, but in such a way that its halves, though distinct, are not widely separated, and in their relation to the lateral bands still act as one. Before division, the central band is usually equal in width to each of the laterals, a relation, in point of size, which is preserved even after division, so that this band, at its divided extremity, is incapable of exerting a stronger influence over the others than does its undivided base. These facts have an important bearing upon what has elsewhere been stated,[1] with reference to the circumnutations and the relations which the bands bear to them. It may also be noted that, in most of the tendrils observed, free torsion was common and conspicuous.

Tensile Strength.—For the determination of the tensile strength of the tendrils during and after coiling, three

[1] Trans. R. Soc. Can., IV.

forms of balances were used. Of these, the first was a torsion balance formed of a brass spring 9.5 c.m. long and 1.6 c.m. diameter, bearing upon the free end a grooved wheel 6.5 c.m. in diameter. This operated against an arbitrarily graduated scale, and carried an index hand. Over the wheel there passed a light, flexible wire, which was drawn through a metal eye fastened to the scale plate, and provided with a suitable loop at the end for the tendril to grasp. The balance was adjusted to an initial tension of 5.31 gr., and a total tension of 254.93 gr. The second balance was constructed of a clock spring with post adjustment, so that the tension could be varied at pleasure. The spring operated upon the face of a board, and from the free end of the former a light wire was led through metal eyes along a horizontal scale, and provided with a suitable loop at the end. The adjustment was made for an initial tension of 120 gr., and a total tension of 900 gr. In both of these instruments the divisions were arbitrary, their value in grains being determined experimentally. The latter was not used at all, and the former to but a limited extent, for reasons soon to appear.

The third and most simple form of instrument, and that which was chiefly relied upon, consisted of a square stick about 30 c.m. long, upon which was fixed a scale in centimetres. Into the end of the stick was firmly fixed a small hook, upon which could be hung the brass spring for direct tension. In this apparatus three springs in all were used, though the two first to be mentioned were employed in nearly all the determinations. Their dimensions were as follows :—

	Length.	Diam. of Spring.	Diam. of Wire.
1 - - - - -	9.7 c.m.	0.3 c.m.	0.25 m.m.
2 - - - - -	11.7 "	0.6 "	0.50 "
3 - - - - -	19.5 "	1.0 "	1.00 "

In using these balances, the spring was hung upon the hook and allowed to run along the scale. To it, the free end of the tendril was then secured by suitable means, and the strain exerted by a direct and steady pull. Readings were then taken of the elongation of the spring, and the value in grains, of the corresponding divisions, was afterward determined experimentally.

July 7th, the tension balance was placed in position in the plant house for a tendril of *Lagenaria* to grasp. The first tendril failed to secure a hold, but on the 10th the second tendril grasped the loop firmly, and on the 12th it completed its double spirals. Inasmuch as both balance and vine were firmly secured, there could be no variation of distance between the tendril base and the point of attachment to the balance, without its being indicated on the scale of the latter.

Although the formation of the double spiral began on the 10th, and was completed on the 12th, no evidence of strain was manifested. The tendril continued to mature normally, but up to the 19th of July, during which time the coils became slightly closer, no evidence of strain was apparent, and the connection was therefore severed. It was most evident from this trial that, since the relation of vine and point of attachment remained unchanged, there could have been no shortening of the tendril in the formation of the coils, but that the total increase of tissue was sufficient to compensate for their formation. It had previously been surmised that the increase of parts after coiling wo ld not fully compensate the shortening due to coiling. In order to determine how far this result was the expression of a general law, many measurements were made, all of which proved to be of a confirmatory nature, and we therefore feel justified in asserting that these tendrils, in the formation of their spirals, fail to exert a strain equal to 5 gr. It would also appear that, during the formation of the spiral, while all parts must of necessity elongate somewhat, the special increase of tissue is on the convex side of the tendril, hence in those soft tissues where the bast is known to be least abundant, and where the vibrogen is prominent, this will appear more strikingly later on.

For the reasons already given, resort was had to simple springs for a determination of the strength of already formed spirals in various stages of maturity. The more important results appear in the following table, in which the "tensile strength" is that determined within the limits of elasticity of the spiral:—

TENSILE STRENGTH OF TENDRILS.

Wt. in gr. L. M. = C. M.

No.	Length of Spiral.	Tensile Strength.	Breaking Strain.	No. of Spring.	Remarks.
1	2.3	101.0 gr.	....	1	*Lagenaria vulgaris.*
4	7.1	36.0 "	....	1	*Sicyos.* Coiled one day.
5	2.5	76.0 "	....	1	*Megarrhiza fabacea.*
6	3.3	161.0 "	....	1	" "
7	5.6	156.0 "	....	1	" "
8	3.3	216.0 "	....	1	*Lagenaria maxima.*
9	...	373.0 "	....	2	" "
10	2.0	160.0 "	....	2	" "
"	..	....	488.0 gr.	2	" "
11	3.0	488.0 "	....	2	" "
a	2.5	338.0 "	488.0 gr.	2	*Megarrhiza fabacea.*
b	5.0	323.0 "	423.0 "	2	" "
c	5.0	203.0 "	360.0 "	2	" "
d	8.9	203.0 "	360.0 "	2	" "
e	8.2	101.0 "	....	1	*Sicyos.*
f	6.8	148.0 "	....	2	*Megarrhiza fabacea.*
g	..	203.0 "	....	2	*Lagenaria vulgaris.*
h	12.0	266.1 "	....	2	*Cucurbita pepo.*
i	8.2	301.1 "	366.6 "	2	" "
j	7.6	626.0 "	666.0 "	2	
k	11.5	266.1 "	....	2	Strain of 366. gr. caused
l	6.3	396.0 "	....	2	separation of tissues, &
m	12.7	206.0 "	....	2	446. gr. broke tendril.
n	..	141.1 "	....	1	*Lagenaria vulgaris.* One day coiled.

As all of the above determinations were made with tendrils which were comparatively fresh and soft, though in different stages of maturity, it would appear evident that the strain which a spring is capable of supporting must vary with maturity of parts, becoming greater with age. It was easily found that, in coiled tendrils, the distinction between the band of bast along the lower side, and the softer tissues of the upper side, was much more prominently marked than before coiling, and when such tendrils, at the proper stage of maturity, were subjected to a carefully augmented strain, it was found possible to cause a complete separation of the bast from the other tissues for a distance of one or more centimetres. Under such conditions of strain, it is also to be note that the tissues along the lower side of the tendril, or the concave side of the spring, do not elongate, but the softer tissues on the opposite side suffer a strong compression and form a spiral around the straightened and resisting bast as a central axis. The compression of parts is to be observed in the strong, transverse corrugations in the surface, as also in the formation of minute drops of moisture which exude from the surface over the entire area of compression, but more particularly along the lines of vibrogen, where also the corrugations are the most strongly defined.

According to the weight or strain imposed, the spirals will be open or closed. This is conspicuously true where vines hang by their tendrils, or where any resistance is offered to attachment. But it must be kept in mind, as our previous considerations show, that the vine cannot be drawn to a support—it must first approach a support in the natural course of growth, and then become secured to it. In harmony with this, it is found that when the strain is slight, or when the vine in growing advances toward the support, the coils become correspondingly closer.

Rigid support is not essential, nor need the object be large. The requirements are met if it be sufficiently irritating, and possess a very moderate degree of stability. Small pebbles, bits of grass and similar objects lying upon the ground, and even small particles of dirt, hardened by rain, have been found sufficient to meet all requirements and cause the formation of double spirals in a normal manner.

Wilted tendrils may be drawn out without any appreciable resistance, while those which have coiled without the influence of a supporting object, and which rarely if ever coil regularly, may be drawn out with a force which rarely exceeds 40 gr. It thus appears that the strain required to draw out the coils of a tendril which is comparatively fresh, is an expression of the force—or, in other words, the tension—developed in all the softer tissues, and required to maintain the tendril as a spiral; or, to state the case differently, it is a measure of the resistance to compression which the softer tissues on the upper side of the tendril offer. Obviously, the full strength can be maintained only so long as the tension of the tissues is undisturbed, or until this latter is replaced by hardening of all parts, when, as in all old tendrils which have been for some time coiled, a new element of strength is introduced.

To more fully confirm the above results, numerous measurements of the tendrils were made to determine the relative lengths of the inner and outer surfaces of the spirals, or the general relation in length of the bast on the lower side and the softer tissues above. The ratios obtained were necessarily a little high for the true mean position of these tissues, from the fact that all the determinations were made from the inner and outer diameters of the spirals, and therefore relate wholly to the corresponding surfaces. The results, however, will be found to harmonize well with those obtained by a different method. The following will sufficiently explain the results in ratios of the inner to the outer surfaces:—

DIMENSIONS OF SPIRALS.

Ratios of Inner and Outer Surfaces.

Cucurbita pepo.

1	1 : 2.0	10	1 : 1.8
2	1 : 2.0	11	1 : 2.7
3	1 : 4.0	12	1 : 2.0
4	1 : 1.7	13	1 : 2.03
5	1 : 2.0	14	1 : 1.33
6	1 : 2.7	15	1 : 5.2
7	1 : 1.8	16	1 : 2.2
8	1 : 1.5		
9	1 : 1.7		1 : 2.29

In all of these it will be noted that the ratio increases or decreases as the coils become closer or more open—a fact which is most strikingly illustrated in Nos. 3 and 15, which we may almost regard as exceptional cases. If they are excluded from the general results, the mean ratio then falls to 1 : 1.94, which approaches more nearly the mean obtained by direct and separate measurement of the tissues themselves.

Other determinations of the same nature were made by carefully separating the bast from the soft tissues, and measuring each separately. Under such circumstances, both tissues may be straightened out without difficulty. A very large number of such measurements were made, the principal of which are as follows:—

Relative Length of Tissues by Separate Measurement.

No.	Bast.	Soft Tissue.	Ratios.	Remarks.
1	14.7 c. m.	16.5 c. m.	1 : 1.12	Lagenaria vulgaris,
2	5.0 "	7.0 "	1 : 1.4	Megarrhiza fabacea.
3	11.8 "	13.8 "	1 : 1.17	" "
4	18.0 "	22.3 "	1 : 1.24	Cucurbita pepo.
5	21.6 "	25.2 "	1 : 1.16	" "
6	15.9 "	19.5 "	1 : 1.22	" "
7	12.1 "	13.7 "	1 : 1.13	" "
8	10.0 "	11.7 "	1 : 1.17	
9	15.4 "	19 4 "	1 : 1.26	
10	15.7 "	18.9 "	1 : 1.20	
11	11.2 "	12.8 "	1 : 1.14	
12	16.5 "	20.9 "	1 : 1.26	
13	22.3 "	26.4 "	1 : 1.18	
14	16.3 "	19.8 "	1 : 1.21	
15	13.2 "	15.3 "	1 : 1.16	
			1 : 1.20	

From this it appears that, although the mean ratio is necessarily lower, the relation which the ratios bear to the character of the spirals is the same as in the previous case. The mean ratio in the latter case is 1 : 1.20, which may be taken as fairly representing the true relative lengths of the tissues under consideration in the average tendril.

Discovery of a Pteraspidian Fish in the Silurian Rocks of New Brunswick.

By G. F. Matthew.

Although the existence of fish remains in the highest beds of the Silurian system in England and Russia has been known for many years, there has been until lately, a singular dearth of evidence of the presence of these vertebrates in beds of similar age in America. While the Devonian system has been found to contain abundant remains of fishes both in the Old World and the New, the Silurian system in America, four years ago, was not known to have any authentic remains of the hard parts of fishes.

The fishes of the Silurian age are of two kinds[1]—Pteraspidian ganoids, known by the hard plates that covered the anterior part of the body, and Selachians, whose presence is known by the occurrence of spines of a peculiar kind. The Pteraspidians had a peculiar, fine, but distinct striation of the covering plates of the body, by which their remains are easily recognized. These fossils have, within a few years, been found in the Silurian rocks of Pennsylvania by Prof. E. W. Claypole, to whose acumen and industry we are indebted for many new facts respecting this interesting, and as yet but imperfectly understood family of fishes.

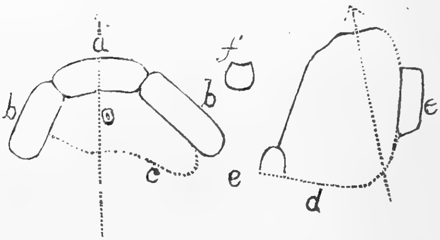
I propose herein to call attention to the discovery in Canada, of fish remains of this peculiar type. The fossils occur in beds of the Silurian system which are found on the southern slope of the Nerepis Hills in King's County, New Brunswick. These beds are of a very fine texture; they are evenly banded, silicious mud-rocks or hardened shales, and pertain to No. 2 of the Mascareen Succession. No. 3 of this series contains marine species such as mark the Lower Helderberg Horizon of New York, or the Ludlow of England.

Only one example of the fish is known, and this exhibits several plates belonging to its dermal covering. A part of the rostrum and of the dorsal scute, and two lateral

[1] A representative of the tuberculated placoderms (Coccosteus) occurs in Barrande's Etage F in Bohemia, but this family belongs rather to Devonian than Silurian times.

plates ("cornua"?) are preserved, as well as the front half or third of the ventral shield; the striæ on the ventral scute are symmetrical in relation to a median line passing through it; there is a detached fragment of a plate with concentric striæ like the eye plate of *Pteraspis rostrata.*[1] There is also a large plate more strongly arched than the ventral scute, on which the striæ are not arranged with entire symmetry; it appears to be the dextral half of the dorsal plate; it resembles the shield of Prof. Claypole's *Palæaspis Americana* in form, and in the linear striæ of the border, but I can hardly think that it belongs to a different individual from that to which the plates already described pertain. On one side of this large plate is a small longitudinally striated side plate, and on the opposite side the fragment of another.

Numbers of carapaces of a small Ceratiocaris occur on the layers with the fish plates. The author is not aware that the existence of a ventral shield has hitherto been observed in any pteraspidian fish, although it is well known to exist in the large Devonian placoderms; the species is evidently different from any other known, and he would propose for it the name *Pteraspis (?) Acadica.*



a. The infra-rostral plate.
b, b. Anterior plates of the ventral shield.
c. The ventral scute—a part only is preserved.
d. The large oval plate—dextral half of the dorsal scute, seen from below.
e, e. Lateral plates of the dorsal shield.
f. Part of the eye-plate. (?)

N.B.—The vertical dotted lines represent the median line of the principal ventral plate and the supposed axial line of the half of the dorsal scute.

[1] Quart. Jour. Geol. Soc., Feb. 1865, p. 62.

The Affinities of the Tendrils in the Virginian Creeper.

By A. T. Drummond.

The Virginian Creeper (*Ampelopsis quinquefolia*, Michx.) is the most familiar ornamental climbing shrub found in gardens in Canada. It has, in its native state, a wide range, extending from about the vicinity of Quebec westward throughout Ontario to the valley of the Assiniboine in Manitoba.

When recently examining a number of these plants in different gardens, my attention was drawn to certain peculiarities in the growth of the tendrils and to the relation these tendrils bear to the panicles of flowers. The leaves of the Virginian Creeper are alternate, and, to the unobserving, the impression conveyed is that, on the young, growing shoots, the side of the stem opposite to the point of junction of the petiole with the stem is always furnished with a tendril. This, however, is not the case. The first two or three leaves formed on the growing stem or branch have no tendrils to correspond. The reason for this is obvious. The stem, up to the time it has put forth three or four leaves, is both robust and vigorous, and, being at the same time short, can readily retain its position without the aid of supporting arms. With the third or fourth leaf, the tendrils make their appearance. Here, however, is an eccentricity on the part of the plant. Instead of the tendrils occurring in consecutive order, one at the base of each petiole but on the opposite side from the leaf, they appear in regular successions of twos, and between each such set of two tendrils, that is, at every third petiole, a tendril is wanting. This peculiarity is uniform, and is characteristic also of *Vitis cordifolia.* The reason for it is not so clear, unless it is explained in any way by the affinities referred to farther on between the panicles of flowers and the tendrils.

An interesting feature in connection with this absence in the Virginian Creeper of the tendril at every third petiole, is that new, vigorous branchlets chiefly occur at the angle between the stem and leaf where the tendrils are absent, a strong, well-developed branchlet being the rare exception where the tendril is present. These branchlets are, of course, at the base of the petiole and not on the side of the stem where the tendril would be expected, were all the points of junction tendril-bearing. Dr. Balfour's contention is that in the vine and in *Ampelopsis Veitchii*, the tendrils are to be looked upon as the terminations of separate axes or as transformed terminal buds, and he adds that in the vine there are no young buds seen in the angle between the stem and leaves nor between the stem and tendrils. In *Ampelopsis quinquefolia* there are, however, invariably young buds in the angles between the leaves and stem wherever the opposite side of the stem is not tendril-bearing, and also in the similar angle of the leaf next below, but not in the angle of the leaf succeeding that lower on the stem. In other words, at the base of every third petiole—but only where a tendril occurs on the opposite side from the petiole—a young bud or branchlet is wanting. In *Vitis cordifolia*, again, there is always a bud, and, in some cases, two, in the angle of each leaf with the stem. As mentioned already, these young buds sometimes develop into vigorous, healthy branches. There is, therefore, in these two species not sufficient foundation for the theory that the tendrils are terminations of separate axes or modifications of the axes, nor do external appearances in these plants suggest it, though it might possibly apply in the case of the lower tendril of each set of two tendrils in the case of *Ampelopsis*. Dr. Asa Gray's view of the tendrils of these two plants is that they are branches of a very slender kind, similar to runners, but intended for climbing and not for propagation, and therefore destitute of buds or leaves. Two instances I have met with of the Virginian Creeper, gave colour to this view, in that each of the two tendrils bore a solitary trifoliate leaf.

There appear, however, to me, rather to be affinities between the tendrils of *Ampelopsis quinquefolia* and the peduncle and pedicels of its flower.[1] The angulation is somewhat simi-

[1] Darwin. Climbing Plants, 136.

lar, but, further, at the base of the petiole, two true stipules are always present, whilst on the tendril at each fork there is —and this also occurs in *Vitis cordifolia*—only one appendage, resembling, in this respect, the similar single appendage at each fork, subsequent to the first, in the peduncle and pedicel of the flower. Again, it will be noticed that in *Ampelopsis quinquefolia* the panicles of flowers possess the same peculiarity as the tendril, in the panicles appearing in successions of twos on the flower-bearing branches, but on the opposite side from the leaves, and in a panicle being wanting opposite each third leaf. The tendrils, further, occur in this plant only on the young leading shoots, and never on the flower-bearing branches which issue from these in the second or succeeding year. We might thus, perhaps, regard the tendrils of the Virginian Creeper as undeveloped panicles, which, appearing this year, serve the important purpose of enabling the parent stem to climb the supporting tree or wall, and thus best attain a position suitable for bearing its fully developed flowers on branchlets, which issue from this stem during next or in succeeding years. Torrey and Gray, in characterizing the order Vitacæ, to which *Ampelopsis quinquefolia* belongs, refer to the lower leaves as opposite and "the upper alternate, opposite the racemes or thyrsoid panicles, which are sometimes changed into tendrils." Passing over the fact that opposite lower leaves is not a character common to all species in the order, the change from panicles to tendrils—which I have seen in *Vitis cordifolia*, but not in *Ampelopsis quinquefolia*—would seem to confirm the view I have taken of the affinities of the tendril in this plant.

Abstract of a Paper on the Cambrian Faunas of Cape Breton and Newfoundland.

By G. F. Matthew.

In a paper read before the Royal Society of Canada on "The Cambrian Faunas of Cape Breton and Newfoundland," Mr. G. F. Matthew points out that the slates at Mira

River, Cape Breton, contain several species of trilobites, which show that these measures are in the upper part of the Olenus Zone, or Lingula Flags of Great Britain. The species observed were the followiug:—*Peltura scarabeoides*, Wahl; *Sphæropthalmus alatus*, Boeck; and *Agnostus pisiformis*, Lin. There is also a small Lingulella similar to that which characterizes the Upper Flags of the St. John Group, and also an Orthis, similar to *Orthis lenticularis*, Dal.

In a small collection of fossils sent to him by Mr. Howley, of the Geological Survey of Newfoundland, a number of species not heretofore reported from that island were observed. With the aid of these and the description of other species given by the late Mr. Billings and by Mr. Whiteaves, Mr. Matthew is able to classify rougbly the Cambrian horizons of that island.

HORIZON OF PARADOXIDES KJERULFI.

The oldest fossils appear to be those of Topsail Head and Brigus in Conception Bay. Mr. Billings describes from these places:—*Agraulos strenuus*, Bill.; *Stenotheca paupera*, Bill.; and *Iphidea*, allied to *I. bella*. To these may be added the following as characterizing the limestones of Topsail Head:—*Paradoxides Kjerulfi*, Linrs.: *Selenopleura*, sp.; *Ptychoparia*. sp.; *Stenotheca*, sp.; *Straparollina?* sp.; *Hyolithes Micmac*.

HORIZON OF THE CONOCORYPHEES.

Manual River, a small stream near Topsail Head, appears to give the next horizon, for Mr. Whiteaves chronicles from this place:—*Microdiscus punctatus*, Salter; *M. Dawsoni*, Hartt; *Agnostus Acadicus*. Hartt; *Conocephalites* (*Liostracus*) *tener*, Hartt; *C.* (*Conocoryphe*) *Baileyi*, Hartt; and *C.* (*Ptychoparia?*) *Orestes*, Hartt. Of these species the second, fourth and fifth do not range as high in the Cambrian beds of Acadia as the others, and it is possible that the collections examined may have been from two horizons. The assemblage of species, however, may be taken to correspond with those of Band C. of the Acadian area. In a fragment of shale from the same locality, the following were found:—*Paradoxides*, sp.; *Agraulos socialis*, Bill.; *Agnostus gibbus?* Linrs; *Hyolithes*, sp.

HORIZON OF PARADOXIDES TESSENI.

A different and probably somewhat higher horizon appears to be indicated by species found at Chapel Arm, Trinity Bay. Mr. Billings describes from this place:—*Paradoxides tenellus*, Bill.; *P. decorus*, Bill.; *Anopolinus venustus*, Bill.; *Obolella* (*Linnarssonia*) *misera*, Bill.; *Solenopleura communis*, Bill.; and *Agraulos socialis*, Bill. In the species from this locality there are also the following:—*Eocystites*, sp.; *Beyrichona?* sp.; *Agnostus lævigatus*, Dal.; *A. punctuosus*, Ang. var., *Agnosti*, other species and *Microdiscus punctatus*, Salt. There are fragments of a *Paradoxides*, which by its hypostome, suture, pleuræ and pygidium is very like *P. Tesseni* of Europe. This is, perhaps, the *P. decorus* of Billings. The organisms from this locality are evidently a Menevian assemblage, equivalent to Band *d* of Division I. of the St. John Group.

HORIZON OF PARADOXIDES SPINOSUS.

This species was quoted on account of the occurrence of *Paradoxides Bennettii*, Salt., at St. Mary's Bay. Discovered many years ago, it was the first which drew attention to the interesting Primordial Fauna of Newfoundland. The resemblance to *P. Harlani*, Green, from Braintree, Mass., has been pointed out by Mr. Walcott and others. Mr. Billings describes from the same locality *Agraulos affinis*. The corresponding species in the Acadian region is found in Division I., Band *c* (and *d*?). An *Agraulos* and a *Ptychoparia* have been described from the slates in which *P. Harlani* occurs in Massachusetts. If we have regard to the associated species, and also to the suture and eyelobe of *P. Bennettii* (=*P. Harlani?*), it seems probable that the horizon of this species is below that of *P. Forchammeri* and *P. Davidis* of the European Cambrian rocks.

HORIZON OF PARADOXIDES DAVIDIS.

In a black, calcareous rock from Highland's Cove, in Trinity Bay, there are abundant remains of a large *Para-*

doxides. The species, so far as the parts preserved give evidence, is *Paradoxides Davidis,* Salt. Associated with this species were the following:—*Paradoxides Loveni,* Ang? (pygidium); *Agnostus punctousus,* Ang., var.; and *A. brevifrons,* Ang.

In Newfoundland there would, therefore, appear to be a fuller representation of the various forms of the genus Paradoxides than has yet been found in any other part of America.

FAUNAS OF THE OLENUS ZONE.

Of the faunas of the higher part of the Cambrian of Newfoundland, except so far as it is developed in the northern and western part of the island, less is known. In the south-eastern peninsula, the beds above the Paradoxides beds are described as shallow-water deposits—sandstones and flags similar to the Lingula flags of Great Britain.

Mr. Billings has described from these upper measures the following species (locality, Bell Island, in Conception Bay):—*Eophyton Linnœanum,* Tor.; *E. Jukesi,* Bill.; *Arthraria antiquata,* Bill.; *Lingula Murrayi,* Bill.; *Lingulella (?) affinis,* Bill.; *L. (?) spissa,* Bill.; and *Cruziana similis,* Bill. From Kelly's Island, in Conception Bay, not far from Bell Island, Mr. Whiteaves describes a pretty little Lingula (*Lingula Billingsiana*). These fossils resemble those of the Lingula flags in Great Britain and those found in the St. John Group; but the determination of exact horizons in the upper part of the Cambrian in Newfoundland must await the discovery of fossils in the finer beds of that part of the formation.

In this classification of the various Newfoundland Horizons in the Paradoxides Zone, Mr. Matthew has placed that of *Paradoxides Kjerulfi* first, or oldest, because that is its position in Scandinavia. *P. Kjerulfi* is by some palæontologists classed as an *Olenellus,* but it has not been shown to possess the peculiar pygidium of that genus.

Invaporation.

By W. L. Goodwin.

About sixty years ago, Thomas Graham made some curious experiments with solutions of salts, enclosing them along with water in tin canisters. The solutions increased in weight by condensing water vapour from the saturated atmosphere. This process he called *invaporation*, in contradistinction to *evaporation*. He showed that different salts invaporate at different rates, e.g., common salt having a comparatively strong power of invaporation, and sodic sulphate very weak. One result of this invaporating power of saline solutions is noteworthy. The atmosphere over the ocean must be drier than that over a fresh-water lake. The vapour tensions of saline solutions have since been determined accurately, and confirm Graham's early experiments. The process of invaporation can be watched easily, and it is certainly a most interesting case of the transference of masses of matter by molecular movements. If a small quantity of dry sodium chloride be put in a glass tube open at one end, and sealed up in a larger tube, or in a well stoppered bottle, along with a quantity of water in a second small tube, the salt gradually attracts the moisture, forms a solution, and at length takes to itself the whole of the water, so that the second small tube becomes quite dry. The process is a slow one, requiring months to complete in some cases; but, even where the proportion of water is very large, the salt is not satisfied until it has taken the whole of it.

My colleague, Professor Marshall and myself, have made a series of experiments with the object of measuring the relative forces with which different salts invaporate. Molecular proportions of two salts were enclosed in the same space with a certain quantity of water, for which they were allowed to strive until they had divided it between them. The experiments were made with pairs of chlorides, and different proportions of water were used with the same pair of salts so as to ascertain the effect of dilution. Some very unexpected results were obtained. For example, when lithium and sodium chlorides were allowed to strive for a small quantity of water, the lithium chloride (a deliquescent salt) took the whole of it, the sodium chloride remaining quite dry. This was the result after the salts were enclosed for several months. But with a larger proportion of water, the sodium chloride obtained a small share. When the proportion of water was greatly increased, the result of the contest was different; for it was found, most unexpectedly, that the sodic chloride was now able to seize upon and retain the lion's share. The explanation is to be sought, in all probability, in the formation of a hydrate by the lithium chloride. Sodic chloride does not crystallise with water at ordinary temperatures, while lithium chloride does. It is probable that the lithium chloride attracts water strongly until a definite hydrate is formed, and, thus satisfied, allows the weaker attraction of the sodium chloride to come into play. Further experiments are being made on this point. We have also made experiments with sodium and potassium chlorides, and find that with a small quantity of water, the sodium chloride takes nearly the whole of it. Larger quantities are more evenly divided. Whether this case is reversed or not with increased dilution, we have not yet determined. The experiments are now being extended to cases in which a well known chemical action takes place, the object being to compare solution with chemical action. Molecular proportions of phosphoric and citric acids have been enclosed with aqueous solution of ammonia, insufficient to neutralise both acids. As is well known, solutions of ammonia salts become acid by loss of ammonia to the atmosphere. These two acids will strive for the ammonia just as the salts do or water. The result of the battle is yet to be seen. We hope by these researches to throw some light upon the vexed question of the nature of solution.

QUEEN'S UNIVERSITY, Kingston, Ont.,
September 20th, 1886.

The Law of Volumes in Chemistry.[1]

By T. Sterry Hunt.

The questions regarding the so-called molecular weights and volumes of liquids and solids, which are now attracting the attention of chemists, can, I think, be better understood if we keep in mind the principles enunciated by the writer in 1853, that "the doctrine of chemical equivalents is that of the equivalency of volumes," and that "the simple relations of volumes which Gay-Lussac pointed out in the chemical changes of gases, apply to all liquid and solid species;" so that "the application of the atomic hypothesis to explain the laws of definite proportions becomes wholly unnecessary." In further illustration of this view it was said, in 1867, that "the gas or vapor of a volatile body constitutes a species distinct from the same body in a liquid or solid state; and the liquid and solid species themselves often [probably always] constitute two distinct species of different equivalent weights." From this it follows that freezing, melting, and vaporization are chemical changes. The union of many volumes of a vapor or gas in a single volume of a liquid or of a solid, is a process of chemical combination, while vaporization is chemical decomposition. Such decomposition is either with or without specific difference, and examples of these two modes are seen respectively in heterogeneous dissociation and in integral volatilization, which latter is the breaking up or dissociation of a polymeric species into simpler forms having the same centesimal composition. Both of these processes are subordinated to the same laws of pressure and temperature, and involve similar thermic changes in the relations of the bodies concerned. In this enlarged conception of the chemical process we find a solution of the problems above named, and an explanation of the distinction which has been made between "the chemical molecule" and "the molecule of the physicist." That the latter has a much less simple constitution than the former, as calculated from the results of chemical

[1] Also Science for September 10, 1886.

analysis and from vapor-density, has been long maintained alike on dynamical and chemical grounds. It is discussed by the writer in 1853 in the essay already quoted, entitled "The Theory of Chemical Changes and Equivalent Volumes,"[1] and again in the late paper of Spencer Pickering in the *Chemical News* for November, 1885.

If, then, as maintained by the writer, the law of volumes is universal, and if the production of liquids and solids by the condensation of vapors is a process of chemical union, giving rise to polymerids, the equivalent weights of which are as much more elevated as their densities are greater than those of the vapors which combine to form them, the hypothesis of atoms and molecules, as applied to explain the law of definite proportions and the chemical process, is not only unnecessary, but misleading. According to this hypothesis, which supposes molecules to be built up of atoms, and masses of molecules, the different ratios in unlike species between the combining weight of the chemical unit or molecule (as deduced from analysis and from vapor-density; $H = 1.0$) and the specific gravity of the mass are supposed to represent the relative dimensions of the molecule. Hence, the values got by dividing these combined weights by the specific gravity have been called "molecular volumes." The number of such molecules required to build up a physical molecule of constant volume would, according to this hypothesis, be inversely as their size. If, however, as all the phenomena of chemistry show, the formation of higher and more complex species is by condensation, or, in other words, by identification of volume, and not by juxtaposition, it follows that the so-called molecular volumes are really the numbers representing the relative amount of contraction of the respective substances in passing from the gaseous to the liquid or solid state, and are the reciprocals of the coefficient of condensation of the assumed chemical units. If steam at 100° C. and 760 millimetres pressure, with a formula, as deduced from its density, of H_2O, and a combining weight of 18, is converted into

[1] See the author's "Chemical and Geological Essays," pp. 426-437, and, further, *ibid.*, pp. 453-458.

water at the same temperature, 1,628 volumes of it are condensed into a single volume, having a specific gravity of 0.9588, which at 4° C. becomes 1.0000. Water is thus 1,628 = (H_2O); and the weight of its volume at the temperature of formation, as compared with an equal volume of hydrogen gas or of steam, in other words, its equivalent weight, is 1,628×18=29,304, which thus corresponds to a specific gravity of 1.000; ice, at its temperature of formation, with a specific gravity of 0.9167, being 1,487=(H_2O) with an equivalent weight of 26,766. The hydrocarbon, C_4H_{10}=58, condenses to a liquid having, according to Pelouze and Cahours, a specific gravity of 0.600, which corresponds to an equivalent weight, as compared with that of water, of 17,582, or approximately 303 (C_4H_{10}), with a calculated specific gravity of 0.5997. The reciprocal of the co-efficient of condensation (or so-called molecular volume) of steam is 18, while that of the gaseous hydrocarbon is 600 : 1000 :: 58 : x= 96.66.

The chemical unit for bodies, which, like these, volatilize integrally, is fixed by the density of their vapors; while for fixed species, like anhydrous oxides and silicates, or for those which by heat undergo heterogeneous dissociation, as for example calcite and hydrous silicates, the unit may be the simplest formula deduced from analysis, or, for greater convenience in calculation in the case of oxides and silicates, may have a value corresponding to H=1, or O=8. The unit for silica thus becomes $Si\,O_2 \div 4 = 15$; that for alumina, $Al_2O_3 \div 6 = 17$; and that for the magnesian silicate, $Si\,Mg_2\,O_4 \div 8 = 17.5$. Such unit-weights as these have been employed by the writer in his late essay on "A Natural Sytem in Mineralogy," in the tables of which they are represented by P; while the values got by dividing these numbers by the specific gravity of the species have been designated unit-volumes, and represented by V. The writer of that essay, in deference to the general usage of chemists, therein adopted the received terminology of "molecular weights" and "molecular volumes," and, failing at the time to grasp the full significance of his own earlier teachings as to the universality of the law of volumes, spoke of the so-called molecular weight as an unknown quantity, although, in accordance with that principle, this molecular weight, or, properly speaking, this equivalent weight, is simply deduced for any body the specific gravity of which is unknown.

MISCELLANEOUS.

SOLUTION OF STARCH IN LEAVES.—A diastatic ferment can be extracted from green leaves in the following way:—The leaves are bruised in a mortar, and covered with cold water; after 24 hours they are pressed, and 1½ volumes of 90° alcohol added to the juice, which is then filtered. The same quantity of alcohol is again added to the filtrate, and after a few minutes, the clear liquid is filtered off and the precipitate washed once or twice with alcohol of 65°. The diastase is obtained in solution by dissolving the washed precipitate in water and filtering. 10 c.c. of such a solution is added to 0.5 gram. of starch into a paste and kept at 63°, and the formation of sugar is shown by comparison with a similar flask to which a few drops of chloroform have been added. The leaves of the potato, dahlia, artichoke, maize, beet, castor oil plant, and the unripe seeds of the opium poppy, sunflower, and castor oil plant, have all yielded positive results. Microbes have not been found in the solution, and the starch was in all cases transformed into a mixture of reducing sugar and dextrine. To connect this with the formation of sugar in growing plants, the author shows, by a series of experiments that, although diastase will only act on starch paste and not on crude starch at 60°, 57°, and 50°, yet at 42° and 34° it always transforms a little crude starch into sugar. The quantity of sugar produced reaches a limit in twenty-four or thirty-six hours; but if it be dialyzed out of the solution as fast as it is formed, the formation is rendered continuous. The same result is produced by diluting the solution, so that it seems to be the accumulation of sugar which puts an end to the diastatic action.

Cuboni's experiment, therefore, in which the disappearance of starch from a vine leaf, placed in the dark, was prevented by an annular incision in the stem above and below the leaf, does not negative the idea that starch is transformed into sugar by a diastatic ferment in the leaf: arrest of sugar formation would, under these circumstances, be brought about by accumulation of sugar in the isolated leaf. When only one incision is made, either above or below the leaf, the starch disappears as usual; and when a grape cluster, either in flower or fruit, is opposite the leaf, the starch disappears, even when the stem is cut through above and below. It appears from this that the demand for fresh supplies of carbohydrates in some centre of growth will drain off the accumulated organ with sufficient rapidity to render its formation continuous.—*Ann. Agronom.*, 12, 200-203.

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Presidential Address before the British Association for the Advancement of Science, Sept. 1886.

By Sir J. William Dawson, C.M.G., M.A., LL.D., F.R.S., F.G.S.,

Principal and Vice-Chancellor of McGill University, Montreal, Canada.

(*Concluded.*)

We may also note a fact which I have long ago insisted on,[1] the regular pulsation of the continental areas, giving us alternations in each great system of formations of deep-sea and shallow-water beds, so that the successive groups of formations may be divided into triplets of shallow-water, deep-water, and shallow-water strata, alternating in each period. This law of succession applies more particularly to the formations of the continental plateaus, rather than to those of the ocean margins, and it shows that, intervening between the great movements of plication, there were subsidences of those plateaus, or elevations of the sea bottom, which allowed

[1] *Acadian Geology*, 1865.

the waters to spread themselves over all the inland spaces between the great folded mountain ranges.

In referring to the ocean basins, we should bear in mind that there are three of these in the northern hemisphere—the Arctic, the Pacific, and the Atlantic. De Rance has ably summed up the known facts as to Arctic geology in a series of articles in "Nature," and from which it appears that this area presents from without inwards a succession of older and newer formations from the Eozoic to the Tertiary, and that its extent must have been greater in former periods than at present, while it must have enjoyed a comparatively warm climate from the Cambrian to the Pleistocene period. The relations of its deposits and fossils are closer with those of the Atlantic than with those of the Pacific, as might be anticipated from its wider opening into the former. Blandford has recently remarked on the correspondence of the marginal deposits around the Pacific and Indian oceans,[1] and Dr. Dawson informs me that this is equally marked in comparison with the west coast of America,[2] but these marginal areas have not yet gained much on the ocean. In the North Atlantic, on the other hand, there is a wide belt of comparatively modern rocks on both sides, more especially toward the south and on the American side; but while there appears to be a perfect correspondence on both sides of the

[1] A singular example is the recurrence in New Zealand of Triassic rocks and fossils of types corresponding to those of British Columbia. A curious modern analogy appears in the works of art of the Maoris with those of the Haida Indians of the Queen Charlotte Islands, and both are eminently Pacific in contradistinction to Atlantic.

[2] *Journal of Geological Society,* May 1886. Blandford's statements respecting the mechanical deposits of the close of the Palæozoic in the Indian ocean, whether these are glacial or not, would seem to show a correspondence with the Permian conglomerates and earth-movements of the Atlantic area; but since that time, the Atlantic has enjoyed comparative repose. The Pacific seems to have reproduced the conditions of the Carboniferous in the Cretaceous age, and seems to have been less affected by the great changes of the Pleistocene.

Atlantic, and around the Pacific respectively, there seems to be less parallelism between the deposits and forms of life of the two oceans as compared with each other, and less correspondence in forms of life, especially in modern times. Still in the earlier geological ages, as might have been anticipated from the imperfect development of the continents, the same forms of life characterise the whole ocean from Australia to Arctic America, and indicate a grand unity of Pacific and Atlantic life not equalled in later times,[1] and which speaks of contemporaneity rather than of what has been termed homotaxis.

We may pause here for a moment to notice some of the effects of Atlantic growth on modern geography. It has given us rugged and broken shores composed of old rocks in the north, and newer formations and softer features toward the south. It has given us marginal mountain ridges and internal plateaus on both sides of the sea. It has produced certain curious and by no means accidental correspondences of the eastern and western sides. Thus the solid basis on which the British Islands stand may be compared with Newfoundland and Labrador, the English Channel with the Gulf of St. Lawrence, the Bay of Biscay with the Bay of Maine, Spain with the projection of the American land at Cape Hatteras, the Mediterranean with the Gulf of Mexico. The special conditions of deposition and plication necessary to these results, and their bearing on the character and productions of the Atlantic basin would require a volume for their detailed elucidation.

Thus far our discussion has been limited almost entirely to physical causes and effects. If we now turn to the life history of the Atlantic, we are met at the threshold with the question of climate, not as a thing fixed and immutable, but as changing from age to age in harmony with geographical mutations, and producing long cosmic summers and winters of alternate warmth and refrigeration.

[1] Daintree and Etheridge, 'Queensland Geology,' *Journal Geological Society*, August 1872; R. Etheridge, Junior, 'Australian Fossils,' *Trans. Phys. Soc.*, Edin. 1880.

We can scarcely doubt that the close connection of the Atlantic and Arctic oceans is one factor in those remarkable vicissitudes of climate experienced by the former, and in which the Pacific area has also shared in connection with the Antarctic Sea. No geological facts are indeed at first sight more strange and inexplicable than the changes of climate in the Atlantic area, even in comparatively modern periods. We know that in the early Tertiary, perpetual summer reigned as far north as the middle of Greenland, and that in the Pleistocene, the Arctic cold advanced until an almost perennial winter prevailed half way to the equator. It is no wonder that nearly every cause available in the heavens and the earth has been invoked to account for these astounding facts.

It will, I hope, meet with the approval of your veteran glaciologist Dr. Crosskey if, neglecting most of these theoretical views, I venture to invite your attention in connection with this question chiefly to the old Lyellian doctrine of the modification of climate by geographical changes. Let us, at least, consider how much these are able to account for.

The ocean is a great equalizer of extremes of temperature. It does this by its great capacity for heat, and by its cooling and heating power when passing from the solid into the liquid and gaseous states, and the reverse. It also acts by its mobility, its currents serving to convey heat to great distances or to cool the air by the movement of cool icy waters. The land, ou the other hand, cools or warms rapidly, and can transmit its influence to a distance only by the winds, and the influence so transmitted is rather in the nature of a disturbing than of an equalizing cause. It follows that any change in the distribution of land and water must affect climate, more especially if it changes the character or course of the ocean currents.[1]

At the present time, the North Atlantic presents some very peculiar and in some respects exceptional features, which are

[1] Von Wœickoff has very strongly put these principles in a Review of Croll's recent book, *Climate and Cosmology; American Journal of Science*, March, 1886.

most instructive with reference to its past history. The great internal plateau of the American continent is now dry land; the passage across Central America between the Atlantic and Pacific is blocked; the Atlantic opens very widely to the north; the high mass of Greenland towers in its northern part. The effects are that the great equatorial current, running across from Africa and embayed in the Gulf of Mexico, is thrown northward and eastward in the Gulf Stream, acting as a hot-water apparatus to heat up to an exceptional degree the western coast of Europe. On the other hand, the cold Arctic current from the polar seas is thrown to the westward, and runs down from Greenland past the American shore.[1] The pilot chart for June of this year shows vast fields of drift ice on the western side of the Atlantic as far south as the latitude of 40.° So far, therefore, the Glacial age in that part of the Atlantic still extends; and this at a time when, on the eastern side of the Ocean, the culture of cereals reaches in Norway beyond the Arctic Circle. Let us inquire into some of the details of these phenomena.

The warm water thrown into the North Atlantic not only increases the temperature of its whole waters, but gives an exceptionally mild climate to Western Europe. Still the countervailing influence of the Arctic currents, and the Greenland ice is sufficient to permit icebergs, which creep down to the mouth of the Strait of Belle Isle, in the latitude in the south of England, to remain unmelted till the snows of succeeding winters fall upon them. Now let us suppose that a subsidence of land in tropical America were to allow the equatorial current to pass through into the Pacific. The effect would at once be to reduce the temperature of Norway and Britain to that of Greenland and Labrador at present, while the latter countries would themselves become colder. The northern ice, drifting down into the Atlantic, would not, as now, be melted rapidly by the warm water which it meets in the Gulf Stream. Much larger quantities of it would remain undissolved in summer, and thus an accumulation of

[1] I may refer here to the admirable expositions of these effects by the late Dr. Carpenter, in his papers on the results of the explorations of the *Challenger*.

permanent ice would take place, along the American coast at first, but probably at length even on the European side. This would still further chill the atmosphere, glaciers would be established on all the mountains of temperate Europe and America,[1] the summer would be kept cool by melting ice and snow, and, at length, all Eastern America and Europe might become uninhabitable, except by arctic animals and plants, as far south as perhaps 40° of north latitude. This would be simply a return of the Glacial age. I have assumed only one geographical change; but other and more complete changes of subsidence and elevation might take place, with effects on climate still more decisive; more especially would this be the case if there were a considerable submergence of the land in temperate latitudes.

We may suppose an opposite case. The high plateau of Greenland might subside or be reduced in height, and the North Atlantic might be closed. At the same time, the interior plain of America might be depressed, so that, as we know to have been the case in the Cretaceous period, the warm waters of the Mexican Gulf would circulate as far north as the basins of the present great American lakes. In these circumstances there would be an immense diminution of the sources of floating ice, and a correspondingly vast increase in the surface of warm water. The effects would be to enable a temperate flora to subsist in Greenland, and to bring all the present temperate regions of Europe and America into a condition of sub-tropical verdure.

It is only necessary to add that we know that vicissitudes not dissimilar from those above sketched, have actually occurred in comparatively recent geological times, to enable us to perceive that we can dispense with all other causes of change of climate, though admitting that some of them may have occupied a secondary place.[2] This will give us, in dealing

[1] According to Bonney, the west coast of Wales is about 12° above the average for its latitude, and if reduced to 12° below the average, its mountains would have large glaciers.

[2] More especially, the ingenious and elaborate arguments of Croll deserve consideration; and, though I cannot agree with him in this main thesis, I gladly acknowledge the great utility of the work he has done.

with the distribution of life, the great advantage of not being tied up to definite astronomical cycles of glaciation, which may not always suit the geological facts, and of correlating elevation and subsidence of the land with changes of climate affecting living beings. It will, however, be necessary, as Wallace well insists, that we shall hold to that degree of fixity of the continents in their position, notwithstanding the submergences and emergences they have experienced, to which I have already adverted. Sir Charles Lyell, more than forty years ago, published in his 'Principles of Geology' two imaginary maps which illustrate the extreme effects of various distribution of land and water. In one, all the continental masses are grouped around the equator. In the other, they are all placed around the poles, leaving an open equatorial ocean. In the one case, the whole of the land and its inhabitants would enjoy a perpetual summer, and scarcely any ice could exist in the sea. In the other, the whole of the land would be subjected to an Arctic climate, and it would give off immense quantities of ice to cool the ocean. But Lyell did not suppose that any such distribution as that represented in his maps had actually occurred, though this supposition has been sometimes attributed to him. He merely put what he regarded as an extreme case to illustrate what might occur under conditions less exaggerated. Sir Charles, like other thoughtful geologists, was well aware of the general fixity of the areas of the continents, though with great modifications in the matter of submergence and of land conditions. The union, indeed, of these two great principles of fixity and diversity of the continents lies at the foundation of theoretical geology.

We can now more precisely indicate this than was possible when Lyell produced his 'Principles,' and can reproduce the conditions of our continents in even the more ancient periods of their history. Some examples may be taken from the history of the American continent, which is more simple in its arrangements than the double continent of Europ-asia. We may select the early Devonian or Erian period, in which the magnificent flora of that age—the earliest certainly known to us—made its appearance. Imagine the whole interior plain of North America submerged, so that the continent is reduced to two strips on the east and west, connected by a belt of Laurentian land on the north. In the great Mediterranean sea thus produced, the tepid water of the equatorial current circulated, and it swarmed with corals, of which we know no less than one hundred and fifty species, and with other forms of life appropriate to warm seas. On the islands and coasts of this sea was introduced the Erian flora, appearing first in the north, and with that vitality and colonising power, of which, as Hooker has well shown, the Scandinavian flora is the best modern type, spreading itself to the south.[1] A very similar distribution of land and water in the Cretaceous age gave a warm and equable climate in those portions of North America not submerged, and coincided with the appearance of the multitude of broad-leaved trees of modern types introduced in the early and middle Cretaceous, and which prepared the way for the mammalian life of the Eocene. We may take a still later instance from the second continental period of the later Pleistocene or early Modern, when there would seem to have been a partial or entire closure of the North Atlantic against the Arctic ice, and wide extensions seaward of the European and American land, with possibly considerable tracts of land in the vicinity of the equator, while the Mediterranean and the Gulf of Mexico were deep inland lakes.[2] The effect of such conditions on the climates of the northern hemisphere must have been prodigious, and their investigation is rendered all the more interesting because it would seem that this continental period of the post-Glacial age was that in which man made his first acquaintance with the coasts of the Atlantic, and possibly made his way across its waters.

We have in America ancient periods of cold as well as of

[1] As I have elsewhere endeavoured to show (*Report on Silurian and Devonian Plants of Canada*), a warm climate in the Arctic region seems to have afforded the necessary conditions for the great colonising floras of all geological periods. Gray had previously illustrated the same fact in the case of the more modern floras.

[2] Dawkins, *Popular Science Monthly*, 1873.

warmth. I have elsewhere referred to the boulder conglomerates of the Huronian, of the Cambrian and Ordovician, of the Millstone-grit period of the Carboniferous and of the early Permian; but would not venture to affirm that either of these periods was comparable in its cold with the later glacial age, still less with that imaginary age of continental glaciation assumed by certain of the more extreme theorists.[1] These ancient conglomerates were probably produced by floating ice, and this at periods when in areas not very remote, temperate floras and faunas could flourish. The glacial periods of our old continent occurred in times when the surface of the submerged land was opened up to the northern currents, drifting over it mud and sand and stones, and rendering nugatory, in so far at least as the bottom of the sea was concerned, the effects of the superficial warm streams. Some of these beds are also peculiar to the eastern margin of the continent, and indicate ice-drift along the Atlantic coast in the same manner as at present, while conditions of greater warmth existed in the interior. Even in the more recent Glacial age, while the mountains were covered with snow and the lowlands submerged under a sea laden with ice, there were interior tracts in somewhat high latitudes of America in which hardy forest trees and herbaceous plants flourished abundantly; and these were by no means exceptional 'inter-glacial' periods. Thus we can show that while from the remote Huronian period to the Tertiary, the American land occupied the same position as at present, and while its changes were merely changes of relative level as compared with the sea, these have so influenced the ocean currents as to cause great vicissitudes of climate.

Without entering on any detailed discussion of that last and greatest Glacial period, which is best known to us, and is more immediately connected with the early history of man and the modern animals, it may be proper to make a few general statements bearing on the relative importance of sea-borne and land ice in producing those remarkable

[1] *Notes on Post-Pliocene of Canada.* Hicks, *Pre-Cambrian Glaciers, Geol. Mag.*, 1880.

phenomena attributable to ice action in this period. In considering this question, it must be borne in mind that the greater masses of floatiug ice are produced at the seaward extremities of land glaciers, and that the heavy field-ice of the Arctic regions is not so much a result of the direct freez ing of the surface of the sea as of the accumulation of snow precipitated on the frozen surface. In reasoning on the extent of ice action, and especially of glaciers in the Pleistocene age, it is necessary to keep this full in view. Now in the formation of glaciers at present—and it would seem also in any conceivable former state of the earth—it is necessary that extensive evaporation should conspire with great condensaticn of water in the solid form. Such conditions exist in mountainous regions sufficiently near to the sea, as in Greenland, Norway, the Alps, and the Himalayas; but they do not exist in low arctic lands like Siberia or Grinnel-land, nor in inland mountains. It follows that land glaciation has narrow limits, and that we cannot assume the possibility of great confluent or continental glaciers covering the interior of wide tracts of land. No imaginable increase of cold could render this possible, inasmuch as there could not be a sufficient influx of vapour to produce the necessary condensation; and the greater the cold, the less would be the evaporation. On the other hand, any increase of heat would be felt more rapidly in the thawing and evaporation of land ice and snow than on the surface of the sea.

Applying these very simple geographical truths to the North Atlantic continents, it is easy to perceive that no amount of refrigeration could produce a continental glacier, because there could not be sufficient evaporation and precipitation to afford the necessary snow in the interior. The case of Greenland is often referred to, but this is the case of a high mass of cold land with sea, mostly open, on both sides of it, giving, therefore, the conditions most favorable to precipitation of snow. If Greenland were less elevated, or if there were dry plains around it, the case would be quite different, as Nares has well shown by his observations on the

[1] These views have been admirably illustrated by Von Wœickoff in the paper already referred to and in previous geographical papers.

summer verdure of Grinnel-land, which, in the immediate vicinity of North Greenland, presents very different conditions as to glaciation and climate.[1] If the plains were submerged, and the Arctic currents allowed free access to the interior of the continent of America, it is conceivable that the mountainous regions remaining out of water would be covered with snow and ice, and there is the best evidence that this actually occurred in the Glacial period; but with the plains out of water, this would be impossible. We see evidence of this at the present day in the fact that in unusually cold winters the great precipitation of snow takes place south of Canada, leaving the north comparatively bare, while as the temperature becomes milder, the area of snow-deposit moves farther to the north. Thus a greater extension of the Atlantic, and especially of its cold, ice-laden Arctic currents, becomes the most potent cause of a glacial age.

I have long maintained these conclusions on general geographical grounds, as well as on the evidence afforded by the Pleistocene deposits of Canada; and in an address, the theme of which is the ocean, I may be excused for continuing to regard the supposed terminal moraines of great continental glaciers as nothing but the southern limit of the ice-drift of a period of submergence. In such a period, the southern margin of an ice-laden sea, where its floe-ice and bergs grounded, or where its ice was rapidly melted by water, and where, consequently, its burden of boulders and other *debris* was deposited, would necessarily present the aspect of a moraine, which by the long continuance of such conditions, might assume gigantic dimensions. Let it be observed, however, that I fully admit the evidence of the great extension of local glaciers in the Pleistocene age, and especially in the times of partial submergence of the land.

I am quite aware that it has been held by many able American geologists[1] that in North America, a continental glacier extended in temperate latitudes from sea to sea, or at least from the Atlantic to the Rocky Mountains, and that

[1] Report of Mr. Carvill Lewis, in *Pennsylvania Geological Survey*, 1884; also Dana's *Manual.*

this glacier must, in many places, have exceeded a mile in thickness. The reasons above stated appear, however, sufficient to compel us to seek for some other explanation of the observed facts, however difficult this may at first sight appear. With a depression such as we know to have existed, admitting the Arctic currents along the St. Lawrence Valley, through gaps in the Laurentian watershed, and down the great plains between the Laurentian areas and the Rocky Mountains, we can easily understand the covering of the hills of Eastern Canada and New England with ice and snow, and a similar covering of the mountains of the west coast. The sea also, in this case, might be ice-laden and boulder-bearing as far south as 40°, while there might still be low islands far to the north on which vegetation and animals continued to exist. We should thus have the conditions necessary to explain all the anomalies of the glacial deposits. Even the glaciation of high mountains south of the St. Lawrence Valley would then become explicable by the grounding of ice on the tops of these mountains when reefs in the sea. In like manner we can understand how on the isolated trappean hill of Belœil, in the St. Lawrence Valley, Laurentian boulders, far removed from their native seats to the north, are perched at a height of 1,200 feet on a narrow peak where no glacier could possibly have left them. The so-called moraine, traceable from the great Missouri Coteau in the west, to the coast of New Jersey, would thus become the mark of the western and southern limit of the subsidence, or of the line along which the cold currents bearing ice were abruptly cut off by warm surface waters. I am glad to find that these considerations are beginning to have weight with European geologists in their explanation of the glacial drift of the great plains of Northern Europe.

Whatever difficulties may attend such a supposition, they are small compared with those attendant on the belief in a continental glacier, moving without the aid of gravity, and depending for its material on the precipitation taking place on the interior plains of a great continent.

I have elsewhere endeavoured to show, on the evidence found in Canada, that the occurrence of marine shells, land plants, and insects in the glacial deposits of that country indicate not so much the effect of several inter-glacial periods, as the local existence of conditions like those of Grinnelland and Greenland, in proximity to each other at one and the same period, and depending on the relative levels of land and the distribution of ocean currents and ice-drift.[1]

I am old enough to remember the sensation caused by the delightful revelations of Edward Forbes respecting the zones of animal life in the sea, and the vast insight which they gave into the significance of the work on minute organisms previously done by Ehrenberg, Lonsdale, and Williamson, and into the meaning of fossil remains. A little later, the soundings for the Atlantic cable revealed the chalky foraminiferal ooze of the abyssal ocean; still more recently, the wealth of facts disclosed by the Challenger voyage, which naturalists have not yet had time to digest, have opened up to us new worlds of deep-sea life.

The bed of the deep Atlantic is covered, for the most part, by a mud or ooze, largely made up of the *debris* of formini-fera and other minute organisms mixed with fine clay. In the North Atlantic, the Norwegian naturalists call this the Biloculina mud. Further south, the Challenger naturalists speak of it as Globigerina ooze. In point of fact it contains different species of foraminiferal shells, Globigerina and Orbulina being in some localities dominant, and in others, other species, and these changes are more apparent in the shallower portions of the ocean.

On the other hand, there are means for disseminating coarse material over parts of the ocean-beds. There are, in the line of the Arctic current, on the American coast, great sand-banks, and off the coast of Norway, sand constitutes a considerable part of the bottom material. Soundings and dredgings off Great Britain, and also off the American coast, have shown that fragments of stone referable to Arctic lands are abundantly strewn over the bottom along certain lines, and the Antarctic continent, otherwise almost unknown, makes its presence felt to the dredge by the abundant

[1] *Notes on Post-Pliocene of Canada*, 1872. One well-marked interval only has been established in the glacial deposits of Canada.

masses of crystalline rock, drifted far from it to the north. These are not altogether new discoveries. I had inferred many years ago, from stones taken up by the hooks of fishermen on the banks of Newfoundland, that rocky material from the north is dropped on these banks by the heavy ice which drifts over them every spring, that these are glaciated, and that after they fall to the bottom, sand is drifted over them, with sufficient velocity to polish the stones, and to erode the shelly coverings of Arctic animals attached to them.[1] If then the Atlantic basin were upheaved into land, we should see beds of sand, gravel and boulders with clay flats and layers of marl and limestone. According to the Challenger Reports, in the Antarctic seas S. of 64° there is blue mud, with fragments of rock, in depths of 1,200 to 2,000 fathoms. The stones, some of them glaciated, were granite, diorite, amphibolite, mica schist, gneiss and quartzite. This deposit ceases and gives place to Globigerina ooze and red clay at 46° to 47° S., but even further north, there is sometimes as much as 49 per cent. of crystalline sand. In the Labrador current a block of syenite, weighing 400 lbs., was taken up from 1,340 fathoms, and in the Arctic current, 100 miles from land, was a stony deposit, some stones being glaciated. Among these were smoky quartz, quartzite, limestone, dolomite, mica schist, and serpentine; also particles of monoclinic and triclinic felspar, hornblende, augite, magnetite, mica and glauconite, the latter no doubt formed in the sea-bottom, the others drifted from Eozoic and Palæozoic formations to the north.[2]

A remarkable fact in this connection is that the great depths of the sea are as impassable to the majority of marine animals as the land itself. According to Murray, while twelve of the Challenger's dredgings, taken in depths greater than 2,000 fathoms, gave 92 species, mostly new to science, a similar number of dredgings in shallower water near the land, gave no less than 1,000 species. Hence arises another apparent paradox relating to the distribution of organic beings. While at first sight it might seem that the chances

[1] *Notes on Post-Pliocene of Canada*, 1872.

[2] *General Report, 'Challenger' Expedition.*

of wide distribution are exceptionally great for marine species, this is not so. Except in the case of those which enjoy a period of free locomotion when young, or are floating and pelagic, the deep ocean sets bounds to their migrations. On the other hand, the spores of cryptogamic plants may be carried for vast distances by the wind, and the growth of volcanic islands may affect connections which, though only temporary, may afford opportunity for land animals and plants to pass over.

With reference to the transmission of living beings across the Atlantic, we have before us the remarkable fact that from the Cambrian age onwards there were, on the two sides of the ocean, many species of invertebrate animals which, were either identical or so closely allied as to be possibly varietal forms.[1] In like manner, the early plants of the Upper Silurian, Devonian, and Carboniferous, present many identical species, but this identity becomes less marked in the vegetation of the more modern times. Even in the latter, however, there are remarkable connections between the floras of oceanic islands and the continents. Thus the Bermudas, altogether recent islands, have been stocked by the agency chiefly of the ocean currents and of birds, with nearly 150 species of continental plants, and the facts collected by Helmsley as to the present facilities of transmission, along with the evidence afforded by older oceanic islands which have been receiving animal and vegetable colonists for longer periods, go far to show that, time being given, the sea actually affords facilities for the migration of the inhabitants of the land, comparable with those of continuous continents.

In so far as plants are concerned, it is to be observed that the early forests were largely composed of cryptogamous plants, and the spores of these in modern times have proved

[1] See Davidson's *Monographs on Brachiopods;* Etheridge, *Address to Geological Society of London;* Woodward, *Address to Geologists' Association;* also Barrande's *Special Memoirs on the Brachiopods, Cephalopods, &c.,:* and Hall, *Palæontology of New York;* Billings, *Reports, on Canadian Fossils;* and Matthews, *Cambrian of New Brunswick, Trans. R. S. C.*

capable of transmission for great distances. In considering this, we cannot fail to conclude that the union of simple cryptogamous fructification with arboreal stems of high complexity, so well illustrated by Dr. Williamson, had a direct relation to the necessity for a rapid and wide distribution of these ancient trees. It seems also certain that some spores, as, for example, those of the Rhizocarps,[1] a type of vegetation abundant in the Palæozoic, and certain kinds of seeds, as those named *Ætheotesta* and *Pachytheca*, were fitted for flotation. Farther, the periods of Arctic warmth permitted the passage around the northern belt of many temperate species of plants, just as now happens with the Arctic flora; and when these were displaced by colder periods, they marched southward along both sides of the sea on the mountain chains.

The same remark applies to northern forms of marine invertebrates, which are much more widely distributed in longitude than those further south. The late Mr. Gwyn Jeffreys, in one of his latest communications to this Association, stated that 54 per cent. of the shallow-water mollusks of New England and Canada are also European, and of the deep-sea forms 30 out of 35; these last, of course, enjoying greater facilities for migration than those which have to travel slowly along the shallows of the coast in order to cross the ocean and settle themselves on both sides. Many of these animals, like the common mussel and sand clam, are old settlers which came over in the Pleistotene period, or even earlier. Others, like the common periwinkle, seem to have been slowly extending themselves in modern times, perhaps even by the agency of man. The older immigrants may possibly have taken advantage of lines of coast now submerged, or of warm periods, when they could creep around the Arctic shores. Mr. Herbert Carpenter and other naturalists employed on the Challenger collections have made similar statements respecting other marine invertebrates, as, for instance, the Echinoderms, of which the deep-sea crinoids present many common species,

[1] See paper by the author on Palæozoic Rhizocarps, *Chicago Trans.* 1886.

and my own collections prove that many of the shallow-water forms are common. Dall and Whiteaves [1] have shown that some mollusks and Echinoderms are common even to the Atlantic and Pacific coasts of North America; a remarkable fact, testifying at once to the fixity of these species and to the manner in which they have been able to take advantage of geographical changes. Some of the species of whelks common to the Gulf of St. Lawrence and the Pacific are animals which have no special locomotive powers even when young, but they are northern forms not proceeding far south, so that they may have passed through the Arctic seas. In this connection it is well to remark that many species of animals have powers of locomotion in youth which they lose when adult, and that others may have special means of transit. I once found at Gaspé a specimen of the Pacific species of Coronula, or whale-barnacle, the *C. reginæ* of Darwin, attached to a whale taken in the Gulf of St. Lawrence, and which had probably succeeded in making that passage around the north of America which so many navigators have essayed in vain.

But it is to be remarked that while many plants and marine invertebrates are common to the two sides of the Atlantic, it is different with land animals, and especially vertebrates. I do not know that any palæozoic insects or land snails or millipedes of Europe and America are specifically identical, and of the numerous species of batrachians of the Carboniferous and reptiles of the Mesozoic all seem to be distinct on the two sides. The same appears to be the case with the Tertiary mammals, until in the later stages of that great period we find such genera as the horse, the camel, and the elephant appearing on the two sides of the Atlantic; but even then the species seem different, except in the case of a few northern forms.

Some of the longer-lived mollusks of the Atlantic furnish suggestions which remarkably illustrate the biological aspect of these questions. Our familiar friend the oyster is one of these. The first known oysters appear in the Car-

[1] Dall, *Report on Alaska;* Whiteaves, *Trans. R. S. C.*

boniferous in Belgium and in the United States of America. In the Carboniferous and Permian they are few and small, and they do not culminate till the Cretaceous, in which there are no less than ninety-one so-called species in America alone; but some of the largest known species are found in the Eocene. The oyster, though an inhabitant of shallow water, and very limitedly locomotive when young, has survived all the changes since the Carboniferous age and has spread itself over the whole northern hemisphere.[1]

I have collected fossil oysters in the Cretaceous clays of the coulées of Western Canada, in the Lias shales of England, in the Eocene and Cretaceous beds of the Alps, of Egypt, of the Red Sea coast, of Judea, and the heights of Lebanon. Everywhere and in all formations they present forms which are so variable and yet so similar that one might suppose all the so-called species to be mere varieties. Did the oyster originate separately on the two sides of the Atlantic, or did it cross over so promptly that its appearance seems to be identical on the two sides? Are all the oysters of a common ancestry, or did the causes, whatever they were, which introduced the oyster in the Carboniferous act over again in later periods? Who can tell? This is one of the cases where causation and development—the two scientific factors which constitute the basis of what is vaguely called evolution—cannot easily be isolated. I would recommend to those biologists who discuss these questions to addict themselves to the oyster. This familiar mollusk has successfully pursued its course and has overcome all its enemies, from the flat-toothed selachians of the Carboniferous to the oyster-dredgers of the present day, has varied almost indefinitely, and yet has continued to be an oyster, unless indeed it may at certain portions of its career have temporarily assumed the guise of a Gryphæa or an Exogyra. The history of such an animal deserves to be traced with care, and much curious information respecting it will be found in the report which I have cited.

But in these respects the oyster is merely an example of

[1] White, *Report U.S. Geol. Survey*, 1882-83.

many forms. Similar considerations apply to all those Pliocene and Pleistocene mollusks which are found in the raised sea-bottoms of Norway and Scotland, on the top of Moel Tryfaen in Wales, and at similar great heights on the hills of America, many of which can be traced back to early Tertiary times, and can be found to have extended themselves over all the seas of the northern hemisphere. They apply in like manner to the ferns, the conifers, and the angiosperms, many of which we can now follow without even specific change to the Eocene and Cretaceous. They all show that the forms of living things are more stable than the lands and seas in which they live. If we were to adopt some of the modern ideas of evolution we might cut the Gordian knot by supposing that, as like causes produce like effects, these types of life have originated more than once in geological time, and need not be genetically connected with each other. But while evolutionists repudiate such an application of their doctrine, however natural and rational, it would seem that nature still more strongly repudiates it, and will not allow us to assume more than one origin for one species. Thus the great ques tion of geographical distribution remains in all its force, and, by still another of our geological paradoxes, mountains become ephemeral things in comparison with the delicate herbage which covers them, and seas are in their present extent but of yesterday, when compared with the minute and feeble organisms that creep on their sands or swim in their waters.

The question remains: Has the Atlantic achieved its destiny and finished its course, or are there other changes in store for it in the future? The earth's crust is now thicker and stronger than ever before, and its great ribs of crushed and folded rock are more firm and rigid than in any previous period. The stupendous volcanic phenomena manifested in Mesozoic and early Tertiary times along the borders of the Atlantic have apparently died out. These facts are in so far guarantees of permanence. On the other hand, it is known that movements of elevation along with local depression are in progress in the Arctic regions, and a great weight of new sediment is being deposited along the borders of the Atlantic, especially on its western side, and this is not improbably connected with the earthquake shocks and slight movements of depression which have occurred in North America. It is possible that these slow and secular movements may go on uninterruptedly, or with occasional paroxysmal disturbances, until considerable changes are produced.

It is possible, on the other hand, that after the long period of quiescence which has elapsed, there may be a new settlement of the ocean-bed, accompanied with foldings of the crust, especially on the western side of the Atlantic, and possibly with renewed volcanic activity on its eastern margin. In either case, a long time relatively to our limited human chronology may intervene before the occurrence of any marked change. On the whole, the experience of the past would lead us to expect movements and eruptive discharges in the Pacific rather than in the Atlantic area. It is therefore not unlikely that the Atlantic may remain undisturbed, unless secondarily and indirectly, until after the Pacific area shall have attained to a greater degree of quiescence than at present. But this subject is one too much involved in uncertainty to warrant us in following it farther.

In the meantime the Atlantic is to us a practically permanent ocean, varying only in its tides, its currents, and its winds, which science has already reduced to definite laws, so that we can use if we cannot regulate them. It is ours to take advantage of this precious time of quietude, and to extend the blessings of science and of our Christian civilisation from shore to shore until there shall be no more sea, not in the sense of that final drying-up of old ocean to which some physicists look forward, but in the higher sense of its ceasing to be the emblem of unrest aud disturbance, and the cause of isolation.

I must now close this address with a short statement of some general truths which I have had in view in directing your attention to the geological development of the Atlantic. We cannot, I think, consider the topics to which I have referred without perceiving that the history of ocean and continent is an example of progressive design, quite as much as that of living beings. Nor can we fail to see that, while in some important directions we have penetrated the great secret of nature, in reference to the general plan and structure of the earth and its waters, and the changes through which they have passed, we have still very much to learn, and perhaps quite as much to unlearn, and that the future holds out to us and to our successors higher, grander, and clearer conceptions than those to which we have yet attained. The vastness and the might of ocean and the manner in which it cherishes the feeblest and most fragile beings, alike speak to us of Him who holds it in the hollow of His hand, and gave to it of old, its boundaries and its laws; but its teaching ascends to a higher tone when we consider its origin and history, and the manner in which it has been made to build up continents and mountain-chains, and, at the same time, to nourish and sustain the teeming life of sea and land.

On the Canadian Rocky Mountains, with special reference to that Part of the Range between the Forty-ninth Parallel and the Head-waters of the Red Deer River.[1]

By George M. Dawson, D.S., F.G.S., A.R.S.M.,

Assistant Director of the Geological Survey of Canada.

The term Rocky Mountains is frequently applied in a loose way to the whole mountain region bordering the west coast of North America, which is more appropriately—in the absence of any other general name—denoted as the Cordillera belt, and includes a number of mountain systems and ranges which on the 40th parallel have an aggregate breadth of about one thousand miles. Nearly

[1] Read before Section C, British Association, Birmingham Meeting, 1886.

coincident, however, with the latitude of the head-waters of the Missouri, a change occurs in the character of this Cordillera region. It becomes comparatively narrow, and runs to the 56th parallel or beyond, with an average width of about four hundred miles only. This narrower portion of the Cordillera comprises the greater part of the Province of British Columbia, and consists of four main ranges, or more correctly speaking, systems of mountains, each composed of a number of constituent ranges. These mountain systems are, from east to west, (1) The Rocky Mountains proper. (2) Mountains which may be classed together as the Gold Ranges. (3) The system of Coast Ranges sometimes improperly regarded as a continuation of the Cascade Mountains of Oregon and Washington Territory. (4) A mountain system which in its unsubmerged parts constitutes Vancouver and the Queen Charlotte Islands. This last is here actually the bordering range of the continent, as beyond it, after passing across a submarine plateau of inconsiderable width, the bottom shelves very rapidly down to the abyssal depths of the Pacific. The Tertiary coast ranges of the south are here entirely wanting.

Between the second and third of the above mountain systems is the Interior Plateau of British Columbia, with an average width of about one hundred miles, a mean elevation of about 3500 feet and peculiar character and climate. The present paper refers more particularly to a portion of the Rocky Mountains proper. This system of mountains has, between the 49th and 53rd parallels, a mean breadth of about fifty miles, which, in the vicinity of the Peace River, decreases to forty miles, the general altitude of the range, as well as that of its supporting plateau, at the same time becoming less. Beyond the Peace River region, these mountains are known only in the most general and unsatisfactory way. The portion of the Rocky Mountains which has been explored, is bordered to the eastward by the Great Plains, which break into a series of foot-hills along its base, and to the westward by a remarkably straight and definite valley which is occupied by portions of the Columbia, Kootanie and other rivers, and is known to preserve its general direction and character for over six hundred miles.

Since the early part of the century, the trade of the great fur companies has crossed the Rocky Mountains chiefly by the Athabasca and Peace River Passes, the first complete traverse of the continent having, in fact, been accomplished by the latter route by that most adventurous of travellers Sir Alexander MacKenzie, thirteen years before the same feat was performed further south by the much advertised Lewis and Clark expedition. Posts once established to the west, these routes became familiar to the traders and voyageurs of the Companies, who in their modest records speak with as much indifference of starting from the mouth of the Columbia or Vancouver Island for Montreal—a journey occupying, under the most favourable circumstances, almost an entire season—as might the modern traveller who makes the traverse by rail in a few days. With the exception, however, of the geographer David Thompson, these adventurers gave little or no information as to the geography of the mountains, which were mapped for them only in days' journeys, and till the date of the explorations carried out under Captain Palliser in this region in 1858 and 1859, nothing was known in detail of the features of the Rocky Mountain Range within the British Possessions. At the inception of explorations for the Canadian Pacific Railway, Palliser's map was still the only one on which any reliance could be placed, and it applied merely to that portion of the range south of the Athabasca Pass. During the progress of the railway explorations a number of passes were examined more or less in detail, including in fact all those which appeared likely to be of service, between the International Boundary on the 49th and the Peace River Pass on the 56th degree of latitude, and the general fact was developed that the gaps became lower toward the north, the Peace River, where it breaks across the range, being, in fact, 2000 feet only above the sea-level. Directness of route and other considerations, however, led finally to the adoption of the Kicking Horse Pass, by which the watershed is crossed at an elevation of 5300 feet. Had it been anticipated by Dr. Hector, who when attached to Palliser's expedition discovered and named this pass, that it would have been traversed by a railway, he might possibly have endeavored to bestow on it some more euphonious name.

In 1874, I examined the South Kootanie Pass in connection with H. M. North American Boundary Commission, and in 1883 and 1884 that portion of the Rocky Mountains between the parallels of 49° and 51° 30′, was explored and mapped in some detail by myself and assistants, in connection with the work of the Canadian Geological Survey. Access to this, the southern portion of the Rocky Mountains in Canadian territory, being now rendered easy by the completion of the railway, its mineral and other resources are receiving attention, and the magnificent alpine scenery which it presents is attracting the notice of tourists and travellers generally. This portion of the mountains, including a length of about one hundred and seventy-five miles, measured along the axis of the range, may be taken as a type of that which is not yet so well known, and some of the main results of the reconnaissance work so far accomplished are here presented.

With certain local exceptions, the geological structure of these mountains is as yet very imperfectly known. In a report of the Geological Survey, shortly to be issued, it is intended to publish such detail as has been worked out. It will here be necessary only to give the main facts, which form the structural basis of the actual surface features. The old crystalline rocks form no part of the Rocky Mountains, either in the district here specially mentioned or northward as far as the Peace River. The lowest rocks here represented are quartzites, slates and shales more or less indurated, with occasionally true schists of a subcrystalline character, forming a series several thousand feet in thickness and referable, so far as the scanty fossil evidence shows, to the Cambrian. Overlying these, with no very marked unconformity, is a great limestone series of Devonian and Carboniferous age, which occasionally holds massive quartzites, and may prove, in the western part of the range, to pass down into Silurian or Cambro-Silurian. Triassic or Permo-Triassic red sandstones appear in some places near the forty-ninth parallel.

In the earliest Cretaceous times, this portion of the Rocky Mountains appears to have been an area of subsidence in which several thousand feet of shales and sandstones were deposited. These contain a characteristic early Cretaceous or Cretaceo-Jurassic flora and have been named the *Kootanie Series.* The conditions at this time appear to have been different from those obtaining in the Western States, as the equivalents of these oldest Cretaceous beds have not there been detected. Deposition, accompanied by some evidence of denudation of the older rocks, continued, over the greater part of the area, till the close of the Cretaceous, and the still later beds of the Laramie are yet found in a few places in the mountains. Throughout the whole of these periods, no evidence of great disturbance is found, and the region was not a mountainous one. For the next ensuing period, however, no representative strata are met with, and it is to this time, coeval with the earliest Tertiary, that the profound changes producing this mountain system are due. The beds were then thrown into a series of parallel folds trending north-north-west by south-south-east, and these, by a continuance of pressure from the west, were closely pressed together, and in many cases—particularly on the eastern side—completely overturned eastward. The subsequent action of denudation on the higher and more ample folds of this corrugated area has almost completely removed from them the whole of the Mesozoic rocks, while along the eastern margin of the disturbed region, in which the folding has been in many places scarcely less severe, the newer rocks still form the actual surface. This eastern belt, with an average width of about fifty miles, forms the foot-hills; while the western portion, with a width of about fifty miles, constitutes the mountains proper, the rugged character of which is almost as much due to the nature of the older rocks there brought to the surface as to its superior elevation.

Though thus, structurally considered, the district of the foot-hills may be regarded as a portion of the folded mountain region, it has characters of its own.

This district presents long ridges, or hills arranged in linear series, the positions of which have been determined by those of the harder sandstone beds. Between these are wide valleys in which the smaller streams course, while the larger rivers, with their sources in the mountains, generally cut across nearly at right angles. Though very well marked south of the Old Man River, these ridges are there generally rather low, and the prairie may be said to spread up to the very base of the mountains, the proportion of wooded country being quite small. North of the North Fork of the Old Man River, however, the hills and ridges are higher and more abrupt, and the wooded areas become more considerable, till about the Highwood River and Sheep Creek, extensive forests, interspersed with tracts of burnt woods, render the foot of the mountains well nigh unapproachable, except along the river valleys. The increased height of the foot-hill region in this vicinity is co-ordinate with a greater elevation in the base-level of the mountains, which here attains its maximum—the levels at which the Highwood and Elbow Rivers emerge from the mountains being approximately 4780 and 4800 feet respectively. The streams which leave the mountains at the lowest levels, are the South and Middle Forks of the Old Man, and the Bow River. The two first may be considered as together occupying a structural break in the front of the range, and have a level at this point of little over 4150 feet. The Bow River, but for its greater size and erosive power, which have enabled it to produce a great valley, would probably have had a much greater elevation at its exit from the mountains. Its actual height at this point is 4170 feet.

Where the summits of the foot-hills are not crested by outcropping ledges of sandstone, their outlines are generally rounded and flowing. The parallel valleys contain a deep, rich, black soil, and under the influence of a sufficiently abundant rainfall, the vegetation is wonderfully luxuriant. Few regions in a state of nature can compare with the southern portion of the foot-hills in beauty.

The base-level of this part of the Rocky Mountains is much higher on the eastern than on the western side. On the east, as ascertained by taking the average level at which the larger streams leave the mountains, it is about 4360 feet, while on the west, the mean elevation of the corresponding portion of the Columbia-Kootanie Valley is about 2450 feet. It is in consequence of this difference that the profiles of the various passes show sudden, steep descents to the west, and the streams flowing westward are also, as a rule, more actively engaged in erosion. The abrupt dip from the watershed, on the west side, was the greatest obstacle in the selection of a practicable railway route, and constituted the most formidable engineering difficulty in the pass actually adopted.

The general trend of this portion of the mountains has already been given as N. N. W.—S. S. E., but when more closely examined it is found actually to include three subordinate directions. That portion of the range which extends on the east side from the forty-ninth parallel, to the South Fork of the Old Man River, has a general bearing of N. 35° W. Thence northward to the Highwood River, the general trend is about N.12° W., after which, the bearing again becomes about N. 35° W., and so continues to beyond the Red Deer River. The portion of the range which runs nearly north and south, is considerably wider than the rest (being about sixty miles in width) and includes a remarkable series of infolds of Cretaceous rocks. The constituent ranges and ridges of both the mountains and foot-hills conform throughout very markedly, to the directions above given; and while the three trends are most clearly shown by the outer, eastern range, they are scarcely less evident on the western border. The least regular, and most tumultuous portion of this mountain region is that in the vicinity of the forty-ninth parallel.

In common with most mountain ranges (and here specially marked, in consequence of the regular parallel folding of the rocks) the ruling features are parallel ridges and valleys, crossed nearly at right angles by a system of transverse breaks. The cause of these cross valleys is not very apparent from a geological point of view, as they do not appear to coincide with any important lines of faulting. The general plan of the foot-hills is repeated in the mountains, on a large scale, and some of the cross valleys are continued quite through the foot-hills to the eastern plains, while others again are found in the foot-hills, which do not effect the mountains proper. It is probable that lines of comminuted fracture or shattering of the rocks may have originated these cross valleys, and it is possible that they constituted an original drainage system for the axis of elevation of the mountains, at a time anterior to that at which the longitudinal valleys became deeply excavated, and that some of them, by drawing to themselves the waters of a number of the longitudinal streams, have succeeded in maintaining their position as main waterways to the present time. The great permanence of these main, transverse drainage valleys is shown by the fact that the heights of land between them, in the mountains, are often equal in altitude to that of the main watershed. In no case, however, in the region now described, does such a cross valley preserve its characters so definitely across the entire range as to form throughout a direct pass, or practicable route of travel, though a near approach to this occurs in the North-Kootanie Pass. The routes offering the greatest facility for crossing the mountains, generally follow zig-zag courses, partly along the longitudinal valleys, and seeking the lowest points at which to cross the intervening mountain ridges. In consequence of this, the lengths of the various transverse passes are often considerably greater than the actual width of the mountains. The following list enumerates the passes known in this part of the range, with the length of each along the direction of the trail, from the eastern to the western base of the mountains. The altitude of each at the watershed or main summit is given in the second column.

	Miles.	Elevation of watershed.
1. South Kootanie or Boundary Pass,	66	7,100
2. North Kootanie Pass,................	48	6,750
3. Crow Nest Pass........................	56	4,830
4. North Fork Pass (1).................	46	6,773

	Miles.	Elevation of watershed.
5. Kananaskis Pass..................	85 (about)	6,200
6. White Man's Pass (2)................	70	6,807
7. Simpson Pass (3).......................	70 (about)	6,670
8. Vermilion Pass (4)	88	5,264
9. Kicking Horse Pass (5)............	104	5,300

It is probable that even within this district there are other passes across the watershed range in addition to these here named. The Indians, in the course of their hunting expeditions, travel on foot in every direction across the mountains, but designate as passes only those routes which are not too steep or rough for horses.

Most of the passes above enumerated cross subsidiary summits of some height west of the main watershed. The South and North Kootanie Passes have long been in regular use by the Indians, and both these, after descending into the Flathead Valley, in the centre of the mountain region, cross a second high "divide" between this river and the Kootanie Valley. The Crow Nest Pass was little used by the Indians owing to the thick forest prevailing along parts of it, but was some years ago chopped out, and rough bridges thrown across a couple of streams, to provide a route for taking horses and cattle eastward across the range. The North Fork Pass was not known, except by Indians, till crossed by myself in 1884. The Kananaskis Pass was traversed by Captain Palliser in 1858, and has been much used by the Indians. The White Man's Pass is probably that taken by a party of emigrants, spoken of by Sir George Simpson, in 1841. Sir George Simpson himself, in the same year, crossed the mountains by the pass to which his name is now attached. The Vermilion Pass

1. Measured from the Elk River Crossing in a straight line to the Kootanie Valley; the western continuation of this pass not having been explored,

2. Measured up the Bow River valley on the east, and to the west crossing the Brisco Range by Sinclair Pass.

3. Measured up the Bow Valley on the east and across the Brisco Range in a direct line by a reported pass.

4. The eastern and western ends of this pass are identical with the last.

5. By the railway line 111 miles.

has long been a much travelled Indian route, and takes its name from copious chalybeate springs, which deposit large quantities of ochre. The Kicking Horse Pass was little known and scarcely used by the Indians, probably on account of the thickness of the woods and rough character of parts of the valley for horses. About fifty miles north of the last named pass is the Howse Pass, and thence to the Athabasca Pass, a further distance of sixty-three miles, no practicable route is known across the axis of the range. In 1884 I learned from the Stoney Indians that a hunting party, having heard reports of abundance of game in the region, had during the summer tried every valley between the Athabasca and Howse Passes, but had been unable to get their horses over, being repulsed either by impassible rocky mountains or by glaciers and snow-fields which filled the intervening valleys. It is in this part of the range that Mounts Brown and Murchison occur, with reputed altitudes of 16,000 and 13,500 feet respectively, and Mount Hooker, also reported to be very lofty. This is probably the culminating region of the range, but as yet we have no accurate or detailed knowledge of it.

In the region here particularly described, Mount Lefroy (of Hector), with an altitude of 11,658 feet above the sea, appear to be the highest peak, but Assiniboine Mountain, the height of which, as seen from a considerable distance, I estimated at 11,500 feet, may prove to be higher. A number of the mountains, however, are known to exceed 10,000 feet in elevation, and whole ranges and groups of peaks surpass 8000 feet. Considerable as such elevations are, the height of the adjacent plains and the yet greater altitudes of the valleys within the range, reduces the apparent dimensions of the mountains, which seldom rise much more than about 5000 feet above the point of view. Though thus lacking in the impressive magnitude characteristic of some other mountain ranges, the scenery has a character of its own, and what it may want in actual size is compensated by its extreme ruggedness and infinite variety, its massive, broken escarpments and bare cliffs, which rise often from valleys densely filled with primaeval forest.

The contrast in respect to form is very marked, as between the Rocky Mountains and the Purcell and Selkirk Ranges west of the Columbia-Kootanie Valley, along the eastern side of which the outer range of the Rocky Mountain system forms an almost continuous wall of bare and shattered, though not very lofty, limestone peaks—a character which the opposite ranges only begin to assume toward their axis, rising at first from the valley in long and rounded slopes thickly covered with forest.

The Columbia-Kootanie Valley has already been referred to as an orographic feature of the first importance. Its general features are those of a strike-valley cut out along the outcropping edges of the massive eastward-dipping limestone formation. Its width, however, is much greater than that of other similarly situated valleys of the region, averaging about five miles in the length of 185 miles between the forty-ninth parallel and mouth of the Kicking Horse River. Circumstances, which need not here be detailed, tend to show that the river which excavated this valley originally flowed southward, throughout its whole length, that during the glacial period it became deeply filled with moraine matter and terraced drift, and that subsequently a southward-flowing river again occupied it. At a still later period, however, partly as an effect of the blocking of the valley by debris brought down by the Kootanie at the point at which that river enters it, but probably also in part as a consequence of a relative decrease in elevation to the north, the present remarkable water-parting was formed. The Columbia now rises in two large lakes in this great valley, and flows northward with a comparatively sluggish current, while the Kootanie—already a large river—enters the valley at right angles, at a short distance from the head of the upper lake, from which it is separated by a narrow neck of gravelly terrace-flat, and flows rapidly southward.

On Wild Horse Creek, a tributary of the Kootanie, placer gold mining has been carried on for about twenty years and the camp is still a moderately productive one. Other streams tributary to the Columbia-Kootanie Valley are known to yield alluvial gold, and additional discoveries are probable. No gold has yet been found on the eastern slopes of the range, but here the infolded rocks of the Kootanie (Creta ceous) series contain numerous seams of coal, some of which are of excellent quality. The coal is generally bituminous, but in the Cascade and Bow River basin becomes an anthracite, and mining operations are here already in progress on the line of the railway. Copper ores and galena are also known to occur in somewhat important deposits, and in 1884, we discovered, on a tributary of the Beaverfoot, in veins in an extensive intrusion of nepheline-syenite, a very beautiful blue sodalite which may prove of value for ornamental purposes.

Throughout the whole of this portion of the Rocky Mountains, large patches of perennial snow are frequently met with at elevations surpassing 6000 feet, and in sheltered localities, even at lesser heights. In the high mountains near the forty-ninth parallel, masses of hard snow and ice exist which appear to have a certain amount of proper motion and might be denominated glaciers, but further north, true glaciers, with all the well known characters of those of the Alps and other high mountain regions, occur. Such glaciers may be seen on the North Branch of the Kicking Horse, at the head-waters of the Red Deer, and elsewhere, and these are fed by snow-fields, the areas of which, though not accurately known, must be, in a number of cases, very considerable. Above a height of 6000 feet, snow falls more or less frequently in every month in the year, and about the first of October, it may be expected to occur even in the lower valleys within the mountain region.

In respect to the total amount of precipitation, the circumstances differ remarkably in the different portions of this comparatively limited tract of mountains, being quite small in the Columbia-Kootanie Valley, heavy on the adjacent western slopes of the range, and again inconsiderable on the eastern slopes. The position of the Columbia-Kootanie Valley, with reference to the prevailing westerly air currents, in the lee of the Selkirk and Purcell Ranges, explains its dry climate. Meeting the western slopes of the Rocky Mountains, the air is still sufficiently moist to afford the relatively abundant precipitation of that region; but on passing still further eastward, across the summit elevations, the conditions are unfavourable to further rainfall. Superimposed, however, on these main features, is a tendency to greater rainfall toward the north, which is specially noticeable—whether from a lessened elevation in the mountain barriers to the west, or other causes—in comparing the conditions in different parts of the Columbia-Kootanie Valley. The total amount of precipitation is evidently least in that part of this valley near the forty-ninth parallel, which is known as the Tobacco Plains. Much of the surface is there open, covered with bunch-grass and dotted with open groves of yellow pine (*Pinus ponderosa*), interspersed with the western larch (*Larix occidentalis*) and Douglas fir (*Pseudotsuga Douglasii*), while the herbaceous plants are of a drought-loving character. Northward in the valley these gradually disappear, the yellow pine and western larch cease abruptly at the head of the Upper Columbia Lake, and the black pine (*Pinus Murrayana*) and Engelmann's Spruce (*Picea Engelmanni*) form the chief part of the forest, which becomes relatively dense. Such small efforts at cultivation as have been made, prove that irrigation is necessary for the successful growth of crops in all the southern part of this valley.

In the lower parts of the eastern foot-hills and the larger valleys in the eastern part of the range, the dry conditions of the Columbia-Kootanie Valley are again to some extent repeated; and even within the range, rather extensive patches of dry prairie and slopes clothed with bunch-grass are found in the mouths of the depressions leading to the passes. The open, prairie character of the southern foot-hills has already been alluded to.

Neither the western larch nor the yellow pine recur on the eastern slopes of the mountains, and the Douglas fir, though abundant in the foot-hills, does not extend within the mountains beyond the larger valleys.

The tree most characteristic of the valleys of the western well-watered slopes, though not abundant in this part of the Columbia-Kootanie Valley, is the western "cedar" or arbor-vitæ (*Thuya gigantea*). Its absence in the eastern valleys is probably due to the want of a sufficiently moist atmosphere rather than to the somewhat more rigorous climate. Lyall's larch (*Larix Lyallii*) forms an open fringe along the upper limit of forest growth in these mountains, or at about 7000 feet, above which arboreal vegetation is scarcely observed. When the leaves of this little larch become yellow, in September, its zone of growth may often be traced, from a distance, with the regularity of a contour-line.

Leaving out of consideration the arbor-vitae, which, as before stated, affects a peculiar station, together with other trees of rarer occurrence, the common conifers may be arranged in a regular series from those tolerant of the most alpine conditions to those which require a high degree of summer heat combined with a dry atmosphere, as follows :—

Larix Lyallii. Strictly alpine.

Abies subalpina. Alpine and sub-alpine and extending to high and cool valleys on both slopes.

Picea Engelmanii. Sub-alpine and extending downward wherever the soil is sufficiently moist, on both slopes.

Pseudotsuga Douglasii. Lower valleys on both slopes.

Larix occidentalis. Base of Mountains on west slope only.

Pinus ponderosa. Base of mountains on west slope only.

Prof. Macoun has made extensive collections of plants in the mountains adjacent to the railway line, and it may be of interest from a botanical point of view to note his observation that a number of mountain plants obtained by myself in the southern part of the region, appear to reach their northern limit there, and do not recur even in the high mountains in the vicinity of the Bow and Kicking Horse valleys. This circumstance is doubtless in connection with the partial break in the continuity of the higher ranges about the head-waters of the Old Man River, and the species wanting are probably those which require relatively dry as well as alpine conditions.

The Indians hunting on the western slopes of this part of the mountains are the Kootanies, (*Kootenuha* or upper Kootanies) with their headquarters in the valley of the same name, together with a small colony of the Shuswap Indians of the Selish stock, with a village near the Columbia Lakes and regarded as intruders by the Kootanies. The Kootanies claim, in theory, all the mountains west of the watershed, as their peculiar hunting-grounds, and in former days made annual excursions for the purpose of hunting the Buffalo, across the range to the Great Plains, where they came into frequent collision with the Blackfoot tribes. The latter in turn occasionally carried retaliatory raids across the mountains to the Kootanie Valley, for the purpose of stealing horses, and many are the tales still told among them of these forays. The eastern slopes of the range and adjacent foot-hills are now hunted over by the Mountain Stoneys, a branch of the Assiniboines. These people are comparatively recent immigrants, dating their connection with the district about forty years back only. They intermarried with a tribe of Rocky Mountain Crees, who formerly maintained themselves here, but have since lost their identity among the Stoneys, though both languages are still commonly spoken. The extraordinary paucity of local names, whether Cree or Assiniboine—even in the case of important streams and mountains—in this part of the region, leads me to believe that the Crees themselves had not very long possessed these mountains, which, it seems highly probable, at no very distant date, were frequented only by the Kootanies. The Blackfoot tribes, being essentially plain Indians, can scarcely be supposed to have inhabited this wild, and to their ideas, naturally repulsive mountain country. The Crees may probably have penetrated to it about the date when they were first supplied with fire-arms by the Hudson's Bay Company, when they are known to have been very formidable and aggressive.

In addition to the buffalo, the foot-hills formerly abounded in other game, particularly the mule deer, wapiti and white-tailed or jumping deer. With the exception of the buffalo, all these animals are still to be found, but in much diminished numbers. The mountains themselves yet afford sustenance to the Indian hunter, the Rocky Mountain sheep or bighorn and the mountain goat being moderately abundant. Black and grizzly bears are also frequently met with, and the puma or mountain lion—held in great dread by the Indians—is occasionally found. The moose is sometimes shot by the Indians, but the cariboo is scarcely, if at all, found within the district here described, requiring more extensive alpine plateaus than those afforded by this part of the mountains. Smaller fur-bearing animals are numerous where they have not been too assiduously trapped. Trout are abundant and large in most of the streams, and the white-fish and lake-trout, are procured from the larger lakes.

No insuperable obstacles to travel exist in these mountains. Many of the passes and trails are open and easily traversed, and the field for mountain climbing and exploration is unlimited, few of the higher peaks having yet been scaled. Starting from the line of railway, or from the vicinity of Fort MacLeod, with a few pack-animals and a small camping outfit, much may now be accomplished in a comparatively short time, the months of July or August being the best, on account of the lowness of the rivers and mountain torrents, which at other seasons constitute formidaable barriers. If fine scenery, combined with adventure of the less hazardous kind, and the pleasure of exploring tracts which yet appear as blanks on the map, will compensate for the minor discomforts attending such an expedition, I can promise that the enterprising traveller will not be disappointed.

SYNTHESIS OF DIETHYL TRIMETHYL AMIDO-BENZENE.

By R. F. RUTTAN, B.A., M.D.,
Lecturer in Chemistry, Medical Faculty, McGill University.

The general reaction on which this synthesis is based was discovered by Prof. A. W. Hofman in 1872.* This eminent observer found that at high temperatures the halogen salts of secondary, tertiary or even quaternary bases of the aromatic series are converted into the salts of their isomeric primary bases by a transfer of the fatty radicles from the side chain to the nucleus. Thus the hydriodide of monomethyl aniline at a high temperature becomes converted into the corresponding salt of toluidine,

$$C_6\ H_5,\ NH\ CH_3 = C_6\ H_4\ CH_3,\ NH_2.$$

This reaction has since found its way into chemical industry, and is largely employed in the Berlin Aniline Factory for the preparation of the higher homologues of aniline, especially of Pseudo-cumidin, which is prepared from dimethyl toluidine according to the following reaction:

$$C_6\ H_4\ CH_3\ N\ (CH_3)_2 = C_6\ H_2\ (CH_3)_3,\ NH_2.$$

It seemed a matter of much theoretical interest to test the reaction still further, and by it to obtain, if possible, a homologue of aniline in which *all* the hydrogen atoms of the phenyl nucleus were replaced by radicles of the fatty series. Taking as a starting point this pseudo-cumidine, in which three atoms of hydrogen out of the five are already replaced by methyl, a modification of Hofmann's method was employed to replace the other two hydrogen atoms by ethyl groups, giving rise to the interesting primary base trimethyl diethyl amido-benzene:

$$C_6\ (CH_3)_3\ (C_2H_5)_2\ NH_2.$$

How far the presence of methyl groups in the benzene ring will retard or promote the introduction of further radicles of another composition, has not yet been determined. This synthesis is the first of a series of experiments designed to

* Berichte der Deutschen Chemischen Gesellschaft, v., 720.

decide this question, which were suggested to me by Prof. Hofmann of Berlin.

In the production of this new base, the first step is the preparation of diethyl cumidine.

For this purpose, carefully dried cumidine hydrochlorate was mixed with somewhat more than the theoretical quantity of ethyl alcohol, and the mixture heated in a closed tube to 120°–130° for four hours, when the following reaction—nearly quantitative—occurs:

$$C_6 H_2 (CH_3)_3 NH_2, HCl + 2 C_2 H_6 O = C_6 H_2 (CH_3)_3 N (C_2 H_5)_2, H Cl + 2 H_2 O.$$

Besides the hydrochlorate of the ethylated cumidine, the product was invariably found to contain some ether. Excess of alkali, added to the contents of the tubes, caused he ethylated cumidine to rise with the ether to the surface, whence they could be easily removed and separated. Distillation very readily removes the ether and water, leaving the basic residue which comes over between 220°–230°.

It is worthy of note that this method of ethylating yielded better results than the usual one of digesting the base with a haloid ether and then separating the secondary base by excess of alkali; moreover, the employment of the more expensive alcoholic iodide is thus avoided.

The ethylated cumidine, again sealed up in tubes with about an equal weight of ethyl iodide, is now heated to a temperature of between 280° and 300° for 8 or 10 hours. If the operation be successful, the tubes on cooling contain a dark jelly-like mass that cannot be poured out. This consists of the hydriodide of the new base mixed with other bases, a small quantity of some fluid, aromatic hydrocarbons and a tarry residue.

The hydrocarbons are driven over by steam, and the residue filtered and treated with caustic potash, when there rises to the top a thick reddish, strongly basic oil.

This oil is separated and fractionated; the greater part distils over between 285° and 290; this is retained and treated with hydrochloric acid. There is formed at once a very insoluble hydrochlorate, crystallising in groups of needles. These are not soluble in cold water to any appreciable extent, very slightly soluble in boiling water, but easily soluble in alcohol. After one or two recrystallizations, this salt was obtained in a state of purity, and proved to be the hydrochlorate of trimethyl diethyl amido-benzene:

$$C_6\ (CH_3)_3\ (C_2\ H_5)_2\ NH_2,\ HCl,$$

which requires the following values—

Theory.			Experiment. I.	II.	III.	IV.
C_{13}	67.20	....	66.82	—	—	—
H_{22}	9.65	....	9.72	—	—	—
N	7.47	....	—	7.61	—	—
Cl	15.68	....	—	—	15.6	15.57

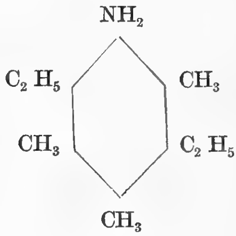
The free trimethyl diethyl amido-benzene obtained from this salt by addition of an alkali, is a liquid boiling between 288° and 290°. It has a specific gravity of .971, and is quite colorless when first set free, but darkens and becomes too thick to pour on standing exposed. The hydrochlorate does not yield a well crystallized double platinum salt, but with palladium chloride it forms a beautiful green double salt in feathery crystals.

The acetate and sulphate crystallize in needles, and are very soluble. The oxalate is very difficultly soluble, and crystallizes in prisms.

The Acetyl compound, $C_6\ (CH_3)_3\ (C_2\ H_5)_2\ NH\ (C_2\ H_3\ O)$, is easily obtained by the action of acetic anbydride; it crystallizes in rosettes of needles, and melts at 182°.

The Isonitril, $C_6\ (CH_3)_3\ (C_2\ H_5)_2\ NC$, is best prepared by mixing the base with an alcoholic solution of caustic potash and chloroform in a small flask fitted with a reversed condenser. A violent re-action ensues, and the pungent isonitril odour is quite marked, thus proving the primary character of the base. After neutralizing the excess of base present with sulphuric acid, the isonitril is extracted with ether, which extract yields on evaporation a thick oil which soon crystallises in short prisms, melting between 190 and 192°.

According to the researches of Froelich,* the methyl groups in pseudo-cumidine, occupy the positions 2, 4 and 5, the amido group being 1. There are thus only the positions 3 and 6 left for the ethyl groups to fill. The constitutional formula for the base is therefore—



ON THE OCCURRENCE OF SCOLITHUS IN ROCKS OF THE CHAZY FORMATION ABOUT OTTAWA, ONTARIO.

By HENRY M. AMI, M.A., F.G.S.

For years past, the occurrence of *Scolithus* in the lower portion of the Cambro-Silurian or Ordovician strata, as it is developed in the St. Lawrence and Ottawa Valleys, as well as in the State of New York and elsewhere, was almost invariably taken as the best indication of the presence of the Potsdam formation.

Scolithus Canadensis, as described by the late Mr. E. Billings in his first volume of the Palæozoic Fossils, p. 96, was shewn to be eminently characteristic of the Potsdam formation, its occurrence in a number of localities having been recorded by him. Since then it has also been found in rocks of the same horizon in various other localities, and well recognized by geologists in general.

The form *Scolithus linearis*, of Hall, is also referred to by Mr. Billings, as occurring in the measures of the Potsdam, as seen at L'Anse au Loup (*loc. cit.* p. 2), but in no other Cambrian or Ordovician formation have the remains of *Scolithus* been recognised as yet, as far as the writer is aware.

* Berichte, xvii, 2573.

In the examination of the measures of the Chazy formation about Ottawa, however, the writer has observed numerous scolithoid remains from strata newer than those at L'Anse au Loup or at Ste. Anne's, Beauharnois, &c.

At the Hog's Back, Nepean, in the county of Carleton, Ont., about three miles from Ottawa city, the Chazy formation crops out in the shape of a partially denuded anticlinal, exhibiting on the eastern side of its axis a considerable thickness of strata consisting of sandstones, sandy shales with calcareous matter, and limestones, given in their natural and stratigraphical sequence from the base up. Some of the shales in the exposure are decidedly argillaceous in character, and hold abundance of a species of Lingula—the *L. Belli* (Billings). This band marks a well defined zone in our Chazy formation, and is referred to as the zone of Lingula Belli (see Geol. Rep. Trans. O. F. N. C., 1885-1886.) Above this zone, and a few feet above the *Scolithus* horizon, the "Leperditia band" occurs here in its normal condition, as described by Sir William Logan and Mr. Billings in the publications of the Geological Survey of Canada at various dates, so that the intermediate beds of an arenaceous nature, on careful examination, are seen to contain abundance of a species of *Scolithus* differing but little, if any, from the true *S. Canadensis* (Billings). The characters of this last agree admirably with the form of those from Hog's Back, although there is no doubt whatever as to the age of the series in question being Chazy.

The second place where the genus in question has been observed is at Britannia, Ont., near the southern shores of Lake Des Chênes, on the Ottawa River, six miles west of Ottawa city. There at Britannia, some four hundred yards south-west of the railroad crossing or station, numerous remains of a species of *Scolithus* were collected on the occasion of the excursion of the Field Naturalists' Club, in September, 1885. On finding it, the question arose, and has since formed the subject of a slight controversy, as to whether or not the rocks there were really Chazy, or that on account of the occurrence of these annelid (?) burrows, the rocks ought to be ascribed to the age of the Potsdam formation. Fortunately, the occurrence of a similar form in the Chazy of Hog's Back had been previously ascertained so that this fact, coupled with the one that the almost perfectly horizontal strata on the Quebec side of the Ottawa, were truly Chazy, and characterised by the prevalence of such types as *Orthis imperator* (Billings), and a Rhynchonella not distinguishable from the *R. plena* of Hall —which measures extended across the river to the Ontario side, beneath the waters of the lake and rapids, without a fault or dislocation in well-nigh horizontal beds—make it beyond doubt that these rocks at Britannia are truly Chazy.

From these two instances, it follows that the occurrence of *Scolithus* remains does not necessarily indicate the existence of Potsdam rocks, but that the beds may possibly be newer or higher up in the series. These cases also indicate the necessity of obtaining collateral evidence of every nature, whether palæontological or stratigraphical, in order to ascertain with any degree of accuracy the precise geological horizon of strata.

The Rhythm and Innervation of the Heart of the Sea-Turtle.*

By T. Wesley Mills, MA., M.D., L.R.C.P., Eng.
Professor of Physiology, M'Gill University, Montreal.

The present paper is intended in part as a continuation of a shorter one which appeared in Nos. 4, 5, 6, of vol. v. of the *Journal of Physiology* on the same subject; but more especially as a continuation of my work on Chelonian heart physiology in general. So far as I know there does not exist in physiology a *systematic* comparison of the resemblances and differences of any one family or genus. I propose therefore to do for the Chelonians in physiology, to some extent at least, what has been done for them in morphology.

It has hitherto been believed that animals resembling

* This paper has also very recently appeared in the *Jour. of Anat. and Phys.*, Edinburgh.

each other in structure closely were similar in physiological behaviour. Such however, has been rather assumption than the outcome of careful comparison.

With the view of discharging this task of systematic physiological comparison, I have, during this past summer, made a large number of experiments on various species of sea-turtles at the Marine Laboratory of the Johns Hopkins University at Beaufort in N. Carolina; and also a limited number of experiments on the land-turtle. I desire to express my thanks to Dr. Brooks, professor of morphology in the Johns Hopkins University for his kindness in facilitating my work.

The marine turtle has much less vitality than other Chelonians, and suffers, when kept for a few days out of the water or deprived of its proper food. In order that my animals should be in the best possible condition, a matter of special importance in connection with the subject of spontaneous rhythm, a structure known locally as a "turtle pen" was constructed on the sea shore, of dimensions $12 \times 8 \times 8$ feet, admitting water freely, and so placed that the animals were never without a certain amount of water at the lowest tide. As learned from a fisherman who made a specialty of catching sea-turtles, their principal food consists of crabs. Upon such those kept for a few days in confinement were regularly fed. Most of the animals upon which I have worked were not kept in the pen for longer than two to four days.

According to Holbrook's work on American Reptilia the three species of marine turtle used in my experiments were *Chelonia caretta* or the Loggerhead, *Chelonia imbricata* or Hawksbill, and *Chelonia mydas* or the Green Turtle.

The conclusions and observations of this paper are based upon prolonged and careful experiments by the direct method on twenty specimens of the marine turtle.

As in my paper on the heart of the Terrapin, the literature of the subject is pretty fully considered, that part will be omitted in this paper, so that it may be kept as short as possible.

For stimulation, as in my work on the Terrapin, a Du Bois inductorium, fed by one Daniell's cell, was employed.

I. *Spontaneous Rhythm of the differents Parts of the Heart.*

The subject is so interesting, and such important conclusions have been drawn regarding it, that I shall give a condensed account of a large number of experiments on this subject.

Exp. I.—*Chelonia imbricata;* caught only twenty-nine hours.

At 10.25 A.M. a ligature placed around the auriculo-ventricular junction; ventricle not arrested till ligature is drawn very tight.

10.28 A.M., 1st beat of ventricle.
10.30 " 2nd "
10.32 " 3rd "
10.34 " 4th "
10.36 " 5th "
10.38½ " 6th "

The rhythm never got faster, but gradually subsided.

Exp. II.—*Chelonia imbricata.*

At 11.35 A.M. ligature drawn tightly at junction of sinus with auricle; complete arrest of all parts posterior to the ligature.

1 P.M. After several pricks with a seeker, a succession of beats but no spontaneous rhythm; sinus beats regularly from the first.

2.15 P.M. Ventricle became rigid throughout almost its whole extent. Right auricle much more vitality than left auricle.

3.30 P.M. Not possible by mechanical excitation to call forth a beat in left auricle; right auricle still somewhat excitable.

Exp. III.—*Chelonia mydas,* most lively specimen of any marine turtle I have seen.

At 12.30 A.M. animal bled freely after destruction of brain. Greater part of auricles proper ("bulged" part) cut away; they continue to beat in harmony with the sinus and sinus extension ("basal") or "flattened" portion of Gaskell.

Soon ventricle cut clearly free from the rest of the heart, *i.e.*. no sinus extension adhering. Sinus and auricles act together in sequence and maintain the original rhythm of 32.

12.45 P.M.–12.48 P.M. Ventricle 3 beats.
12.54 " Ventricle 14 beats in 1 minute.
12.58 " " 17 "
12.58 P.M.–1.02 P.M. Several small groups of beats.
1.03 " Ventricle 8 beats in 1 minute, all grouped.

1.09 P.M.–Ventricle a rhythm	of	7 beats 1 minute.	
1.10 "	"	7	"
1.11 "	"	5	"
1.13 "	"	16	"
1.14 "	"	11	"
1.15 "	"	12	"
1.20 "	"	12	"
1.25 "	"	8	"
1.30 "	"	8	"
2.25 "	"	4–6 and irregular.	

N.B.—2.50 P.M. After a previous pause of several minutes. rhythm began again, at first, only at the edges of the ventricles, then grows gradually stronger and spreads over more of the ventricle, but never involves the whole of it.

The last observation is important, as it shows how contraction of certain fibres of the ventricle tend to call into action others, and strengthen those already acting, but weak. Similar cases have been reported for the Terrapin.

The above cited experiment furnishes the best-marked case of spontaneous rhythm I have met.

EXP. IV.—*Chelonia caretta,* about 3 feet long; out of water two days.

1.05 P.M. Ligature between sinus and auricle and sinus extension does not arrest rhythm of auricles and ventricle, *till it is drawn very tight.*

No spontaneous rhythm of any part posterior to the ligature.

N.B.—1.30 P.M. On attempting to get the ventricle to pulsate in response to a prick from a seeker, it *passes into fibrillar action.* This case presents a great contrast to the previous one, but the animal in the latter case had been out of the water two days, while the other specimen was quite fresh.

EXP. V.—*Chelonia mydas.*

11.10 A.M. Ligatured between ventricle and parts just above; former arrested at once.

12.10 P.M. Ventricle a beat now and then, on an average 1 in the minute, auricles and sinus a rhythm of 30.

1.10 P.M. Ventricle 5 beats in 3 minutes at irregular intervals.

1.50 P.M. Ventricles 3 beats in 4 minutes.

2.50 P.M. Auricles irregular; right beats before left; ventricle 5 beats in 5 minutes.

4 P.M. Ventricle has almost ceased to pulsate, but a touch of the

finger suffices to start the ventricle into a rhythm of 24, lasting for two minutes.

This latter observation illustrates well the great *sensitiveness* or excitability of the ventricle of the sea-turtle.

Exp. VI.—*Chelonia mydas;* animal bled to death; after destruction of brain.

1.30 P.M. Cut away sinus from auricles, sinus extension, and ventricle; very soon a rhythm arises in the latter parts.

2.10 P.M. Right auricle beats slightly before the left.

2.40 P M. Left auricle beats only feebly; ventricle getting rigid.

3.10 P.M. Ventricle wholly rigid; right auricle beating at rate of 12: left auricle quiescent; vertical section made between the auricles, &c.; right auricle continues to beat.

Exp. VII.—*Chelonia imbricata.*

10 A-M. Cut away side ventricle from rest of heart; then the auricles proper from the sinus extension and the ventricle free from the parts above it. This gives rise in the ventricle to a rapid rhythm of excitation for a very short time, followed by a rhythm of 1–2 in the minute for 3–4 minutes; rhythm of heart at time of section, 20.

10.15 A.M.	Sinus extension a rhythm of 19, and irregular.		
10.30 A.M.	"	"	13.
10.45 A.M.	"	"	12.

Ventricles no pulsation throughout.

12 noon. Ventricle rigid; sinus extension a rhythm of 15, and irregular; auricles proper die much later than ventricles, but have no spontaneous rhythm whatever.

This experiment clearly demonstrates the greater tendency to, and capacity for, spontaneous rhythm of the sinus extension (or " basal " or flattened portion of the auricle) than any other part, including the auricles proper.

To state the results of the rest of my experiments would be very much of a repetition of the above; the experiments have been numerous and occupied much time, and justify, I think, the following conclusions for the sea-turtle:—

1. The power of originating spontaneous rhythm is in the order: sinus, sinus extension, auricle, ventricle; that of the sinus being much the best marked.

2. The degree of spontaneous rhythm of the ventricle varies with the species (and individual) and the state of nutrition and general vitality of the animal. This probably applies also to the rest of the heart, but is most conspicuous

in the ventricle. *C. mydas* has shown much the greatest capacity for spontaneous cardiac rhythm of the species of marine turtles examined by me.

3. The spontaneous rhythm of the ventricle never equals that of the original rhythm of the ventricle, in fact, usually remains very slow indeed.

An examination of the cases reported from my experiments above will show that the ventricle has a purely spontaneous rhythmic tendency, but that this tendency is after all rather feeble.

In all the experiments, the heart was left *in situ*, surrounded either by pericardial fluid, blood plasma, or serum, so that its nutrition was provided for.

When ligatures were used, a certain quantity of blood was imprisoned necessarily within the cavities thus shut off.

A glass vessel was also placed over the heart, thus forming a moist chamber.

The heart of the marine turtle is much more sensitive to conditions of nutrition than that of either the land tortoise or the Terrapin, which is, of course, an obstacle in the way of the development of spontaneous rhythm.

I have found that unless the ligatures used are somewhat fine and *drawn very tight*, a rhythm may arise possibly not equal to the original one, nor to that of the part of the heart usually dominating the rhythm in question (*e.g.*, auricle the ventricle), thus imitating a genuine spontaneous rhythm; while in reality it is in part due to stimulation from the wave of contraction of the part above, the ligature causing a sort of marked "block" only.

With so sensitive a ventricle as that of the marine turtle, I am satisfied the attachment of a lever and the effects of the same on the rhythm would be considerable. If feeding the heart could be so regulated that the pressure within its own special arterial system did not exceed the normal, it might be unobjectionable; but it is difficult or impossible to ascertain what this *norme* is. I therefore regard results obtained with the attachment to the heart of a recording lever, suspension of the heart and feeding it through its own vessels, except under the conditions defined above, as not those of spontaneous rhythm, but as in part due to excitation; and for these reasons it seems to me my experiments really indicate the amount of genuine spontaneous rhythm of the heart of the Chelonians more nearly than those of Gaskell, in which he has employed suspension, recording levers, and feeding.

At the same time I am inclined to believe that in the land tortoise the ventricle has greater tendency to spontaneous rhythm than in some other kinds of Chelonians.

Since the part of the heart, not sinus proper and not constituting the more prominent part of the auricles, is different in appearance, in structure to some extent, and in function, especially in its spontaneous rhythmic power, as well as conductivity, &c., and inasmuch as it, in these respects, approximates more closely to the sinus than to the auricle proper, it would, I think, conduce to clearness, if this part were considered and called the *sinus extension.* This seems the more natural, seeing that a similar structure, manifestly more like the sinus than the auricle, exists in the fish.*

Though this division was not clearly defined in my paper on the Terrapin, "auricle" is used in the sense of the auricle proper, or bulged part between sinus and ventricle.

II. *Reflex Cardiac Inhibition.*

The results of my experiments on this subject may be shortly stated as follows:—

1. Prolonged gentle tapping with a forceps over the abdominal organs had less effect than a pushing down movement with a seeker, and still less than a single sharp blow with the forceps.

2. Stimulation of the brachial plexus, with a strong interrupted current, has not, in general, produced much slowing of the rhythm. In one case it seemed to quicken it.

3. Sponging over the peritoneum vigorously has generally produced cardiac slowing or arrest.

Peculiar Effects.—1. In certain cases, electrical stimula-

* "On the Structure and Rhythm of the Heart in Fishes," &c., vol. vi. No. 4 and 5, *Journal of Physiology.*

tion of the anus has caused marked arrest of the heart; but in others, a preliminary slowing, followed by an accelerated rhythm, while the current is still passing.

2. In certain cases, stimulation of the liver has led to the usual cardiac arrest; but in others, acceleration has been the first result and the only one; while in still others, acceleration has followed and preceded slowing.

It is to be understood that, in all these cases, the spinal cord and medulla oblongata were intact.

The significance of such results as those cited aboved are discussed in my paper on the Alligator.*

Upon the whole, it may be said that, while in the matter of cardiac arrest by reflex agency, there is much similarity among the different genera and species of Chelonians, the *Chelonia mydas* is the most susceptible of the three species examined by me; and the Slider Terrapin, is almost if not quite equal to it in this respect, and in advance of the other marine turtles. The condition of the animal at the time of experiment is also a most important factor.

III. *Stimulation of the Vagi.*

The possible effects of stimulation of the vagi in the marine turtles are:—

1. Preliminary weakening of the beat, most marked in the auricles, without arrest of the heart's action or change in the rate of beat. This may occur with a very weak current; but more frequent is—

2. Arrest of the auricles; the rest of the heart continuing either with unchanged or a slowed rhythm and weakened beat. Gaskell† has stated in his paper on *Testudo Græco* that he had never seen any evidence that an excitation wave is able to travel from the sinus to the ventricle and cause a ventricular contraction independently of a wave of contraction over both parts of the auricle. The latter statement is at variance with my observations on the Terrapin and still more frequently on the marine turtles. Often, when both auricles proper are arrested by stimulation of

* *Journal of Anat. and Phys.*, vol. xx.

† *Journal of Physiology*, vol. iii. Nos. 5 and 6.

the vagi, the rest of the heart, including sinus extension, may beat as usual; and this holds equally well, as I have observed, for the Alligator and the Fish.

3. Arrest of the heart by diminution of the force of the contractions to zero, as often occurs in the Frog, does *not*, so far as my observations go, occur in any Chelonian.

4. The ventricle with the auricles may cease, the sinus and sinus extension continuing to beat. But such stop is likely to be very brief, the wave of contraction soon passing on.

5. Preliminary acceleration, which is very rare in the S. Terrapin, occurs more frequently in the sea-turtle, but never except with the stimulation of a weak current.

I have noticed brief preliminary acceleration soon followed by slowing, the strength of the current remaining the same, when the heart's powers have been much enfeebled.

Arrest of the sinus, auricles and ventricles continuing to beat, is unknown.

Diastolic relaxation during stimulation is, perhaps, in the marine turtle rather less marked than in the Terrapin; but it does occur, and equally well in the bloodless heart.

The After-Effects of Vagus Stimulation.—These are very similar in all the Chelonians; in all, stimulation of the vagus may be followed by a rhythm without increase; a rhythm with slight increase or with marked increase; and the same law holds equally well in the sea-turtle as in the Terrapin that *the rate of increase in the force and frequency of the beats of the heart is in inverse proportion to those prevailing at the time of stimulation;* from this it follows that a weak heart, one needing help most, is the one the vagi nerves can actually improve most effectually. This has been illustrated to me over and over again when working on the marine turtles; thus, when, as the heart is getting weak, the left auricle, as is the rule, falls into a condition of great enfeeblement, while the right is comparatively strong, the stimulation of the vagus will restore the left, for a time at least, to harmony of rhythm with its fellow, and produce marked improvement in the strength of the beats.

The after acceleration in the sea-turtles, especially in *C.*

caretta and *imbricata* seems to reach its maximum sooner than in the Terrapin. This does not apply equally to C. *mydas*, I think. Further, when the heart is enfeebled in all kinds of Chelonians, the maximum is more rapidly attained, and this remark applies with especial force to the marine turtles.

The beat may recommence after standstill from vagus stimulation, in the order: sinus (always), sinus extension, ventricle, auricles; or in the order: sinus, sinus extension and auricles, ventricle; and the same holds for the Alligator and the Fish.

Unilateral Effects of Vagus Stimulation.—These have been referred to in my paper on the Terrapin (pp. 249, 250), and relate especially to greater dilation of one auricle, than the other during stimulation of its corresponding nerve. While such dilating effects have been noticed for the sea-turtle, arrest of an auricle answering to the vagus stimulated, has been more frequently observed than in the Terrapin; in several cases this phenomenon has been very pronounced, and has followed on every stimulation of the nerve with a sufficiently *weak current.*

Stimulation of the Central End of one Vagus, the Medulla and the other Vagus being intact.—The results may be stated briefly as follows:—

1. In all the specimens of the sea-turtle examined in this way (with one exception, in which there was doubt as to the soundness of the medulla) either arrest or slowing of the rhythm has followed.

2. In most cases this could be repeated 3 to 6 times at short intervals, but with less and less effect on each occasion. Considering the great vital tenacity of the nerves in the Chelonians, this seems to point to exhaustion of the inhibitory centre.

3. In a certain proportion of cases there is decided after-acceleration (*e.g.*, from 33 to 38 beats).

4. As was seen with the Slider Serrapin, there are great differences in capacity for this form of inhibition in different specimens of the same species.

C. mydas gave much the most pronounced and certain results in my experiments on the marine turtles.

In one instance, with a weak current, preliminary increase in the rhythm occurred, followed by slowing and even short stops of the heart.

Prolonged alternate Stimulation of the Vagi.—The following account of an experiment on this subject furnishes the case of longest cardiac inhibitlon yet published :—

Exp.—*Chelonia imbricata*, 2 feet long.

12.32 P. M. 1. Stimulation of left vagus for 30 minutes, maintains constant standstill ; then current withdrawn ; after a latency of 14 seconds, rhythm re-established after 1-2 minutes. (First stimulation from 12.32 to 1.3 P. M.)

2. At 1.5 P. M. Stimulation of right vagus till 2.10 P. M.; after the current withdrawn, a latency of 16 seconds before rhythm began.

3. Stimulation of left vagus till 3.32 P. M.; when current shut off.

4. At 3.35 p. m. Stimulation of right vagus till 4.25 p. m.; latency 30 seconds.

5. Stimulation of left vagus, from 4.25 P. M. till 5.40 P. M., when beats began to appear.

Thus in all there was *continuous inhibition of the heart for more than six hours ;* for the periods between the stimulation of the right and left vagi were only of sufficient length to ascertain that the heart would still beat, and in none of these cases did the heart begin to pulsate while the current was passing. It was, in fact, evident that the power of the vagus was not exhausted. To this remark, the right vagus at 4.26 p. m. is an exception, but in that case,the electrodes were at once, on the appearance of a beat, transferred to the opposite vagus.

It will also be noted that the periods of latency, after the stimulation ceases before a beat appears, lengthens with each stimulation.

Comparative inhibitory power of the two vagi.—The following is the statement of the results in 8 cases :—

***Arrest of the heart with the induced current*:**

Specimen I.	Left vagus,	secondary coil	$\frac{1}{2}$ over primary.		
"	Right "	"	$\frac{3}{4}$	"	
" II.	Left "	"	at 10 cm. from primary.		
"	Right "	"	5	"	"

Specimen	III.	Left	vagus,	secondary coil at 4 cm. from primary.
"		Right	"	" 1 " "
"	IV.	Right	"	} equal in power.
"		Left	"	
Specimen	V.	Right	vagus	} equal in power.
"		Left	"	
"	VI.	Left	"	inhibits with 2 c. at 3 cm.
"		Right	"	" " 5 "
"	VII.	Right	"	" " 6 "
"		Left	"	requires the strongest current.
"	VIII.	Left	"	} both at 4 cm.
"		Right	"	

A comparison of these results with those reported for the Terrapin (pp. 247, 248, 249) will show a great resemblance. In by far the larger number of cases, the right vagus has greater inhibitory power than the left, exceptions to this, though few, sometimes occurring. In the marine turtle, no case in which the left vagus was wholly without effect on the rhythm was found.

This difference between the two vagi, which does not seem to be confined to the Chelonians, but is seen also, as I have shown, in the Alligator, calls for explanation. Meyer's[1] explanation, that there were certain cases in which there were no inhibitory fibres in the left vagus, does not agree with facts; for in all cases, the left vagus has some effect either on the force or the rate of the beat. It has been seen that in the Chelonians and Alligator, arrest of the sinus leads almost invariably to arrest of the rest of the heart, whether that arrest be brought about by the vagus or by a ligature placed between the sinus and auricle; and in those cases in which one vagus is unable to maintain the rest of the heart in standstill, it is always because the sinus is not controlled.

Gaskell[2] has shown that the part of the vagus known as the "coronary" nerve is that which influences the force of the beat of the auricle and ventricle while the rate depends on the sinus.

The peculiar unilateral vagus effects, pointed out in my paper on the Terrapin, and in this one, seem to me to throw new light on this question.

[1] *Hemmungsnerven System des Herzens*, Berlin, 1869.

[2] *Journal of Physiology*, vol. iii. Nos. 5 and 6.

Beating in harmony with the sinus proper are the terminations of the great veins leading into the sinus. It is easy to see that their conjoined power, which, so to speak, is the *governing* propelling force of the whole heart, is greater, *i.e.*, there is a larger wave of contraction, on the right side than on the left. Now, it is to be observed, that in all those cases in which the left vagus, under the influence of a weak current, can arrest the left auricle and perhaps the left part of the sinus and its associated veins, that inasmuch as the right part of the sinus keeps pulsating, sooner or later the left part is overcome; whereas, when the right part is arrested, its wave is so large, its controlling force so great, the left is of itself so weak, that its wave (also weakened) may not be able to pass on to the sinus extension and auricles; moreover, this left part and its veins, as I have often noticed when the heart is dying, ceases to pulsate before the right part of the sinus and its veins. I would then explain the greater effect of the right vagus as a rule by the character of the contraction wave, associated with the right part of the sinus and its associated veins, and by the fact that the nervous supply to this seems to be chiefly from the right vagus, rather than to any deficiency in the kind or number of the inhibitory fibres in the left vagus; both may supply an equal number of such fibres, but if the supply be even partially unilateral, then the results follow as I have endeavoured to explain.

Inasmush as the force of the auricles is very much lessened by vagus stimulation, great weakening of the beat of the sinus may suffice to arrest the auricles and ventricle without complete arrest of the sinus; in such cases, sinus arrest is not the sole cause of the stop of auricles and ventricle, nor absolutely essential to it.

Intracranial Stimulation of the Vagus.—The peculiar inner conformation of the skull of the sea-turtle, and its great thickness and hardness, make examination of the roots of nerves intracranially very difficult. One such examination gave the following results :—

Exp.—Rhythm 5-6.

Stimulation of nerve roots from the medulla led to very prolonged inhibition, followed by an accelerated after-rhythm of 7-8.

IV. *Faradisation of the Heart.*

As in the Terrapin, Alligator, and Fish, the result obtained depends on the strength of the current and the condition of the heart.

The sinus being in good condition, and the current sufficiently strong, it is arrested, but if the heart be much exhausted, no arrest may follow; arrest of the sinus, of course, leads to stoppage of the rest of the heart, unless, as often happens, there is escape of current.

The same arrest of auricles occurs on stimulation, unless the heart be very much exhausted.

Dilation is less prominent in the ventricle of the sea-turtle than in that of the Terrapin; but the bluish appearance accompanying it, and the light points where the electrodes are applied, are manifest.

I have never obtained, in the sea-turtle, arrest of the ventricle by stimulation of this part of the heart with the interrupted current; on the contrary, stimulation of the ventricle gives rise to a more rapid pulsation; or, especially if the nutrition be imperfect, a peculiar form of contraction, which, as it does not exactly resemble that denoted by such terms as fibrillar, peristaltic, &c., I have called intervermiform, which seems preferable to peristaltic, inasmuch as the latter has acquired a very definite physiological meaning, which it is not well to extend.

With a very weak current in all but the freshest hearts, the dilation following the stimulation is much more local, and there may be no marked effects as far as rhythmic variation is concerned.

But in a heart very much exhausted it is often quite impossible to arrest the sinus or any part of the heart with the strongest current.

That the white dots seen at the points of application of the electrodes are due to marked contraction of the heart muscle, the behaviour of the Alligator's heart renders extremely probable; but that the other effects are due, not to the influence of the current directly on the muscle itself, but indirectly through the nervous mechanisms of the heart, several considerations render highly probable.

1. The effects of the current are very like those of stimulation of the vagus nerve itself, as illustrated above (arrest, dilation, &c.)

2. When the nutrition of the heart is impaired (and its nerves have probably suffered the most), it is impossible to produce the usual effects, arrest of the sinus, auricle, &c.; while at the same time it is possible to send the ventricle into the peculiar intervermiform action referred to above. This and many other things I have seen, such as the readiness with which even the mammalian heart, long under experiment, &c., goes into a similar action known as the Kronecker-Schmey phenomenon, leads me to believe that this latter also is to be explained, at least in some cases, by peculiar qualities of the muscle rather than through nerve influence; further, in the case of the mammal, this phenomenon and the intervermiform action referred to in the Chelonians, are alike wholly uninfluenced by vagus stimulation.

3. Sponging over the heart, arrests it when fresh, while later it may give rise only to intervermiform action in the ventricle; this seems to me a very strong argument in favor of nervous influence.

4. After the free application of atropine to the Fish's heart *in situ*, it is impossible to arrest it either by sponging it over or by the application of the electrodes to the sinus; but it is possible to initiate the intervermiform action by this procedure.

V. *Evolution of Function and Cardiac Death.*

In all the Chelonians, the invariable order in which the different parts of the heart die is: (1) ventricle, (2) auricles proper, (3) sinus extension, (4) sinus.

I have studied this subject especially in the sea-turtle, and find that invariably the right auricle outlives the left; and, as has been before indicated, the right moiety of the sinus, and its pulsating venous extensions, tend to outlive the left moiety and its corresponding venous parts.

The death of the ventricle also takes place in a certain segmental order, which is virtually the same in all cases, and which is indicated by dotted lines and numbers (Plate, fig. 5).*

It will be seen from the above figure that the left side of the ventricle dies before the right, and that the last segments to die are a superficial one, extending from the vessels downwards, and another, involving the apex and a portion extending obliquely upwards to the right of it; speaking generally, the *cavum venosum* is the last part of the ventricle to die. From what has been said, it appears that as the heart's vitality is being lowered, a more primitive condition of things is reached, *i.e., the heart comes to consist of the sinus, the auricle, and a simplified ventricle;* or to put it otherwise, the parts least dependent on the constant supply of nourishment are those that are oldest in the development of the heart, as those also of greatest independent rhythmic power; so that observation on the order in which any heart dies may be a means of reading its developmental history. It is more difficult to study this subject on the mammalian heart, but Harvey long ago pointed out that the right auricle was the last to die, and that the left ventricle was the first, though he does not seem to have emphasized the significance of this fact.

When in the animal scale among vertebrates a second auricle is acquired, as it is first among the Dipnoi, it is small and of comparatively much less functional importance than the right.

In the sea-turtle, not only is the right auricle endowed with greater vitality than its fellow, but it is conspicuously larger, the left, however, making a certain degree of advance, as to size, on the condition existing in the Dipnoi.

The ventricle in the sea-turtle is much more sensitive to a stimulus than that of other Chelonians; it also has much less vitality, can bear deprivation of its regular nourishment

* The plate referred to will appear in the continuation of this paper in the next No. of this Journal.

less successfully, as the sea-turtle has less vital tenacity than other genera of this family; indeed, there often seems to be associated great vital tenacity of the animal with a corresponding resisting power of the heart, as evinced in the case of *Batrachus tau*, the fish on which my experiments were chiefly made.

VI. *Nerves with Peculiar and Inconstant Influence.*

Reference is made in my earliest communication on the Chelonians* to a fine nerve which on the first stimulation produced cardiac arrest followed by acceleration, but the later stimulation of which seemed to be without effect on the rythm.

I have described what seemed to be accessory vagi in the Alligator.

In the sea-turtle, I have met with fine nerves traceable upwards towards the superior cervical ganglion and downwards to the heart, which have acted in a somewhat inconstant manner. Thus sometimes such a nerve has given purely vagus effects; again, a first stimulation has caused slowing, and all later stimulations only acceleration; while others again have shown no action beyond the first one, on repeated stimulation. But this I have also noticed to hold for the small accelerating branch from the middle cervical ganglion in the Terrapin. Of course, such fine nerves die readily, and are easily exhausted by stimulation, and it may be that the inhibitory fibres in some cases are fewer and are exhausted sooner than the accelerating ones: however, such phenomena, in the present state of our knowledge, are rather puzzling.

Is there a Physiological Depressor Nerve in the Chelonians? The question has been already answered in the negative by my experiments on the Terrapin. After making two tests on the sea-turtle, the latter of which was in everyway satisfactory, the variations in blood-pressure being indicated in a rather sensitive way by a simple contrivance, it was impossible to find any fine nerve which produced marked lowering

* *Journal of Physiology*, vol. v. Nos. 4, 5 and 6.

of the blood-pressure when stimulated, although very many were tried. Some of the nerves that might be suspected as depressors had a function (peripheral end) which is referred to in the preceding section.

It may then be said that *there is no nerve with the functions of a physiological depressor in the Chelonians.*

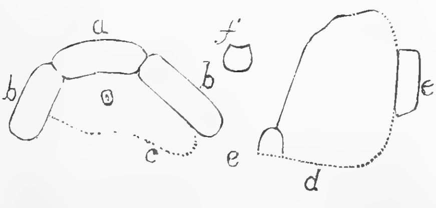
(*To be continued.*)

Additional Note on the Pteraspidian Fish found in New Brunswick.

By G. F. Matthew, F.R.S.C.

Since writing my former communication in reference to the above organism, I have had opportunity for a further examination, and add a few remarks herein to those published in the October number of the *Record.*

On comparison of the plates of this fish with those of the Placoganoids of the Devonian Age, which alone of the earliest fishes are, at the present time, reputed to have been armoured above and below, it seemed probable that the



hexagonal plate (*c* in the above figure) in the Acadian fossil was the ventral plate, corresponding as it does in form to the large ventral plate of Pterichthys; and this view seemed the more probable as this was the flatter, and apparently the thinner of the two large plates of this fish.

A careful comparison with the known genera of Pteraspidian fishes, however, makes it probable that this is not the correct view to take of the position of these plates relative to the dorsal and ventral sides of the creature which they covered.

In *Pteraspis* (Kner) which, however, is a Devonian and not a Silurian genus, there is a considerable resemblance in the ornamentation of the test, and generally in the dorsal armature, to the covering plates of the Acadian fish; but if we attempt to compare the different plates of which the shield of our Pteraspidian fish is composed, with those of Pteraspis, they will be found to differ widely from that genus. On the other hand, if the plates *a*, *b* and *c* be compared with those of the genus *Cyathaspis* (Lank.), the correspondence of parts is striking.

In Prof. E. Ray Lankester's monograph on the fishes of the Old Red Sandstone,* we appear to have only one example of this genus described, for although *Cyathaspis* (?) *Symondsi* is described under this head, it seems very doubtful whether it should be so referred. The typical species *C. Banksii* (H. & S.) is Silurian, and possesses a set of plates quite analogous to those of the Acadian fish. There is also on the central plate ("dorsal scute") a tubercle, indicated in Prof Lankester's figures, which holds the place of a similar circular elevation on the shield of the Acadian fossil (see fig. *c*). In Prof. Lankester's examples of *C. Banksii*, the surface markings appear to have been obscure, except on the rostral and lateral plates; we do not know, therefore, how far the markings on the main plate of each of these two fishes were similar. In the Acadian species the triangular space between the tubercle above referred to and the front of the chief hexagonal plate *c* possessed a group of sinuous and looping, mostly transverse, striæ, differing in direction from the longitudinal striæ that mark the rest of the plate.

Curiously enough, the plate *d* possesses characteristics analogous to those of the scute of the genus *Scaphaspis* (Lank.). The markings on the surface of this plate are almost exactly parallel to those of the "dorsal" scute of

* Memoirs of the Palæontographical Society, London, vol. xxi.

Scaphaspis truncata (H. & S.), in the fine example figured by Prof. Lankester (plate ii. fig. 3, Memoirs cited), and the plate is similarly a little asymmetrical.

The association of these two types of fish plates at several localities may not be altogether without significance. Thus in the Downton Sandstones of England there are *Cyathaspis Banksii* and *Scaphaspis truncata.* In the Onondaga variegated shales of Pennsylvania, Prof. Claypole has found *Palæaspis** *bitruncata* and *P. Americana*.. So far as form goes, it may be seen that the former is comparable with the "dorsal scute" of *Cyathaspis,* as Prof. Claypole has observed, while the latter in outline is not unlike the shield of *Scaphaspis.* It should be remarked, however, that in the course of the surface markings, as figured by Prof. Claypole, *Palæaspis Americana* differs both from the Scaphaspis of the Downton Sandstone and from plate *d* of our Acadian species.

Before closing this note, I may refer to a few other characteristics of the Acadian fish. The plates *c* and *d* possess the two ranks of striæ which, according to Prof. Lankester, distinguish the Silurian from the Devonian Pteraspidians; the contrast between the larger set and the smaller intermediate set of striæ is more marked on plate *d* than on *c*; and the borders of both of these plates, as also the whole of the lateral and rostral plates differ in having striæ of uniform size. The superior prominence of certain of the striæ therefore belongs only to the two larger plates of the dermal covering, but it is a useful character in distinguishing these older fish from the more typical Pteraspids of the Devonian system, in which no part of the dorsal scute presents these strikingly unequal striæ or ridges.

The fineness of the striæ in the plates of the Acadian fish is quite up to the highest standard of tenuity in the fish plates of Prof. Lankester's Memoir, there being from 150 to 200 of them in the width of an inch. The plate *c* is abundantly dotted with minute pits apparently marking the

* *Quart. Jour. Geol. Soe.*, London, Feb., 1885. This genus is separated from the other Pteraspids on account of organic differences in the structures of the plates, not because of difference in form.

sites of mucous glands, which Prof. Lankester mentions as a feature of shields of the genus *Pteraspis*: from this he infers that a secreting membrane probably covered the surface of the calcareous plates in Pteraspis. If his reasoning is correct, the plates of the Acadian fish were also probably clothed with a similar covering.

St. John, N.B., Dec., 1886.

Miscellaneous.

Radiation from Plants.—Acting upon the suggestions contained in Darwin's well-known experiments relative to the protection against excessive radiation from leaf surfaces, and so against injury, afforded by the various positions which certain leaves are known to regularly assume at night, Rev. G. Henslow seeks a more general application of the law than had previously been observed. He finds that even in those plants, the leaves of which are not so hypnotic in the mature state, there is usually well-defined hypnotism in the young leaves, and that in any case, the vernation bears a most important relation to the protection of leaves against radiation from their upper surfaces, and also against dessication through the action of dry winds passing ever them. In the latter case, he shows by experimental determination, that in many cases, the loss of moisture in weight, from young leaves artificially extended, exceeds that from leaves which maintain their normal form of vernation, several times. Of the examples which he cites, the ratios of loss between the naturally and artificially exposed leaves, vary from 1 : 5·1 to 1 : 1·2.—*Jour. Lin. Soc.*, xxi.

Development in Septic Organisms.—The Rev. W. H. Dallinger, in his presidential address to the Royal Microscopical Society, in February, 1866, traced in a masterly manner the development of certain forms found in septic fluids, requiring for their study at once the very best instruments and the greatest skill. This unrivalled investigator modestly left out of account the skill, and dwelt on the great improvements in microscopes within the last few years. An outline of what takes place cannot better be sketched than in Dallinger's own words. The creature (monad) he describes as a protoplasmic cell with nucleus, and having a pair of flagella projecting from the pointed end. "The nucleus is the centre of all the higher activities of these organisms. The germ itself appears but an undeveloped nucleus; and when that nucleus has attained its full dimensions in size, there is a pause in growth, in order that its internal development may be accomplished. When this is the case, it becomes manifest that the body sarcode is, so to speak, a vital product of the nucleus. Moreover, it is from it that the flagella originally arise. In the same way, it is only by a complicated and beautiful series ef delicate activities in the nucleus that the wonderful act of fission is initiated, and in all probability carried to the end. So, too, all the changes that go with fertilization and the production of germs are a series of correlated activities, due, at the beginning at least, wholly to the nucleus." All the stages are figured, from the bare nucleus (original germ) down to the amœboid form prior to conjugation with another individual, and the conjoint formation of a quiescent mass of protoplasm, which finally gives rise to a cloud of protoplasmic dust, as it were, which represents the germs or nuclei of yet undeveloped individuals, thus completing the entire cycle.—*Jour. of Roy. Mic. Soc.*

The Digestive Process in some Rhizopods.—Physiology, as a field for original investigation, has been recently entered by ladies. Miss Greenwood, Demonstrator of Physiology, Newnham College, Cambridge, has published a paper on the above subject. Her investigations were confined chiefly to the two interesting forms Amœba and Actinosphærium. The latter, as is well known, has a spherical protoplasmic body, honeycombed with numerous vacuoles, and with filiform pseudopodia protruded from its surface. Her method of work may be described as chemico-microscopical. The digestive process is considered under the heads: (*a*) Ingestion, (*b*) Digestion, (*c*) Egestion. In these two forms, no digestive *ferment* has as yet been found. Many accounts of intra-cellular digestion in invertebrates have been published, but not a few of them are mere fragments. Miss Greenwood draws the following conclusions in regard to the above-mentioned two forms:—1. They show constant and promiscuous enclosure of solid matter, which is received in the vacuole of ingestion. The nature of the latter is doubtful. The formation from the surrounding medium points to its aqueous character; but the rapid death of the enclosed prey, in Amœba at least, argues some influence or secretion from the enclosing animal. 2. Starch grains are not digested by Rhizopods. 3. Fat globules are not digested by Amœba; a slow digestion of them probably takes place in Actinosphærium. 4. The fate of digested matter depends on its character. If it is innutritious, the vacuole of ingestion disappears; if nutritious, it undergoes change not effected by direct contact with the acting protoplasm, but by something passed out of the protoplasm into what has become the *vacuole of digestion*, in fact, a secretion. This case resembles that of the higher animals, in so far that the secretion is passed into a cavity—the cavity in this case being intracellular. 5. This secretion is probably not acid. It cannot apparently act on cellulose walls, but *diffusing* through the coats of cellulose clothing organisms, acts on the contained protoplasm. There is thus some evidence for the view that Rhizopods normally derive fat and carbohydrate from the splitting up of solid proteid—in which they would resemble the highest mammals. They can also probably utilise matter already in solution. 6. The formation of the digestive secretion is not stimulated by bodies incapable of digestion or unsuitable for nourishment. 7. At a certain stage of digestion, there may be temporary loss of fluid around the food; later, the *vacuole of ejection* succeeds the digestive vacuole; and by the outward opening of this vacuole all remains of former food are expelled from the body (excretion). The crystals found in Amœba Proteus and the *contractile* vacuole seem to have no direct connection with digestion. After the ingestion of food, the "proper" granules gather around it; this may have a digestive significance, but such cannot be positively asserted. Observation of the behaviour of these two forms in relation to the digestive process have led to the belief that there are *differences* of a non-essential character.—*Jour. of Physiology*, Eng.

The Liver Ferment.—Miss Florence Eves, B.Sc., of Newnham College, has published a research bearing on this question: Is there a liver ferment which converts glycogen into sugar or not? An affirmative answer to this question has been given since the time of Bernard, but the existence of such ferment was rather an assumption than a demonstrated fact. Miss Eves treated the livers of various animals, especially of the sheep, according to approved methods, with a view of extracting a ferment. The results of her work may be summarised about as follows:—1. There is evidence of the existence of an amylolytic ferment in the (dead) liver, but the amount is very small; a portion of this may be fairly assumed to have been derived from the blood remaining in the unwashed liver, since an amylolytic ferment can be extracted from blood. 2. The sugar formed *post-mortem* in the liver is true dextrose, as had been previously shown. 3. The sugar formed by the isolated liver-ferment is *not* dextrose. It is of smaller reducing power, and may be possibly maltose. It seems natural, therefore, to conclude that the *post-mortem* conversion in the liver is *not* due to ferment action. The *rapid* appearance of sugar in the liver after death is rather to be attributed to the "specific metabolic activity of the dying cells." The same cause suffices to explain the more gradual production. This conclusion would relieve physiology of at least one ferment, and it must be confessed that ferment action seems to be bearing a large share—an undue share in the physiological explanations of the day.—*Jour. of Physiology*, Eng.

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Physiology of the Heart of the Sea-Turtle.

By T. Wesley Mills.

(*Concluded.*)

VII. *Anatomy of the Sympathetic System of Nerves in the Sea-Turtle.*

The detailed description which I have given of this system for the Terrapin,[1] and which, judging from the account of Gaskell[2] and Gadow, applies largely also to the land tortoise, may, with slight modification, be considered as expressing the relations of the sympathetic, vagus, &c., for one species of sea-turtle, viz., *Chelona mydas*. The resemblance in this respect of this one species to the Terrapin, and its wide divergence from the other species of sea-turtle examined by me, have been very surprising.

In *C mydas* there is the same difference in the size of the sympathetic and the vagus; the same tendency to union for part of their course; the marked distinctness of the ganglion

[1] *Journal of Physiology*, vol. vi., pp. 264-266. [2] *Op. cit.*

on the main sympathetic stem, &c., seen in the Terrapin; and the figure given in Plate (fig. 4) is intended to show in a general way the condition of things present in the Terrapin and *C. mydas.*

But as no satisfactory description for physiological purposes has been published for the marine turtles, I shall describe what I have found on the examination of a large number of cases. So much difference has been found in individuals, and the general plan is so disguised, that it was only after considerable examination and comparison that the typical structure could be defined.

In *C. caretta* and *C. imbricata*, the great size of the sympathetic in the neck, almost equal to that of the vagus, is in striking contrast with the condition in *C. mydas*, which has the sympathetic scarcely larger than in the Terrapin; also in the two first-mentioned species the vagus and sympathetic run widely apart throughout their whole course; in *C. mydas*, as in the Terrapin, they sometimes fuse, but not inseparably.

As regards the condition existing at or near the entrance of these nerves into the skull, much difference in details has been found.

In the Loggerhead and Hawksbill there is always more or less fusion above at this point; but in some cases there does not seem to be any genuine blending, for the nerves (vagus, glosso-pharyngeal, and sympathetic) are separable by a "seeker." There is a slight cord-like swelling in the sympathetic, and beyond this, two separate divisions enter the skull together, and do not seem to have any close connection with the sympathetic.

In these two species I have never found above any such well-defined fusion as exists in the Terrapin and *C. mydas.*

But by far the most remarkable condition found in *C. caretta* and *C. imbricata* is that seen in the third ganglion of the sympathetic stem. It was only after finding a case like that shown in fig. 3 that it became clear that in this ganglion the third and fourth ganglia of the stem were fused together; but when *C. mydas* was examined, it was seen that fusion was not, in that species, the rule, but the exception, as in the Terrapin.

What is depicted in Plate (fig. 1) as *ganglion cardiacum basale* must be regarded as the results of the fusion of the inferior cervical ganglion and the first thoracic (G. stellatum).

All of the ganglia, except this one, are very ill-defined cordiform swellings, scarcely recognizable but for the branches they give off.

The accelerating branch from the middle cervical ganglion is very much more constant and very much better defined even in *C. mydas* than in the Terrapin. The branch has not in my specimens ever been paired.

The vagus ganglion on its main stem is slightly better marked than the one corresponding to it on the sympathetic. It gives off a very great number of strong branches to parts below (fig. 2.)-

The brachial plexus in the sea-turtle is exceedingly strong, and forms an interlacement of great complexity. The branches proceed from the fifth or sixth to the ninth metamere.

From the ganglion cardiacum basale, several branches proceed upwards to the different parts of the brachial plexus, and downwards to various parts, some of them probably to the heart.

VIII. *Cardiac Acceleration by stimulation of the Sympathetic.*

I. Stimulation of the sympathetic above the middle cervical ganglion produces no decided and constant effects on the cardiac rhythm; but influences the eye as in the Terrapin and land tortoise, *i.e.*, the lower lid is depresssed and the upper lid elevated; at the same time, the pupil is moderately dilated. In consequence of the imperfect development of the nictiating membrane in the sea-turtle, little effect is seen in this structure; the dilation of the pupil has seemed to me to be less marked than in the Terrapin. It has now been shown that in all the Chelonians the main sympathetic has throughout similar functions, not only on the heart but on the eye.

2. Stimulation of the branch from the middle cervical ganglion has produced more constant effects than the cor-

responding one in the Terrapin; but, generally, the increase, in force of the cardiac beat has been greater than the increase in rate.

3. Stimulation of the ganglion cardiacum basale, or the main stem beyond it, to the next metamere below, gives decided accelerating effects.

I have thought that stimulation of branches from this ganglion connected with the brachial plexus had accelerating effects, but of this I do not feel quite certain. The same laws as have been laid down for vagus acceleration apply in this case, especially the law of inverse proportion.

IX. *Further comparison of the Chelonians.*

By way of comparison, I have made a series of experiments on a limited number of specimens of one genus of land tortoise (*Pyxis*).

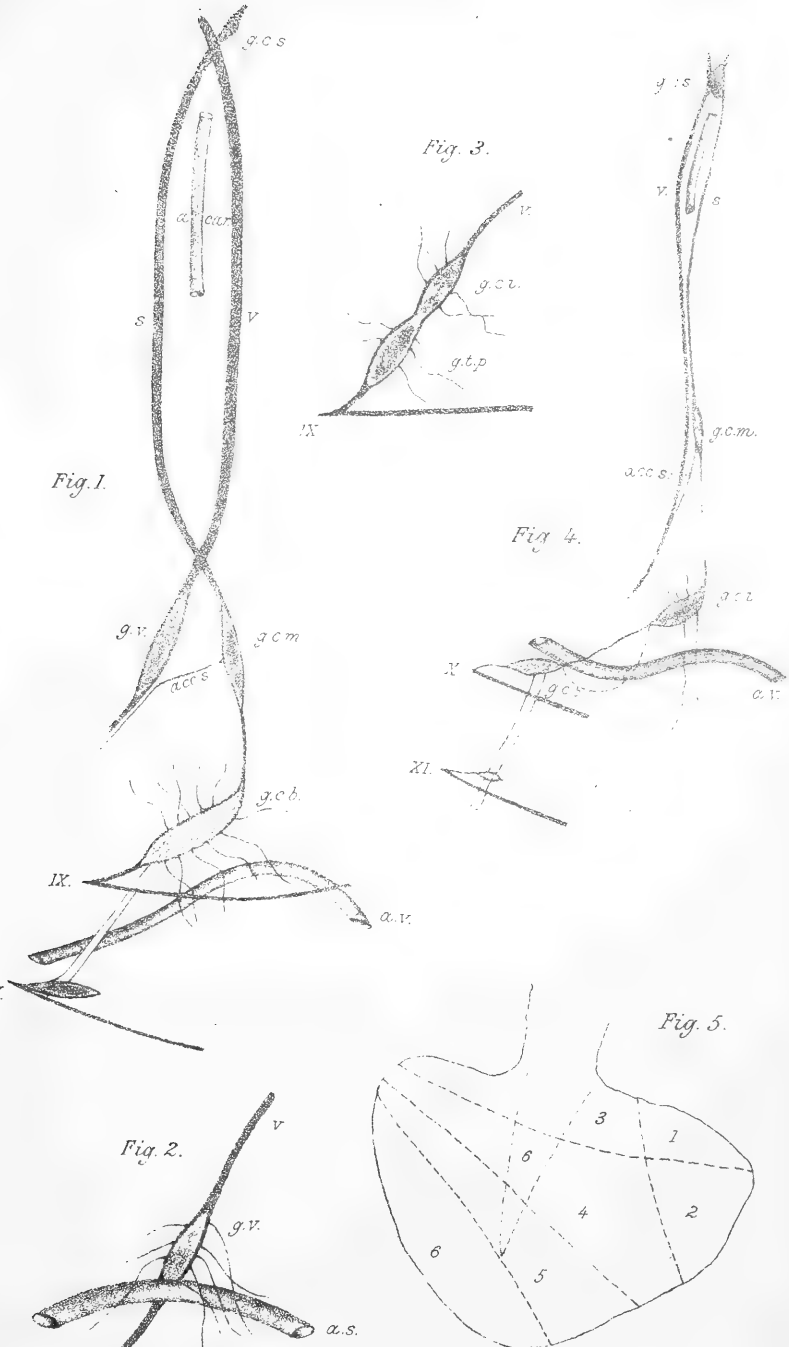
In most respects, the heart of this tortoise behaves more like that of the Terrapin than of the sea-turtle. The heart's general appearance is also more like that of the former. In the sea-turtles, some species have the ligament at the apex of the heart very highly developed, fibrous bands extending often half way up the ventral surface of the ventricle; and with great breadth of apical attachment. The ventricle is also, in the sea-turtles, paler, of less vitality and much more sensitive, as before pointed out, than in the other Chelonians.

In the specimens of the land tortoise examined by me, the holding power of the left vagus has been less than the right, and I think such differences are better marked than in the water tortoises or marine turtles.

The superiority of the right auricle has been better shown in the marine turtles than in the other Chelonians I have studied.

The independent rhythmic tendencies are greater in the land tortoise, I am inclined to believe, than in most other Chelonians.

The land tortoise and Terrapin resemble each other more than they do the marine turtles in the amount of dilation following direct faradisation of the heart; also neither the Terrapin's nor the land tortoise's heart enter with the same facility into intervermiform action as the sea turtle's.



HEART OF SEA-TURTLE.

Prolonged stimulation of the vagus has not led, in the land tortoise, to such pronounced results, as regards cardiac inhibition, in the few cases examined by me, as in other Chelonians.

The Chelonians constitute morphologically a very compact group, and it will be seen that the resemblances in the physiological behavior of this group is in accord with their anatomical likeness. It has been pointed out several times, that *C. Mydas* is physiologically more closely related to the Terrapin than the other species of sea-turtles I have studied; and it is in this one that the most anatomical resemblance, as far as the cardiac nerves are concerned, is found.

Throughout this paper, differences in the physiological behaviour of different species and genera of Chelonians have been pointed out; but it must be remarked that many minor variations, readily discernible by the eye, but not easily expressed in words, have been noticed during the year over which these investigations have extended.

The explanation of the different action of drugs on animals closely related anatomically, may possibly be reached by some such comparison as I have endeavored to carry out for the Chelonians.

EXPLANATION OF PLATE.

Fig. I. Relations of the sympathetic, vagus, &c., in *Chelonia imbricata* and *C. caretta*. S., sympathetic; V., vagus; *g.c.s.*, ganglion cerv. super.; *a. car.*, arteria carotida; *g. v.*, ganglion of the vagus stem; *g. c. m.*, ganglion cerv. med.; *g. c. b.*, ganglion cardiac. basal,; *acc. s.*, accelerating symp. branch. *a. v.*, arteria vertebralis: ix, x. refer to the metamere concerned.

Fig. 2. The vagus ganglion with its leash of branches. *a. s.*, art. subclavia.

Fig. 3. Shows partial fusion of *g.c.i.*, the gang. cerv. infer., and *g.t.p.*, the gang. thoracic. prim.

Fig. 4. The sympathetic, &c., in the *Terrapin*: to a large extent the same in *Chelonia mydas*. The lettering, as in previous figures. The dotted line between *g.c.i.* and *g.c.b.* indicates that a branch, sometimes present, completes an *annulus Vieussenii.*

Fig. 5. Ventricle with areas marked off by dotted lines, the numbers indicating the order in which these areas die.

Chemical Notes on Wheat and Flour.

By J. T. Donald, M.A.

(Read before the Natural History Society, Montreal, January 31, 1887.)

The quantity of flour used in the preparation of the staple bread is so much in excess of that used for all other purposes, that any examination of flour as a commercial article must necessarily be made from the point of view of its bread-making qualities.

In the baker's estimation, strength and color are the most important qualities of flour. In the matter of color alone, the whiter a flour the better. Strength is a term employed not always in precisely the same sense, but by it is generally meant the "capacity of a flour for producing a well risen loaf." For bakery use it is, I believe, impossible to obtain a flour that is too strong, and the flour most in demand for bread making is that known as "strong bakers'." The baker's demand for "strong" flour begets the miller's search for a "hard" wheat, for experience has shown that it is only from a "hard" wheat that a "strong" flour can be obtained; soft wheat yielding a flour deficient in strength.

The hardness and softness of wheat and strength of flour are physical characters, but they correspond to important differences in the chemical composition of the grain and flour. A "hard" wheat and a "strong" flour are always richer in nitrogen than a soft wheat and a weak flour, and of this greater amount of nitrogen in the "hard" wheat and "strong" flour a larger percentage is insoluble albuminoids or gluten than is the case in the soft wheat and weak flour. * The average nitrogen yielded by analysis of a series of soft Canadian wheat was 1.74 p.c., whilst a series of hard Manitoba wheat averaged 2.32 p.c. nitrogen. A sample of hard wheat from Portage la Prairie yielded moist gluten 36.43 p.c.; a soft wheat from Gretna gave, by similar treatment, only a shade under 25 p.c. or 24.96 p.c.

* U.S. Dept. Agriculture, Bureau of Chemistry Bulletin, No. 4, page 30.

Flour made in this city, branded "strong bakers", gave moist gluten 32.00 p.c., dry 12.41 p.c., whilst a sample, which would not rank as bakers' from same milling gave only 28.78 p.c. moist gluten, and 9.27 p.c. dry.

The connection between "hard" wheat and "strong" flour is thus clear, but the question will arise, why should some wheats be soft and others hard? This question I am unable to answer, but I wish to present certain facts connected, I think, with the solution of the problem, in the hope that some of our members, reasoning from these facts, may throw light upon the subject. It is true there are certain wheats which, however they may have become so, are now soft varieties and tend to reproduce a soft wheat, whilst other varieties known as hard tend to reproduce hard. But we also find that a wheat which in one part of the country will reproduce a hard grain, will in another locality yield a soft. And still further, a locality which in one season yields hard wheat, will, in a succeeding one, from similar seed, produce a soft grain.

The officers of the Bureau of Chemistry in the U.S. Dept. of Agriculture, have made an exhaustive examination of wheats collected from all parts of the Union, from which it appears that as we proceed from the eastern seaboard westward, the wheat is harder and harder until the States on the Pacific slope are reached, where the wheat of the country is again soft. In our own country, every miller knows that Ontario wheat is soft, and that for the production of a strong flour, western wheat must be used. (I am told, however, that there is a small area near Ottawa which produces a very hard wheat.) But all western wheat is not hard. A sample received from Gretna, a town south of Winnipeg, and just on the boundary line, is soft in comparison with a sample from Portage la Prairie, about fifty miles west of Winnipeg on the line of the C.P.R. These samples, on careful examination, will show that the hard wheat is darker in color than the soft—an experienced eye can easily detect the difference in the two samples.

With reference to this Portage la Prairie sample, I may add that wheat grown in the same neighbourhood last summer, i.e., summer of 1886, has shown traces of softness. The theory that this was caused by the extreme drought would be tenable if other localities in the Province had been affected in like manner, but other sections which last season produced wheat verging on soft have this season grown wheat of increased hardness. Specimens of wheat last fall, raised from No. 1 selected seed, showed from 40 p.c. to 50 p.c. soft. The wheat had a peculiar mottled appearance, some of the kernels being partly hard and partly soft. This was the case in many lots around Portage la Prairie. Still another point in this connection: spring wheat is always harder and yields a stronger flour than fall wheat. The Bureau of Chemistry, already referred to, reports that a sample of Dakota spring yields 14.35 p.c. albuminoids, whilst a fall variety from the same territory contains only 10.68 p.c. The analyst adds, "The weight of one hundred grains of the *winter* variety was 3.513 grams; of the *spring* grain, 2.755 grams. The smallness of size and richness in albuminoids may be due to a lack of starch owing to short period of growth and rapid maturity, and consequent inability to assimilate as much of the carbohydrates as the winter wheat." *

I may add that I am told by a gentleman who has travelled extensively through Manitoba and the Northwest, that when in a hard-wheat locality the grain does show signs of softness, it is in the grain grown on higher lands that softness first appears.

Turning now our attention to flour, we must remember that almost, if not, indeed, all merchant milling is conducted by roller milling process. In this process, the grain is passed through a series of rolls until the floury portion is separated from the germ and the coats, with whatever foreign matter may be adhering to the latter. The duty of the first set of rolls is to split the wheat along the crease, so that foreign matter within it may be removed by special appliances. The floury portion of the grain is separated from the coats in large particles, and these particles known

* Bulletin, No. 4, p. 19.

as "middlings" are ground between stones. Remembering that the coats of the wheat adhere very firmly to the floury material, and that the portion of the grain closely attached to the bran coats is the most highly nitrogenous of the whole, we can understand that this outer floury portion is to a certain extent carried away attached to bran, and that the flour from this part of the grain is so contaminated with small pieces of bran that the color is darker than the flour from the interior of grain. This darker flour, rich in gluten, forms "strong bakers'," while the whiter and less nitrogenous material is known as "patent." A third kind is known as "low grade." It is very dark in color, and contains numerous particles of bran and germ. Although highly nitrogenous, it contains only a low percentage of gluten, and will yield a very dark bread, owing both to presence of bran and germ and the action of the ferments present in them, which, during process of leavening, act upon the starch, converting it into dextrine and allied products.

The roller process is distinguished for the completeness with which it removes germ of the grain during manufacture of flour by flattening and sifting it out. The germ contains much ash, oil and nitrogen, and if allowed to be ground with the flour, darkens it by the presence of the oil, which is readily oxidised under certain conditions, and renders it very liable to fermentation, owing to the peculiar nitrogenous bodies which it carries.

In speaking of germ it may be noted that there is at present on the market an article known as "wheat germ meal," which is sold as a substitute for oatmeal for porridge, and for use in other forms. It is an excellent meal, extensively used in Winnipeg and other western cities. The name, however, is misleading, the substance has no connection with the germ. It is really "middlings," the particles of the floury portion of grain that are separated from the coats in passing through the rolls, and which are subsequently converted into flour by grinding between stones.

As already stated, from the roller mills three grades of flour are placed upon the market, known as *strong bakers'*, *patent* and *low grade.* The proportion of each depends upon the wheat that is used, and the particular market for which each grade is intended, and is varied at the discretion of the miller. An average percentage is about as follows:—32 p.c. patent, 4 p.c. low grade, and 64 p.c. bakers'.

The *strong bakers'* is richest in gluten, and somewhat dark in color owing to branny particles. A sample manufactured in this city gave 12.40 p.c. dry gluten. This grade is ordinarily used in making what is known among the bakers as the "brown" loaf. The large percentage of gluten enables the baker to produce with strong flour a large loaf which may be baked without pans.

Patent is a whiter flour, on account of fewer branny particles, and coming to a greater extent from inner part of grain has a lower percentage of gluten. A sample made at same time with sample *strong* just mentioned, yielded 9.20 p.c. dry gluten, whilst the *low grade* of the same milling showed only 6.30 p.c. dry gluten. The "patent" is the flour for family use, and the higher grades are used by bakers in the manufacture of white bread, loaves made in pans. Since this *patent* has not the high percentage of gluten found in *strong* loaves large and baked without pans cannot be so readily obtained from it.

Thus far I have spoken only of one cause of the strength of a flour, viz., the percentage of gluten, and so far as *bakers'*, *patent* and *low grade* from the same wheat are concerned, the quantity of gluten is a measure of the strength of the flour. But if a comparison is to be instituted between two samples of *bakers'* or of *patent*, or if it be necessary to determine the suitability of any flour for bakers' use, one must know not only the quantity of gluten the sample will yield, the quality of the gluten must be taken into consideration. In some flours the gluten is very firm and elastic, in others it is soft and sticky. In the latter case, a well risen loaf cannot be obtained, as the gas disengaged in fermentation is released by the soft gluten, whereas in the elastic gluten, a firm, porous mass is formed. The best test of quality of gluten is obtained by a trial baking; but some more rapid and convenient test is desirable, and to be of service to the baker in valuing his flour for strength must in character approximate to baking. An excellent test consists in exposing the gluten under proper conditions to such a temperature that the moisture of the moist gluten is vaporised, and in process of vaporisation and escape, expands the gluten. A soft, inelastic gluten readily allows the steam to pass out from the mass, whilst a firm, elastic gluten presents greater resistance to the steam, and is therefore expanded to a greater extent. The higher the quality of the gluten, the greater the expansion it undergoes.

I have yet to refer to the effect of frost on grain, and on the flour produced from such grain. This is an important point, inasmuch as for several seasons (excepting harvest of 1886) the wheat in many parts of the Northwest was injured by frost, and the Northwest is the great wheatfield of Canada, the feeder of the numerous mills in this and the adjacent Province of Ontario.

The effect of frost is seen in the bluish color and shrivelled appearance of the grain; the flour from such wheat is poor in gluten, and the quality of the diminished gluten is low. I am unable to indicate the precise changes which the constituents of the grain have undergone as result of being frozen. It seems that both the starchy and albuminoid matters of the grain are affected by frost. It seems probable that the frost directly acts upon the albuminoids, and through them upon the starch.

A sample of flour from frozen wheat yielded only 25 p.c. moist gluten, whilst flours obtained from similar wheats which had not been frozen, gave on analysis 27 and 28 p.c. moist gluten. Not only does freezing diminish the amount of gluten in the wheat, but it also affects the quality of the gluten. In flour from frozen wheat, the total amount of matter extracted by cold water in half an hour was 5.58 p.c., whereas in a sample of same grade from sound wheat, it was only 4.60 p.c., i.e., flour from frozen grain had nearly 25 p. c. more matter soluble in water than that from sound flour. The soluble albuminoids of the frozen amounted to 1.30 p.c., whereas in the flour from sound wheat, soluble albuminoids were only .95 p.c., i.e., flour from frozen grain had about 50 p.c. more soluble albuminoid matter than that from sound grain; clearly showing, I think, that frost had rendered soluble both gluten and starchy matter.

Why frost renders the gluten of wheat inelastic is uncertain. It may be that whilst a low temperature renders gluten soluble, a still lower coagulates to a greater or less extent the albuminoids, and coagulation is inimical to elasticity.

Be the cause what it may, the fact remains that flour from frozen grain contains a large percentage of soluble albuminoids and carbo-hydrates and a low percentage of gluten of slight elasticity.

In conclusion, I wish to call attention to a flour known as "Entire Wheat Flour," which its proprietors claim is neither a white nor a Graham flour, but a "flour of the entire food substance of wheat, and of that part only, discarding the innutritious husk or outer bran; a flour in which every food element of the wheat is preserved."

Undoubtedly the entire wheat flour contains a greater percentage of phosphates than ordinary flour, and perhaps of gluten, too, for it is a difficult matter to remove all the flour from the bran, and the flour near the bran is richer in gluten than is that of the interior of the grain, although the wheat is not girdled by a layer of gluten cells as proprietors of this flour and others believe. This supposed layer of gluten cells is really a layer of the bran in which is present a very active ferment known as *cerealin.* It is owing to the action of this ferment, not the presence of branny particles as such, that bread made from whole or entire meal is dark colored. "The dark color is due to excess of dextrinous matter derived from action of *cerealin* on starch. This excess of dextrine causes dough to become soft and clammy, on which account the loaf is apt to become sodden." To this dextrine is also due the sweetness of Graham or whole meal bread. It is often claimed for the whole meal bread that it is a remedy for dyspepsia; this claim I believe is well founded, not, I think, because such bread is more digestible than ordinary bread, but because the branny particles present cause irritation to such an extent that the bread is prematurely expelled from the digestive organs, and by this means the oppressive feeling of dyspepsia is removed. It follows, therefore, that although the "entire wheat flour," or whole meal, may contain more nourishment than white flour, the system is able to obtain more nutriment from the ordinary white flour.

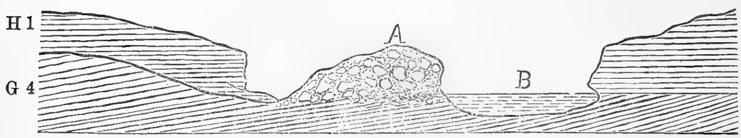
On a Permian Moraine in Prince Edward Island.

By F. Bain, Esq., North River, P.E.I.

The Trout River, which is the eastern branch of the Mill River, Prince Edward Island, flows in a deep and picturesque valley, cut through the horizontal Triassic strata which cap the rock formations of this part of the country. On either side of the stream, the rounded hills of fertile red sandstone rise two hundred feet, clothed with bright, deciduous groves or golden with the ripened fields of autumn. At the foot of these hills, at a place called Blackman's Island, a conspicuous ridge or mound, ten to twenty feet in height, fifty yards broad, and five hundred yards in length, runs along the left bank of the river, assuming much the appearance of a Quaternary glacial moraine. On examination, however, we find that it is formed by a hard mass of sandstone conglomerate, which has resisted denudation, while the surrounding softer strata have been carried away. A stratified portion at its base shows it to possess the same general dip as the Permian rocks of the district, viz., S. 22° E. $<$ 2°. General direction of the conglomerate ridge, S. 35° E. The superior beds, which once overlaid it, as seen in adjacent sections, are horizontal.

This ridge of ancient conglomerate is composed of rounded masses of red sandstone, sometimes two feet in diameter, gravel, sand and clay, with some fragments of primary drift, all intimately wrought up together, without any trace of stratification, except in the lower member mentioned. The whole is now consolidated into firm rock, hardened in part by carbonate of lime. It contains no organic remains, except that some of the included masses of sandstone show the usual traces of Permian conifers. It appears to me evidently to have been a glacial moraine of the close of the Permian. The large, rounded masses of stone, intimately wrought up with clay, sand and gravel, without stratification or other indication of sedimentary origin, I do not think can be referred to any other cause than that of ice operation. The angular fragments of primary rocks—quartzites and felsites—sometimes more than six inches in diameter, which it contains, show that the usual agents of a drift period were in operation, conveying material from great distances.

Section showing relation of Moraine to accompanying Formations.



A. Supposed Permian Moraine. B. Water level, Trout R.
H 1. Triassic Sandstone and Shales. G 4. Permian Sandstone.

The rounded blocks of sandstone contained in this deposit prove that at the time of its formation the underlying Permian strata had been consolidated into firm rock, and that a great lapse of time must have intervened between their deposition and its formation.

The deposits immediately succeeding this, and forming the base of the Trias, are of clay shale or shaly sandstone, and are nearly destitute of organisms. As we mount in the formation, however, more traces of life gradually come in, till at its summit, 200 or 300 feet above the horizon of the moraine, the dark-coloured sandstones bear evidence of an abundance of life, among which were tree ferns, stony corals and gigantic reptiles. On the other hand, the deposits immediately underlying the moraine, and forming the summit of the Permian, are very devoid of organized remains; but as we descend in the system, life becomes more abundant, until in the lower Permian we find the brown and grey rocks filled with the remains of a luxuriant vegetation, of which tree ferns and coniferous trees of the genus Dodoxylon formed an important feature.

The middle portion of this system of deposits, so devoid of organisms, forms a broad belt of red rocks widely distributed over the Island, forming its most characteristic red sandstone scenery, and appears to represent a period of depressed temperature in the past, which found its climax in a glacial period at the time of the formation of the ancient moraine. This line is specially interesting as being also the line of division between the Permian and Trias, where such a marked change in life is known to have taken place. Our ancient moraine, then, standing grim and sphinx-like by the glassy flow of the quiet Mill River, probably contains in its dark bosom the secret of that great change in life, viz., an era of glacial cold.

The Permian in England and in India bears evidence of extensive ice action, and it is exceedingly interesting to find the same in the Permian of Eastern Canada. In Europe the lower Permian shows generally a warm climate, though at its base is a line of drift material. The same line of drift material occurs at the base of the Permian in Prince Edward Island, followed by the same evidence of long-continued warm climate. The upper Permian in Europe indicates, by the absence of corals and the character of its mollusca, a cool climate. In Prince Edward Island we have seen that there is evidence of the same depression of temperature, which culminated in an era of ice and drift.

Life in the Bahama Islands.

By T. Wesley Mills, M. A., M. D.

Professor of Physiology, McGill University.

Having been invited to form one of a party of seven naturalists intending to visit the Bahama Islands last May, I gladly embraced the opportunity to learn something of that tropical region which so fascinates the imagination of every true lover of nature; the more so as we were to have the opportunity of seeing in operation those forces which explain the origin and growth of coral islands.

The expedition was headed by Professor Brooks of the Johns Hopkins University, under whose auspices we sailed, and to the wise generosity of which, science in America is so much indebted. There being no direct steam communication with Abaco, we were obliged to make use of a small sailing vessel, taking with us our laboratory outfit, and a supply of provisions sufficient for at least part of our intended stay. It was hoped that the voyage would not last longer than eight or ten days from Baltimore, our port of embarkation, but owing to stress of weather, contrary winds, etc., it extended over nineteen days. These days, however, were not without instruction. The tedious hours on deck were employed in observing the life around us, more especially such as we could capture by the hand-net.

Being obliged to put into harbor off the Carolina coast, we visited some small islands which were frequented by numerous sea-birds, especially gulls and terns. During our examination of these islands, it came to light that the people from the neighbouring coast were accustomed to visit them in the breeding season of the birds and gather the eggs in hundreds for food; so that the shooting of birds to supply ornaments for ladies' hats is not the only method of extermination practised. The capture of a white-rumped petrel, soaring near the deck, by a hand-net, was by the sailors assigned as the cause of all our misfortunes; such is the superstitious character of seamen to the present day.

Upon reaching the Gulf Stream, the increase in temperature necessitated a change to lighter garments. Sea captains immerse a thermometer in the water from time to time in order to ascertain when they strike the warm current.

The interest was maintained throughout by dipping up Gulf-weed, (*Sargassum bacciferum*), a fucoid in which numerous creatures take refuge, such as small barnacles, minute crabs and other crustaceans, nudibranch, tectibranch and heteropod mollusks, hydroids, together with small and beautiful fishes. The general resemblance of the creatures found to the weed itself was striking, though there were exceptions to this, a few forms being brightly colored, while *Sargassum* is of a faded green color. The Portuguese man-of-war (*Physalia*) was frequently to be seen floating by, his frail bark being trusted to the by no means smooth if not actually raging sea.

A form of medusa of the genus *Linerges* was met for several days while we were in the Gulf Stream, and it is singular that it should have appeared at about the same hour (4 p.m.) on each successive day. But of all our captures, none was more interesting than that of *Argonauta*, a female, provided therefore with shell, and, as it turned out, with eggs in the shell. When taken, it was alive, and having placed it in water in a glass vessel, its mode of locomotion, by jets of water forced through its siphon, could be observed beautifully. The sight of this was effective in somewhat reving some of the party sadly prostrated by sea-sickness. The creature was, of course, pickled with miserly care by the fortunate possessor.

At last, after so many days, which with all the interest we could put into them, were, from the want of accommodation, etc., on so small a vessel, weary ones, we sighted the Bahama "bank," took a pilot on board and began to revel in experiences at once the newest, most impressive, and in many respects the most delightful of our lives. A brief reference to the geography of the Bahamas may here be in place. This group of islands, keys and rocks lies between 21° and 27° N. latitude, and 72° and 79° W. longitude. One finds all transitions between the large island of Abaco and mere rocky projections; all are, however, of coral formation, and the keys are simply small islands, usually without vegetation, though some of the larger ones are densely covered with plant life. While the water over the reefs is nowhere deep, not often exceeding six fathoms, just ouside them the ocean has great depth. This abrupt change partially explains the danger to mariners, and shipwrecks are still too common.

We were bound for Green Turtle Key, which is separated from Abaco by about two miles of shallow water, one might say a sort of lagoon. This is the largest of the keys, measuring about a mile in length and less than a quarter of a mile at its widest part. Most of the small keys are uninhabited, but Green Turtle Key has a population of about 600.

The water over the "bank" or submerged coral formation is termed "white," except when green plants or colored algæ grow on the bottom, owing to its remarkable clearness. But viewed at a little distance, the surface of the water presents a beauty and variety of color related to the arrangement of clouds, etc., which it is impossible to express in words, and which a *series* of paintings might portray, though very inadequately.

Such is the transparency of the water, that with a "water-glass," objects lying on the bottom can be clearly discriminated at a depth of 4–5 fathoms; in fact we were accustomed to indicate by this means to our native diver exactly what we wanted him to bring up, a plan which was uniformly successful.

Having rented one of the largest houses on the key, it was fitted up as a laboratory and dwelling place combined. Our stay lasted through the month of June, which was an exceedingly busy time for us; we were in a new world, and daily fresh objects presented themselves for examination.

The rest of this paper will be devoted in great part to illustrating how largely the phenomena which have been associated with the formation of coral islands may be illustrated, in one small area. Here we find at once the requisite temperature (not below 68°), the clear water and the shallow depth, the conditions under which the coral animal flourishes. The teeming life now there explains the results of that which has been and which has determined conditions that render the existing life possible. In this paper, at all events, it will not be possible more than to glance at the subject in a general way. If the reader will suppose that he is sailing over the "bank" or submerged part of the reef, a distance of, say, two miles one way, and an equal distance in a direction at right angles to this, what may he expect to see on the bottom by the aid of his water-glass? The latter can be made very easily by puttying a pane of glass into one end of a rectangular wooden pipe two feet long and about six inches wide. He will pass several small keys, very much alike, but the ledges of each of which will be found to shelter myriads of marine creatures of every great group among the Invertebrates.

Over the bottom, dull white from the fine calcareous mud, may be seen in one part, Algæ of the most various shapes and colors, in which group here, owing to calcification, the plant bears a marked external resemblance to the Alcyonoid corals, which may be seen in some cases at no great distance, waving to and fro under the gently swaying water, the whole suggesting, as one looks down, a submerged garden.

In another area may be observed in masses large and small the branching Madrepore (*Madrepora cervicornis*); in still another region, Millepore and Fungoid corals, for it soon becomes evident that the conditions, over even so limited an area, do not suit each tribe equally well. Around and among the very branches of the dead corals especially may be seen representatives of all the different great divisions of the Echinoderms, many Mollusks, Crustaceans, Annelids, etc. While the Sponges may be found in many different regions, they have selected and flourished over certain parts of the bottom to such an extent, that the sponge fishing is very much confined to this quarter. However, Sponges may be seen growing almost everywhere, on coral stones, and even on offshoots of the Mangrove, which, by its peculiar habit of sending down branches into the mud of the bottom on the shores which it overhangs, and repeating this process again and again, forms a network for entrapping everything which may be washed up, thus becoming, as pointed out by Dana, a causative factor in the growth of coral islands.

After this hasty glance at the bottom, let us turn to the shore at low tide. The edges of the key have been undermined by the waves, and here in the little caves thus formed, and on the sides of the rocks, may be seen Crustaceans of every family, and among these, some of the large and peculiar forms which render museum collections objects of interest even to the scientifically uneducated. The spiny lobster (*Palinurus*) may be observed stealthily lurking under shelving rocks, below low water mark. Mollusks, the representatives of many families and genera, may be found on the sandy shores or attached to the rocky margins of the key. Conspicuous among these are the members of the peculiar Chiton family.

The shore is strewn with the most beautiful shells, no longer occupied by the animals which once carried them about; many of them to be taken possession of by the numerous genera of hermit crabs, which clamber over the rocks. Several hundred yards from the water's edge may be found a burrowing crab with powerful claws, rarely to be seen in daytime, though his nightwork leaves evidence palpable enough in the heaps of upturned sand. Not to speak of numerous peculiar and beautifully colored fishes to be observed in the coves referred to, an interesting member of the Cephalopods—the poulp (*Octopus*) abounds in the holes in the rocks which the waves have scooped out. From some study of this creature I am prepared to endorse the view that his intelligence is of a high order, a fact which one is prepared for, considering the mass and concentration of his nervous system.

So far as the formation of the coral island is concerned, I shall only refer to the action of forces that may now be observed in operation on even this small key. This island has increased in one direction, within the memory of the inhabitants who have reached the age of fifty, by some thirty yards. Beach formation, the work of the waves in grinding and comminuting the dead remains of corals, mollusks, crustaceans, etc., will account for this, probably without the assumption of any general or local elevation of the ocean bottom. One sees on every hand, the evidence of solution, cementing and comminution; and these are the processes which serve to explain the growth of coral islands. The waves, dashing up, erode small cavities; these are enlarged by the retained sea-water, which has remarkable solvent power over the calcium carbonate of which the whole key may be said to be composed; for it will be remembered that not only are the coral skeletons made up of this substance, but that the greater part of the hard remains of nearly all invertebrates is likewise of the same composition. By the cementing power of lime salts in solution, the shells of mollusks, etc., may be seen glued, either entire or in fragments, to the rocks of the key margins, so that a coral island is in reality a conglomerate with a fairly uniform chemical composition. It should be mentioned that on the shoals around this small island (key) the "King Conch" (*Strombus gigas*) is very abundant, and from the size and weight of its shell, it must contribute more to the formation of the calcareous total than could scores of other mollusks or of crustaceans.

But leaving the water and seeking for land animals, one may speedily dispose of the mammals, for there are none on Green Turtle Key, except a few dogs, cats, pigs, and probably rats and mice, though as to the latter I am not certain. Almost as numerous as the grasshopper with us is a small grayish-brown lizard of about 5–6 inches in length, with a handsome orange throat. Of land snakes there are none, I believe; turtles abound in the waters, and are much sought for food, as are also, their eggs, laid in the sand on the beach.

The tree-frog is found, but there are, of course, no fresh water ponds of any considerable size in which other tribes of Amphibians might live; if they exist here at all, their numbers must be very small. Excepting the common fly, the mosquito, spiders, centipedes, and cochroaches, land Arthropods are not abundant. The spiders, centipedes and cockroaches, however, attain an enormous size; and the latter fly about at night to the great annoyance of the unhappy mortal who is trying to fall asleep. The scorpion is found, living mostly amongst decaying vegetable matter; but it does not seem to attain its greatest size here; its sting is regarded by the inhabitants as serious, but not dangerous or fatal. The Lepidoptera are moderately well represented, some of the forms being large; and among the Hymenoptera, a large yellow-banded wasp is the most conspicuous.

On Abaco, a fly, resembling our common house-fly, but larger and with a more pointed abdomen, is a terrible blood sucker. Strangely enough, it is never found on Green Turtle Key, though only two miles distant. One of the natives told me that nothing could induce him to live on Abaco, on account of this fly.

Up to the present I have confined myself almost exclusively to Green Turtle Key, and the waters surrounding it. In referring to the bird and plant life, it may be more instructive to compare forms as found on the smaller and larger islands. Owing to the kindness of Mr. Jennings, the member of our party who has devoted most attention to the birds, I am in possession of accurate notes, from which the distribution of those birds found in the Bahamas by him may be learned. As much of the matter relating to the birds and plants must be in some degree new to science, it may be well to arrange it in more technical form than has been thought desirable in the other portions of this paper.

Mimocichla plumbea, "Blue Thrush," met with in Abaco but not seen on Green Turtle Key; habitat: Bahama Islands; common at New Providence, Andros, and Abaco.

Margarops fuscatus, a large thrush, belonging to the same family as the mocking-bird. Its habits are quite terrestrial, and its song is very sweet. It is found upon several of the West Indian Islands, seen upon one small key some distance from Abaco.

Mimus polyglottus, "Mocking-bird;" this species is very rare in Cuba, and Cory does not mention it as inhabiting any other of the West Indies. It is very common on Green Turtle Key; in N. A. it is found from the Atlantic to the Pacific as far north as 42°, but is not common north of 38°.

Certhiola bahamensis, Bahama Honey-creeper; is found in the Bahamas and Florida Keys; abundant on Green Turtle Key, and seen on No-Name Key and Abaco; the native name for this bird is "Tip-Toe."

Vireo altiloquus barbatulus, Black whiskered Greenlet. "Whip-tom-kelly," "Sweet-joe-clear;" habitat: Cuba, Bahamas and South Florida; met with once on Green Turtle Key, and at no other point.

Callichelidon cyaneoviridis; this pretty swallow is found in the Bahamas; it was common on Green Turtle Key and Abaco.

Spindalis zena townsendi; a beautifully marked bird, belonging to the family Tanagridae or the Tanagers. This species was abundant on Abaco, opposite Green Turtle Key, and two specimens were obtained on the latter. This bird was first taken by the naturalists of the U. S. Fish Commission Steamer "Albatross," early in 1886, and described by Mr. Ridgway.

Euetheia bicolor, "Parroquet;" this small finch is given its name by the natives on account of its appearance, which was absurdly like a very diminutive parroquet; habitat: Bahama Islands and Antilles; seen on Abaco only.

Argelaius phœniceus bryanti, the Bahaman form of the common red-winged blackbird; common on Green Turtle Key, but observed nowhere else.

Tyrannus dominicensis, Gray King Bird; habitat: West Indies and Florida; common on Green Turtle Key.

Chordeiles virginianus minor, Cuban Night-hawk; habitat: Antilles and Florida; common on most of the Abaco keys.

Crotophaga An., Black Witch, Savanna Blackbird: habitat: Tropical America, West Indies and Florida; several observed on Green Turtle Key.

Dryobates villosus insularis; a specimen of this small woodpecker was obtained on Green Turtle Key; habitat: Northern Bahama Islands.

Centuris blakei, a species of woodpecker, belonging to the same genus as the Red-bellied Woodpecker; it was first taken on Abaco by the "Albatross" party; our specimen was procured on Abaco.

Cathartes aura, Turkey Vulture; habitat: North and

South America; in North America from Atlantic to Pacific N. to 53°, resident N. to about 40°, occasional individuals N. to Nova Scotia and New Brunswick; one specimen seen on Abaco.

Columba leucocephala, White-crowned Pigeon; habitat: West Indies and Florida keys. Extremely abundant on some of the Abaco keys, though none seen on Green Turtle Key that could be identified as this species.

Columbigallina passerina, Ground Dove; habitat: Middle America, West Indies, South Atlantic and Gulf States, N. to Carolina; common on Green Turtle Key, and on other keys in the vicinity, and on Abaco.

Symphemia semipalmata, Willet; one specimen taken on Green Turtle Key; habitat: Temperate North America, Atlantic coast from Nova Scotia to Florida, West Indies and S. to Brazil.

Nycterodius-violaceus, White-crowned Night-heron; habitat: N. South America, West Indies and South Atlantic and Gulf Coasts, rarely N. to Middle States; Observed on Green Turtle, No-Name, and Fish Keys.

Phœnicopterus ruber, American Flamingo; habitat: Atlantic coast of Central America, N. to Florida and West Indies, rarely to South Carolina; recorded from Bermuda; found on Abaco.

Pelecanus fuscus, American Brown Pelican; habitat: Atlantic and Pacific coasts of tropical and sub-tropical America, north to Carolina and California; met with about most of the Abaco keys.

Phalacrocorax dilophus floridanus, Florida Cormorant; habitat: South Atlantic and Gulf coasts; found breeding on Hog Key.

Tachypetes aquilus; Frigate, Man-of-war Bird; habitat: coasts of tropical and sub-tropical America, north casually to Long Island; large flocks of these birds frequented Hog and Fish Keys, and occasionally individuals were seen at other places.

Phæton flavirostris, Yellow-billed Tropic Bird; habitat: Atlantic coast of Central America, N. to Florida and West Indies; met with at Hog and Fish Keys, and at one place on Abaco.

Larus atricilla, Black-headed or Laughing Gull; habitat: Atlantic coast of America, South to Lower Amazon, N. casually to Maine; common at Joe's, Fish, and other keys.

Sterna hirundo, Common Tern; habitat: East North America; common on several of the Abaco keys.

Sterna antillarum, Least Tern; habitat: warm temperate America, Central America, and West Indies; common on Abaco keys.

Sterna fuliginosa, Sooty Tern; its range extends over the warmer sea coasts of the globe; in America, N. to Carolina, casually to New England; extremely abundant at Fish key.

Sterna anæsthetica, Bridled Tern; its general range coincides with that of the last species, but in North America it is found in Florida only; procured at Lower Fish Keys, but it was not nearly so abundant as S. fuliginosa.

Among the birds, specimens of which were obtained but not yet identified, are a Grossbeak, two Warblers, a Parrot, a Dove, and two species of Humming-bird.

Green Turtle Key is densely covered with vegetation which is, however, in marked contrast with that of the adjacent large island of Abaco, by the absence of very large or forest trees. On Abaco may be found the pine, *Pinus Cubensis* (?) resembling *Pinus Tæda*, also the red cedar, *Juniperus Virginiana*; cedar prevails near the numerous swamps in the north-eastern part of the island; the pine may reach a height of 80 feet.

Among other common trees are the mastic, "dogwood," white torch, bullet, and "poison wood" (probably *Rhus toxicodendron.*)

In the lowest part of the island, the mangrove (*Rhizophora Mangle*) forms dense thickets.

Ferns, bromeliads and orchids flourish abundantly, both on Green Turtle Key and on Abaco.

The small keys are devoid of trees proper, but shrubs, vines, coarse grasses, etc., abound. Among these are turtle grass (*Gomphrena*), morning glories (*Convolvuli*), a pea vine with rope like stems (*Carnavalia.*)

A plant imported by florists, the "West Indian Lily" (*Pancratium*), grows along the sandy margins of many of the islands.

The "Button-wood" (*Conocarpus*), with its conspicuous silvery leaves, flourishes on every hand.

Green Turtle Key has the most varied flora of all, in proportion to its size, owing probably to the fact that it alone among the smaller islands is inhabited by man. The cocoanut palm flourishes in beauty and vigor at one end of the Key, though the natives make very little use of the fruit themselves.

One island, named Cocoanut Key, is covered with a grove of these trees, planted some seven years ago. One of the most interesting remembrances of the trip is that of a morning spent on this key, where the cocoanut palm may be seen in all stages of growth, from flowering to the production of the ripe fruit, while beneath the trees, the fallen parts suggest most plainly the economic uses to which the plant may be put. I could get no evidence that the cocoanut ever grows spontaneously in the Bahamas; it is in all cases planted, and does not bear fruit for six or seven years.

Many fruit trees now grow wild on Green Turtle Key, such as the banana, orange, lemon, sapodillo, mango, shaddock, mammee, custard apple (Pawpaw), hog plum, tamarind, date palm (rare), fig (rare.)

None of these can be said to be cultivated in the proper sense; they may, in fact, be found intermingled with shrubs, vines, etc., forming a thicket as dense as any in a Canadian forest, and when caught in one of them, I could not help making the comparison and at the same time noting the contrast.

Conspicuous on the low sandy region near the shore is the manilla, a species of Agave, with its powerful, long, spiked leaves, and its solitary flower stalk, which reaches a height of at least 20 feet.

In the same region, a cactus (*Opuntia*) abounds in large and dense masses. Insects, I observed, play a great part in the fertilization of the flowers of this plant.

One of our party, Mr. F. H. Herrick, collected and preserved a considerable number of plants. These were submitted for identification to Prof. Eaton and Mr. W. A. Setchell, of Yale College. The results of their work have appeared in the Johns Hopkins' circular, from which I extract the following table.

The sixty-six species of the list represent about forty natural orders or families.

Those plants marked by a †, constituting about one third of the whole, are not known to occur in the Southern States or on the Florida Keys and are, it is likely, peculiar to the Bahamas.

Plants found on Abaco alone are marked accordingly, and those observed only on Green Turtle Key are marked by the letters G. T. Local, popular names are enclosed in quotation marks.

FLOWERING PLANTS.

1, *Agave* sps (?). "Manilla Plant."
† 2. *Alternanthera flavescens*, Moquin.
3. *Argemone Mexicana*, L. Prickly Poppy. (G. T.)
4. *Artemisia vulgaris*, L. Common Mugwort, (G. T.)
† 5. *A. hispida*, Pursh. "Bastard Geranium."
6. *Asclepias paupercula*, Michx. Milkweed.
7. *Bidens leucantha*, W. Beggars' Ticks.
8. *Borrichia arborescens, D. C.*. "Bay Lavender."
† 9. *Brumfelsia*—(?). Tall shrub.
10. *Carnavalia obtusifolia*, D. C, Coarse vine (Pea family).
†11. *Catopsis nutans*, Gris. (?). Epiphytic Bromeliad. "Wild Pine." (Abaco.)
†12. *Cenchorus hirsutus*, L. "Courage Bush."
†13. *Cenchrus tribuloides*, L. (Grass).
†14. *Cladium occidentale*, Schrader. (Sedge).
†15. *Coccoloba uvifera*. Shrub or small tree. "Sea Grape."
16. *Conocarpus erectus*, L. V. *erectus*, Gris. "Button-wood."
17. *Cyperus Vahlii*, Stendel.
18. *Datura stramonium*, L. Jamestown Weed. (G. T.)
19. *Dichromena leucocephala*, Michx. (Sedge). (Abaco).
†20. *Echites suberecta*. Common Climber.
†21. *Eupatorium integrifolium*, Berb.
22. *Euphorbia* sps (?). "Milkweed."
†23. *Eunodia littoralis*, Swtz.
†24. *Ficus trigonata*. "Wild Fig..' (G. T.)
25. *Fimbristylis spadicea*, Vahl. (Sedge).
†26. *Genipa clusifolia*, Gris. "Seven-year Apple."
27. *Gomphrena*—(?). "Turtle Grass."
28. *Jacquinia armillaris*, Jacq. "Joe-Bush."

29. *Juniperus Virginiana*, L. Red Cedar.
†30. *Lantana involucrata*, L. Low shrub.
31. *Lepidium Virginicum*, L. (G. T.) Pepper grass.
32. *Malvaviscus arboreus*, Cas. "Red Cherry." Shrub.
33. *Melanthera deltoidea*, Michx.
34. *Melia Azederach*, L. "Pride of Winter." China Tree.
†35. *Oncidium Guibertianum*, Rich. Epiphytic Orchid, (Abaco).
36. *Opuntia* (?). "Prickly Pear." Cactus.
†37. *Pancratium Carolinianum*, L. "Lily." (Amarillis family).
†38. *Passiflora cupraea*. L. (Pawpaw Key). Passion Flower.
39. *Pimpinella Anisum*. Anise. (G. T.)
†40. *Pinus Cubensis*, Gris. (?). (Abaco).
41. *Plantago major*, L. (G. T.) Common Plantain.
†42. *Rhacicallis rupestris*, D. C. "Seaweed."
43. *Rhizophora Mangle*, L. Mangrove.
44. *Rhus*—(?). "Poison Wood."
45. *Ricinus communis*, L. Castor-oil Plant. (G. T.)
46. *Sabbatia gracilis*, Pursh. (Joe's Cay).
†47. *Sapota Achras*, Miller. "Wild sapodilla."
48. *Scaevolo Plumieri*, Vahl. Low shrub.
49. *Smilax Havanensis*, Jacq.
50. *Solanum aculeatissimum*, Jacq. Apple of Sodom. (G. T.)
51. *Stenotaphrum Americanum*, Schrank. (Grass).
52. *Strumpfia maritima*, Jacq. Low shrub.
†53. *Suæda linearis*, Torr.
†54. *Tetrazygia eleagnoides*. D. C. "Black Torch-berry."
†55. *Tillandsia canescens*, Sw. (?). "Wild Pine." (Abaco).
56. *T. bulbosa*, Hook. "Wild Pine," (Abaco).
57. *Uniola paniculata*, L. Spike Grass.
58. *Verbascum pulverulentum*. Mullein. (G. T.)
59. *Vincetoxicum palustre*, Gray.

FERNS.

60. *Acrostichum aureum*. L. (Abaco).
61. *Adiantum tenerum*, Swz. (Abaco).
62. *Aneimia adiantifolia*, Swz. (Abaco and G. T.)
63. *Aspidium patens*, Swz. (Abaco);
†64. *Davallia clavata*, Swz. (Abaco).
65. *Polypodium incanum*, Swz. (Abaco, on trees).
66. *Tænites lanceolata*, R. Br. (Abaco, on trees).

It should be mentioned that while the banana abounds, the pine-apple (*Ananassa sativa*) is the only fruit grown for exportation by the inhabitants of this portion of the Bahamas. The plantations are principally on Abaco.

One of the most important scientific results of the expedition remains to be noted. Up to last summer, the development of the Stomatopods had never been traced from the eggs, owing propably to the difficulty of obtaining the latter, for these crustaceans do not carry their eggs about with them, but deposit them in their usually inaccessible burrows; but the softness of the coral rock permits of its being broken up, and in this way a supply of eggs was obtained by Prof. Brooks, who was able to work out their development in part at Green Turtle Key and to continue it on preserved material during this past winter. Morphologists will await the results of this investigation with unusual interest.

Illustrations of the Fauna of the St. John Group.

No. 4.—On the smaller eyed trilobites of Division I., with a few remarks on the species of the higher divisions of the group.

By G. F. Matthew, M.A., F.R.S.C.

A.—The smaller eyed trilobites of Division I.

(*Abstract.*)

The Trilobites described in this paper include representatives of the genera Ellipsocephalus, Agraulos, (or Arionellus) Liostracus,* Ptychoparia and Solenopleura. These genera, and especially Liostracus and Ptychoparia, are closely related. From a study of the young of these two genera, it would appear that Ellipsocephalus retains some features which are not so prominent in the young or adult of the other kinds, especially the eyelobe extending far towards the back of the head, as in the oldest types of Para-

*The two species here referred to Liostracus probably represent a new genus, or perhaps Angelin's original genus, for it is difficult to see how Liostracus, as defined by Linnarsson and Brögger, differs from Ptychoparia, and from this genus the one in the St. John group is distinct.

doxides. In other respects this genus (Ellipsocephalus) appears to be the most primitive type of the group of species to which this paper relates; its pleuræ are short and but little bent or pointed, its glabella is long and prominent , the facial suture is short and distant from the glabella, and the occipital furrow is faint.

The changes during growth in Liostracus and Ptychoparia are suggestive, and may be briefly presented as follows:—Omitting the first stage, indicated in all these trilobites, but which cannot be said to be special to any one, namely that in which the test of the creature is represented by an oval body with an umbilicus-like depression, one may first speak of a phase of the growing embryo in which the rachis is distinctly raised throughout its whole length and the cephalic shield, and the pygidium, indicated by a strong groove across the axis, about two-thirds or three-quarters of its whole length, from the front of the embryo. At this stage, the occipital ring is faintly outlined by a shallow groove across the rachis, and a similar, but fainter groove, indicates the first ring of the axis of the pygidium. The cheeks of the cephalic shield and the side lobes of the pygidium still form a continuous, rounded surface, except that in some examples these two parts of the body are indicated on the side lobes of the test by a faint transverse line. At this stage we are unable to distinguish even the family of the trilobite by the form of its test, for with its single ring in the pygidial part, and the enlarged front of the anterior end of the axis in the cephalic portion of the embryo, the later stages may as well exhibit to us a Conocoryphean as a Ptychoparian trilobite.

In the next stage of growth in which the cephalic shield and the pygidium are entirely separated, features appear in the former which enable one to distinguish the trilobites of this family from the Conocoryphidæ, these are the less perfectly semi-circular form of the cephalic shield, the greater prominence and comparatively larger size of the glabella, and the presence of eyelobes. At this stage in Ptychoparia and Liostracus, the dorsal suture is much nearer the margin than in the adult, a point in which these young tests resemble the adult in Ellipsocephalus and Agraulos.* The ocular fillet in these minute head shields appears close to the anterior margin, as in the Conocorypheans, but the development of the anterior limb of the cheeks in the later stages pushes it backward. In the advanced position of the ocular fillet, as well as in the long and prominent glabella in these little tests, we are again reminded of Ellipsocephalus, but a counterpart of the straight facial suture and the short eyelobe, comparatively distant from the posterior margin, is to be found in Agraulos, rather than Ellipsocephalus.

The form of the anterior margin in these young tests exhibits affinities in another direction, for in the depressed front, with narrow, sharp, threadlike marginal fold, which appears at this stage of growth, there is a counterpart to the same portion of the shield in the adult of Liostracus and Solenopleura.

The two genera last named with Ptychoparia exhibit an important departure from the primitive type in the withdrawal, during growth, of the eyelobe from the vicinity of the lateral margin, of the shield toward the side of the glabella. From this position of the eyelobe results an extension of the posterior margin of the middle piece of the headshield, a character which is most pronounced in the species of pelagic habits, and which extension is accompanied by a corresponding prolongation of the pleuræ.

Another change which occurs during growth, namely, the contraction or shortening of the eyelobe, is one which, among the genera under review, is most obvious in Solenopleura; and this genus stands out from the others also in the inflation or enlargement of the cheeks at the expense of the glabella, and in the ornamentation of the test by tubercles and granulations.

These three peculiarities of certain of these early trilobites, viz., the withdrawal of the eyelobe towards the

* The references herein to the standing of Agraulos relate to the species which are near in form to the type, but there is a species in the lower part of Div. I. which combines the characters of this genus with those of Ellipsocephalus.

glabella, the shortening of the eyelobe, and the more profuse ornamentation of the test, are most noticeable in those species, whose remains are entombed in the fine dark-grey argillaceous sediments, and least observable in those found in coarse shale and sandstone.

As regards the most salient characters of the five genera above-named, they may be arranged as follows:—

Genera having the most primitive suture ..	Ellipsocephalus. Agraulos.
Genera most completely representative of the average characters of the group....	Liostracus. Ptychoparia.
Genus exhibiting the widest departure from the primitive type..............	Solenopleura.

How much is yet to be learned respecting the origin of the Cambrian fauna! With the extensive and careful researches which have been made during the last score of years in the oldest sedimentary rocks, how little has been accomplished toward piercing the wall of barren formations that severs the Eozoon of the Laurentian system from the earliest primordial forms! It can hardly be that a fauna which blossomed out into such a variety of types at the base of the Cambrian System had there its beginning. Here, in the Paradoxides Zone, the species of animals, both in Europe and America, have a strong representative aspect, but only a limited number are found to be identical. There is a similar, though not identical succession of forms, in the several members or groups of strata which compose this zone, as if a stream of new species were coming in on both sides of the Atlantic; and yet certain genera which are found in the deposits of one continent are not to be met with in those of the other. With these facts before us, the dictum that Life originated in the Primordial Zone seems untenable.

On the contrary, we are lead to surmise that at some other point on the surface of the globe than any which has yet been explored, the ancestors of the Primordial Fauna will yet be found: it may be years before it shall be recovered, and in lieu of actual knowledge, inferences based on the study of the embryological forms of the species of the Primordial Fauna are a means of bringing before our mental vision a conception of what that fauna may have been. Dr. Henry Hicks has surmised that the Cambrian Fauna came from the central region of the North Atlantic Ocean, invading the continental margins on each side of the oceanic area; but whatever its origin, it would appear that the fauna reached Europe and America by independent routes, if we may judge by the representative species present in the two continents.

The following is a rough estimate of the number of animals in the several orders which have so far been found in Division I. of the St. John Group; it shows that the fauna is thoroughly representative of the earliest Cambrian stage, being characterized by the great preponderance of the trilobites over all other forms, and by the prevalence of brachiopods with horny shells. This list is not to be regarded as final.

Classes and Orders of Animals in Division I.

	Genera.	Species	Var.	Genera.	Species.	Varieties
Rhizopoda (Sponges, &c.)				3	3	1
Hydrozoa (Graptolites, &c.)............				2	2	
Echinodermata (Cystidians)				1	1	
Brachiopoda (Lamp shells, &c.)				6	12	2
Pteropoda (Sea butterflies, &c.).........				2	5	4
Gasteropoda (Sea snails, &c)..........				2	7	
Crustacea (Crustaceans)				14	35	14
Order Phyllopoda .	2	3				
" Ostracoda ..	3	4				
" Trilobita ...	9	28	14			
	14	35	14	30	65	21

The appearance and disappearance or extinction of the genera and species composing the above fauna is shown by the following statement of the composition of the subfaunas existing in Division I., so far as this has been ascertained:—

RANGE OF GENERA.

Genera peculiar to Band *b*	5	
" that pass from *b* to *c*	5—10	
" peculiar to *c*	7	
" that pass from *c* to *d*	15—22—32	
Deduct genera common to *b*, *c* and *d*		5
		27
Add genera peculiar to *d*		3
Total number of genera		30

RANGE OF SPECIES.

Species peculiar to Band *b*	6	
" that pass from *b* to *c*	5—11	
" peculiar to *c*	29	
" that pass to *d*	6	
" " " by varieties	7—42—53	
Deduct species common to *b*, *c* and *d*		4
		49
Add species peculiar to *d*		16
Total number of species		65

B.—PRELIMINARY NOTES ON THE HIGHER CAMBRIAN FAUNAS OF THE ACADIAN REGION.

Owing to the prevalence of shallow water conditions in the St. John basin during much of the time in which its deposits were forming, it is not easy to distinguish the upward limit of the formation, or to say how much of Cambrian time is represented in its deposits; it is highly probable, however, that it covers nearly the whole of the Cambrian age, as the Ctenopyge beds, whose place is shown further on, consist of a great mass of fine-grained, dark grey and black, slaty shales, which are undoubtedly deep water deposits. Burrows and trails of sea-worms, and shells of Lingulella, etc., are found in the sandy beds above and below these Ctenopyge shales. By means of the Ctenopyge beds, and by what is known of the Cambrian fauna in Cape Breton, the author is able to indicate the position of some of the faunas which lie at higher levels than those hitherto observed in the Acadian Cambrian rocks.

Of the true Oleni no examples have yet been found in Acadia, but the fauna of the upper part of the Lingula Flags (=the upper part of Regio A of Angelin) is present both in the St. John basin and in Cape Breton. In the former area the fossils are found in calcareous nodules, "lentiles," etc., and beside a Ctenopyge allied to *C. spectabilis*, there are several species of Brachiopods (Kutorgina, Orthis, etc). In Cape Breton, the measures are fine shales, with calcareous layers, and contain *Peltura scarabeoides*, *Sphæropthalmus alatus*, etc. In the Kennebecasis basin, near St. John, there are also beds with brachiopods and trilobites belonging to the Middle or Upper Cambrian.

The following list will show what European horizons have been recognized and what are still unknown in Acadia:

Fauna with	Ceratopyge	Unknown.
Do.	Peltura	Cape Breton.
Do.	Ctenopyge	St. John Basin.
Do.	Olenus	Unknown.
Do.	Paradoxides Forchammeri	do.
Do.	P. Abenacus (near Tessini)	St. John Basin.
Do.	P. Eteminicus (near rugulosus)	do.
Do.	of earlier date (probably the equivalent of that holding P. Kjerulfi)	do.

The fauna of the Potsdam Sandstone, which may be regarded as equivalent to that of the Ceratopyge beds, has not been recognized in the Acadian region. Above the Ceratopyge beds are found in Europe the shales containing the first of the true graptolitic faunas, and with this, or after this, come in the trilobites of the Second Fauna. The deep water faunas noted in the above noted list as missing may be accounted for by the shallow water beds in the St. John basin, there being two masses of such beds in the sediments that were accumulated in this basin.

Note on the Occurrence of Jade in British Columbia, and its employment by the Natives,

By George M. Dawson,

WITH QUOTATIONS AND EXTRACTS FROM A PAPER BY PROF. A. B. MEYER, ON NEPHRITE AND ANALOGOUS MINERALS FROM ALASKA.

From the Strait of Fuca northward along the entire coast of British Columbia and Alaska to the Arctic Sea, implements of jade or closely allied materials are found in considerable numbers, either in association with relics of various kinds, in shell-heaps and about old village sites, or in other cases still preserved, though scarcely now used, by the natives. Of implements which may collectively be designated as "adzes" or "celts;" those of jade form a considerable proportion of the whole. Jade is also found, in a similar manner, at least as far inland as the second mountain system of the Cordillera belt—that represented by the Gold, Cariboo and other ranges—and is notably abundant among specimens from Indian graves, etc., along the lower portions of the Fraser and Thompson Rivers, within the territory of the people of Selish stock. Elsewhere in the interior of the province, jade implements are rarer, a circumstance probably in part to be accounted for by the fact that adzes or adze-like tools have not been so much employed by the interior Indians as by those of the coast, who are pre-eminent as dexterous workers in wood, and noted for the size and superior construction of their wooden houses and canoes.

While jade was evidently a material highly prized and carefully hoarded, the aggregate quantity of this mineral in use by the Indians and Eskimo of the coast at any one time previous to the introduction of iron tools among these peoples, must have been very great—so great as to clearly indicate that its origin is proximately local, and to preclude a belief in the theory that it was obtained casually, or in the course of trade, from remote sources. The facts are indeed such as to fully bear out the autochthonous origin of this material, which has on several occasions been ably contended for by Prof. A. B. Meyer, of Dresden, whose remarks on this point, bearing on this particular district, are quoted further on. In addition to the facts above stated, it may be added that the numerous jade implements which have been examined from different parts of the coast and from the Fraser valley, give evidence among themselves of local peculiarities of colour and texture.

Though much valued, I am not aware that there is any reason to believe that superstitious or sentimental feelings have been entertained respecting jade by the natives. In the absence of metals, its useful properties were alone sufficient to recommend it to their attention, as it is the best available non-metallic material from which to manufacture tools with permanent cutting edges. Its compactness in texture and toughness are very considerable, its hardness (6·5 to 7) greater than that of ordinary steel, and as great as is compatible with grinding down or sharpening with the only substance in the possession of the natives for that purpose—quartz or silicious rocks.

My attention has been specially drawn to the use of jade by the Indians, by the occurrence of two partly worked small boulders of that material on the lower part of the Fraser (at Lytton and Yale respectively), and the discovery in 1877, in old Indian graves near Lytton, of evidence that the manufacture of adzes had there been actually carried on. These facts seem to point to the valley of the lower Fraser or to that of its tributary, the Thompson, as one, at least, of the localities from which jade has been derived, though, so far as I am aware, it has not yet been found *in situ* in any part of British Columbia. The partly worked boulders to which allusion has been made, are more particularly described below. They resemble in shape and size the well rounded stones which are abundant in rough beaches along the more rapid parts of the Fraser River, and present a peculiarity in polish which is often found to characterize these stones, and which appears to be due to the action of the sand which is drifted by the wind along these beaches during periods of low water. All the circumstances, in fact, tend to show that they may have been picked up on the immediately adjacent banks of the river.

The term jade is here used in a somewhat general sense, as no exhaustive mineralogical examination of the various specimens has been attempted, though a typical piece of the Fraser River mineral from the vicinity of Lytton, which has been examined by Dr. B. J. Harrington, proves to be a true nephrite, and other analyses of specimens from the same region render it probable that most, if not all the jade there found, is referable to the same species. The implements here collectively classed as jade all have, however, the characteristic lustre, texture and fracture of that mineral, and a mineralogical hardness of between 6 and 7. The colours represented are very varied, as the subjoined enumeration will show, and several more or less blended tints often occur in the same specimen. The implements and fragments here particularly referred to, are those derived from the region above defined, which are in the museum of the Geological Survey of Canada, or deposited in the Peter Redpath museum of McGill College, in Montreal. The stones of a pale gray or whitish colour, of which the examples occur in the collection of Mr. F. Mercier, in the first named museum, are all from the northern part of Alaska, and are with little doubt to be classed as pectolite, as stated by Professor Meyer in passages subsequently quoted.

The specimens referred to, classified according to colour, arrange themselves as below :—

Grey-greens to greenish greys, pale and dark, generally streaked or mottled ; translucent to sub-translucent and opaque..............................	23
Dark greens, varying from leek-green to sap-green, and generally translucent........................	15
Browns, shading to greenish and greyish, generally streaked, opaque..................................	7
Pale bluish and and yellowish greens, translucent....	6
Greyish-blue and bluish-grey, translucent (probably pectolite)..	6
Green and grey, and green and black, mottled........	4
	61

The same series of specimens, classified according to form and use, show the following proportions :—

Adzes..	44
Drill-points or borers (all from Alaska)	6
Cut boulders..	2

Sockets for fire-drills (both from Alaska)	2
Mallets (both from Alaska, and probably pectolite)	2
Fragments	2
Spear head (?)	1
Burnisher or whetstone (from Alaska, and probably pectolite)	1
Pendant (from Alaska, and probably pectolite)	1
	61

Of the above specimens, sixty-one in number, seventeen show evidence, more or less distinct, of having been sawn in the manner subsequently noticed.

The chemical composition of jade is such as to show that it can scarcely be supposed to have originated from the usual materials of sedimentary rocks* by ordinary processes of metamorphism. The origin of a mineral of this kind must be sought among rocks immediately or proximately of eruptive origin, in connection with certain classes of which (as, for instance, minerals of the pyroxene group) it may reasonably be supposed to have arisen as an alteration product. This view appears to be borne out by an examination of the suites of specimens of which those here classed as jade form a part. Some of these specimens are perfectly homogenous and structureless to the eye, consisting apparently of pure translucent jade. Others are clouded or variegated in colour, more opaque, and becoming in some instances distinctly laminated. A few exhibit on polished surfaces, at right angles to the planes of lamination, a minutely lenticular structure, as though granules varying in composition or colour had been welded together by pressure acting in a single direction, in the manner frequently observed in fragmental volcanic rocks. One or two specimens, which though apparently forming terms of the same series with the jades, can scarcely be classed as such, are pretty evidently of fragmental origin, and have the appearance of altered volcanic ashes or sand. None of the examples show any definite evidence of having been veinstones.

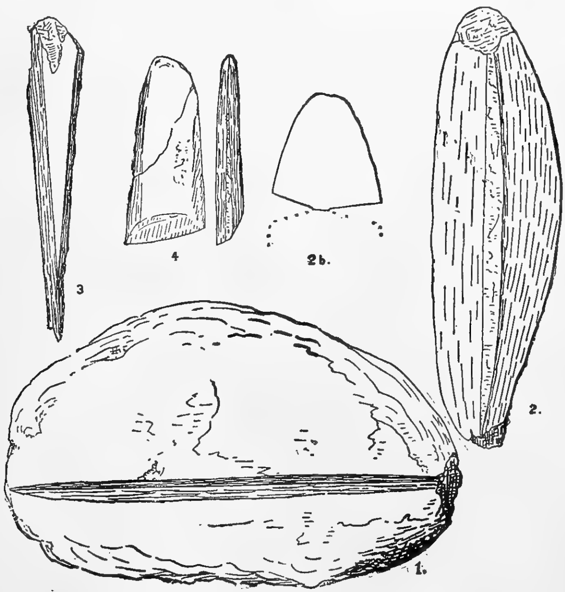
If it be admitted that jade has resulted from the alteration

* It seems reasonable to exclude from this class certain rocks occurring among the older crystalline schists, the material of which has very possibly been originally volcanic.

of minerals or materials of eruptive origin, the important part which volcanic rocks play in the portion of the Cordillera belt which is included in British Columbia, and the great amount of alteration which some of these have suffered, go far to explain the abundance of jade implements among the natives of the same region, while the great continuity of identical geological conditions in a direction parallel to the coast, may well go hand in hand with the abundance of jade implements actually occurring along the same line. In the province of British Columbia, we find volcanic rocks forming considerable portions of at least five distinct geological systems, viz., the Cambrian, Carboniferous, Triassic, Cretaceous and Miocene. Of these, the first and last may be excluded from consideration; the Cambrian as not yet recognised in the districts in which jade tools are found, the Miocene as being in general, if not in all cases, in a nearly unaltered state. It is among the highly altered and recomposed volcanic rocks of the Carboniferous and Triassic, that silicates of the jade class might be expected to occur; and I feel little doubt that when these rocks are carefully investigated, they will be found to be the sources of the jade, though the Indians of the region have usually, if not invariably, obtained their supply from loose fragments and boulders.

The peculiar adaptability of jade to the manufacture of implements is shown by the mode of working it which has been in use by the natives, which is clearly indicated by specimens from different parts of the whole region from the Fraser River to the Arctic Sea. A suitable fragment having been discovered, it has evidently been carefully sawn up into pieces of the required shape and size, the sawing having been effected either by means of a thong or a thin piece of wood, in conjunction with sharp sand. This rude method of dividing the stone must have been very laborious, and produced a widely gaping cut before any great depth was obtained. From the fragment of a boulder obtained at Lytton (Fig. 2) flat pieces intended for adzes have been sawn off, the cuts having been carried in from the surface, on each side, till it became possible at length to break the central rib by which the piece to be detached was still united to the main mass. The boulder from Yale (Fig. 1) shows the same process in an earlier stage, though deep cuts have been made on both sides of the stone, one of which is shown in the illustration. Several of the adzes or chisels show that the same method of sawing was adopted to trim off the edges of the flat pieces first obtained, and to render them parallel sided. Pieces thus cut from the edges of adzes are represented among specimens from graves near Lytton. Figure 3 represents a selvage piece of this kind, which has been sawn through on two sides. Figure 4, presents front and side views of a small adze from the same place, the edge still showing the median rib between two opposite saw-cuts, which has not been ground of.

Having been thus roughly blocked out by sawing, the surfaces of the adze were next generally ground flat. In the more finely worked specimens, this subsequent grinding has almost or altogether obliterated the original shaping furrows, and the surfaces have eventually been well polished.



(All the figures one-fourth actual size.)

Description of Figures.

Fig. 1. Partially cut boulder of brownish, opaque jade, found in an excavation at Yale by Mr. T. Eales.

Fig. 2. Portion of a boulder of green, mottled, sub-translucent jade obtained from the Indians at Lytton by Rev. Mr. Good. The figure shows the surfaces of two deep sawn-cuts, with a rough intervening projection where the stone has eventually been broken.

Fig. 2 *b*. Section of the same specimen at right angles to the last, showing depth and gaping character of the saw-cuts.

Fig. 3. Selvage piece, probably cut from the edge of an adze, ground flat on two sides, and sawn from back and front at both edges. Pale green translucent jade from old Indian graves near Lytton.

Fig. 4. Front and edge views of a small adze, showing saw-cuts from front and back nearly meeting, and a narrow intervening broken rib. Jade nearly identical in appearance with the last, and from the same place.

EXTRACTS FROM A PAPER BY PROF. A. B. MEYER, ON NEPHRITE AND ANALOGOUS MINERALS FROM ALASKA.

[Uber Nephrit und ähnliches Material aus Alaska. Jahresbericht (xxi) des Vereins für Erdkunde zu Dresden, 1884.]

"The hypothesis has been contended for, principally by Prof. Heinrich Fischer of Freiburg in Baden, and has even recently maintained, that the rough material for the nephrite and jadeite implements which have been found throughout America, is of Asiatic origin. I opposed that hypothesis in my work, 'Jadite und Nephrit-Objecte,' (1882-83) and in my essay, 'Die Nephritfrage, kein ethnologisches Problem,' (1882-83), taking for my ground general arguments which, however, forced irresistible conclusions upon me, and in particular I had, by induction, become convinced of the presence, in America, of the required rough material.

"Meanwhile, sooner than I could have expected, the discoveries of later travellers have brought to light facts which establish the occurrence of rough nephrite at least, in North-west America; consequently, the theory of importation of *this* material falls to the ground, as far as it refers to importation into America, and it will be the same as to American jadeite. It is also autochthonous. This might, in advance, be confidently asserted; how much more so now that the rough nephrite has been discovered.

"It was, indeed, long a matter of doubt, whether there occurred in America any nephrite implements, or whether all the so-called mineral from that continent was not jadeite. Both Prof. A. Arzruni, of Breslau, (Zeitschrift für Ethnologie, 1883, p. 172), and myself, arrived at the conclusion that there had not yet been produced any positive proof of the occurrence of nephrite in America. Since that date, Prof. Arzruni has been able to declare, with certainty, after microscopic examinations, that an axe from Venezuela was made of a nephrite of typical structure, (Z. f. Eth., Ver., 1883, p. 528): 'It is the one in the Ethnological Museum in Berlin, from the Karsten collection, (1852), V. A. 25, on the catalogue.' Prof. Fischer had already made mention of this specimen in 1875 (N. u. J. p. 47, fig. 62), but could recognize it only as 'approaching a nephritoid composition.'

"I shall, therefore, be all the more justified in describing here two nephrite implements which Messrs. Arthur and Aurel Krause brought from the Thlinkeet Indians in south-east Alaska, and which in the 'Catalogue of the Ethnological Collection from the country of the Chukches and South-east Alaska,' by these two gentlemen (Supplement to part 4, Vol. V, of 'Deutschen Geographischen Blätter,' 1882) is thus described :—

No. 143. Small stone axe, named *tayéss.**

No. 168. Battle-axe of nephrite, with wooden handle, named *kœt-oo'*. The sharpened stone is called *tzoo-ŭta,* the handle, *ā'-shak-tee.*

"The specimens belong to the Bremen Natural History collections and the director, Dr. Spengel, was so good as to trust them to me for examination, after Prof. Arzruni had kindly called my attention to their presence in this museum.

* This is probably Tai-i (Tyee of Gibbs' vocabulary), a Chinook jargon word, meaning 'chief' or 'chief's,' commonly used to denote anything especially valuable or of superior quality.—G. M. D.

"On p. 10, of the catalogue is appended the following remark: 'As to the origin of the stone weapons and utensils, the Thlinkeets can give no other information but that they are very old.' The specimens bear now the numbers 2303 and 2316."

Prof. Meyer then proceeds to describe in detail the two implements above referred to. The colours of the first (No. 2303) are said to be, by Radde's scale, grass-green, yellow-green, and yellow-green-grey; the specific gravity 2·96. The second and larger implement (No. 2316) is grass-green, yellow-green-grey, and green-grey; the specific gravity, 2·92, and the hardness less than usual in nephrite, owing to an incipient decomposition, which is clearly apparent on microscopical examination Under the microscope, the mineral is found to possess a very peculiar netted fibrous structure, which is minutely described by Prof. Arzruni. It is said to resemble closely a nephrite from the Kitoj River in Siberia.

An analysis by Dr. Frenzel of this specimen (No. 2316) shews it to be a nephrite, with large proportions of alumina and water. An analysis of a specimen from Point Barrow, also quoted, clearly resembles the last, but contains less alumina and water.

"As already stated, nephrite axes which were known to come from North America, have been previously believed to have originally been derived from Asia; they were asssumed to be the first stage of the supposed advance of nephrite eastward. Prof. Fischer was not the only one to contend for this view till even quite lately, as seen in particular in the XVth Vol. of 'Archiv. für Anthropologie,' (1884, p. 164); where it is said that a nephrite borer from the Mackenzie River agrees very well with the Siberian nephrite, and that it would therefore be difficult to prove that the rough material is of North American origin, a view which after the above communication is now indefensible. Nordenskiöld has also in his work 'The Voyage of the Vega' broken a lance for the same contention.* In the

* Prof. T. W. Putnam in a communication to the Massachusetts Historical Society in 1868 still maintains the probable Asiatic origin of jadeite objects found in Central America.

2nd vol. (1882), is represented a harpoon-point of bone and nephrite * from Port Clarence (about 65° N. latitude, north of Norton Sound), and he says: † 'Among these (*i. e.* the ethnographical objects obtained in Port Clarence by barter), may be mentioned bone etchings and carvings and several arrow-heads and other tools of a species of nephrite so puzzingly like the well known nephrite from High Asia, that I am disposed to believe that it actually comes originally from that locality. In such a case, the occurence of nephrite at Bering Strait is important, because it cannot be explained in any other way than by supposing that the tribes living here have carried the mineral with them from their originial home in High Asia, or that during the stone age of High Asia, a like extended commercial intercommunication took place between the wild races as now exists, or at least some decades ago existed, along the northern parts of Asia and America.'

"Already in my essay, 'Die Nephritfrage, kein ethnologisches Problem' (March 1883), I expressed the following view: 'Nephrite implements, from the Aleutian Islands, and from the Eskimo on the American side of Bering Strait, may just as well have come from sources in the New World,' and that without trusting ourselves to pass judgment in advance on the matter. In the meanwhile, Mr. Baird's 'rough material' was discovered (Ausland, 1883, p.p. 456, 540, 580), though as we shall see farther on, it was not nephrite, but only a mineral exteriorly very similar to nephrite. Capt. J. A. Jacobsen, however, brought from Alaska, real rough nephrite, which seems to set the question at rest.

"Prof. Arzruni was so good as to place at my disposal, the following statement:—

"'According to kind communications of Capt. Jacobsen, green neprite is known to the Eskimo *in situ*, in the extreme north-west of Alaska. Capt. Jacobsen obtained a number of objects, made of this mineral, and also some

* Page 229, Fig. 3, of English transalation, by A. Leslie, London, 1881.

† Page 236 of English translation.

rough pieces which he thought to be nephrite. Thanks to the courtesy of Mr. Bastian, I was enabled to examine, microscopically, splinters of this mineral. The worked object which furnished me splinters, is a chisel which Capt. Jacobsen obtained on Queen Charlotte Islands. In its microstructure this nephrite does not at all differ from that described above. According to Capt. Jacobsen, there are also objects of this green nephrite all over Vancouver Island and in the Chilkat territory on the continent.

After describing the colours of the objects, Prof. Arzruni continues:—" 'Capt. Jacobsen states that the rough stone is obtained at five days' journey inland. He did not visit the spot himself, though he knows the position of the rocks. The best of the extracted pieces are chosen for working. Only two Eskimo shamans know the locality, and keep it secret. Of the rough pieces obtained and supposed to be nephrite, two proved to be such, namely, numbers 407 and 409. No. 407 is described by Mr. E. Krause as a rolled pebble or boulder, which, by the whetting of knives, etc., on it, has been superficially ground, but not for the purpose of working it. A slice of this piece presented a microscopic appearance quite analogous to that of the slices from the two nephrite implements previously described. No. 409, on the contrary is, according to Mr. Krause, a small piece of nephrite, altogether untouched for the purpose of working. It agrees in all points with No. 407 It is of a beautiful green, semi-translucent, of a structure somewhat laminated, and with magnetite inclusions. It was found during Capt. Jacobsen's stay at Norton Bay, near St. Michael, at the Kwichpak mouth, about twenty miles north of the Yukon river, and is a rolled pebble. A quite similar structure is seen, according to Mr. Krause, in No. 408 of the collection, a boulder or rolled stone, which has been used in its natural shape as a whetstone, whereby it has been superficially smoothed. In reference to the absence of any other rough specimen, Capt. Jacobsen remarks that nephrite constitutes for these people their most valuable property, which they naturally do not allow to lie unutilised, any more than we ourselves our money, but which they work up immediately they have obtained it from the shamans who quarry it in the mountain. Moreover, whether the pieces be rough, partly or altogether worked, does not affect the question of the actual occurrence of nephrite there in the country, for any one who will not acknowledge the fact of the occurrence, until it has been reported by an European eye-witness. Nobody will, any more than Capt. Jacobsen, doubt the correctness of the reiterated testimony of the natives, considering the large number of nephrite objects which are scattered in the whole district, and especially along the west coast and on the islands.' "

"Henceforth the occurrence of rough nephrite in Alaska must be considered as established, and it is quite certain that it is also worked in the country itself. The nephrite comes neither in a rough nor in a wrought state from Asia; such a view cannot be any longer entertained. Capt. Jacobsen remarks also as against such hypotheses, that if Siberia were the place of origin, there would surely be found in the Chukches country larger quantities of rough and of worked specimens for transportation, but they are there scarcely known.

"In reference to the described nephrite chisel from Queen Charlotte Island, Mr. Arthur Krause called attention to the following passage in Dawson's report,—Geological Survey of Canada, 1878-79, p. 146 B—where, on the subject of the stone implements in the island, it is said:— 'The material of these tools appears to be a matter of indifference, as I have seen them made of hard, altered igneous rocks, like those so common in the country, of a hard, sandy argillite and of the peculiar greenish jade, which the natives of some other parts of the province prize so highly. This latter mineral is not, according to the Haida, found in the islands, but has occasionally been obtained in the course of trade.'

"After the discovery of rough nephrite in Alaska, there is no need of referring to Asia to account for the nephrite implements of North America, nor indeed any part of America, which besides, on general considerations, would never have been necessary.

"Mr. Arthur Krause further called the attention of Prof. Arzruni, to another passage on a rough mineral in North America,—respecting which, it indeed remains to ascertain whether the mineral is really nephrite. In Sir John Richardson's work, published in 1851, 'Arctic searching Expedition,' we read (Vol. I., p. 312): 'At a cascade in Rae River, ten miles above its mouth, walls from eight to twenty feet high, of bluish-grey quartz-rock, in thin layers, hem in the stream. . . . . At this place, Mr. Rae discovered (1849) among the limestone and quartz-rock, layers of asparagus-stone or apatite, thin beds of soap-stone and some nephrite—or jade—a group of minerals which belong to primitive formations.' The Rae River empties into Coronation Gulf, about 115° W. longitude, and 67½° N. latitude, and the Mackenzie River, the nephrite borer from which Prof. Fischer would not acknowledge to be of American origin (see above), flows half-way between the gulf just named and Cape Barrow.

"Mr. Virchow has lately (Zeitschrift für Ethnologie, 1883, p. 482) endeavoured to contest the belief as to the occurrence of nephrite in Alaska as follows: 'Nothing could be more natural than that even Mexico and Central America should have been provided from the north-west coast, and there would be nothing surprising if, after the nephrite question has been seemingly altogether set at rest for America, the old way of the Toltecs were again suddenly proved to be the commercial path of nephrite.' Herewith the transportation hypothesis which has fortunately been set aside as to commercial intercourse from continent to continent, is again taken up by Mr. Virchow, in reference to inter-regional trading in America, a view against which I not only entertain the gravest doubts, but hold to be undefensible, for it will be found there are in America quite as many different localities yielding nephrite (and jadeite) as have already been recognized for Asia and for Europe. I propose shortly to develop the last point. A number of well known general considerations are opposed to Vichrow's contention, especially the fact that the Alaska nephrite is of a type different from those of Venezula and

Brazil. Axes from both these countries have been mentioned by Prof. Arzruni (Zeitschrift für Ethnologie, 1883, p. 482), who has since informed me that the Brazilian axe represents a type of nephrite so far unknown, from which that of the Venezuela axe again differs."

The latter part of Prof. Meyer's paper relates to a white or grey mineral which has been referred to as 'jade,' but which proves to be pectolite. His remarks on this subject may be summarized as follows:—

The rough mineral from Alaska reported on by Mr. Baird, and previously alluded to, proved to be neither nephrite nor jadeite, but pectolite. Specimens altogether unworked, were not found, but so many that were only partly worked that there can be no doubt of their local origin. Small pieces of a rolled boulder, which had been used as a hammer for breaking bones, and which was obtained at Point Barrow, behave chemically in just the same way as pectolite from Bergenhill, New Jersey. Both were decomposed by acids, after heating to redness and gelatinised. The composition approaches the formula $(Ca, Na_2, H_2)\ Si\ O_3$.

Capt. Jacobson also collected many implements of the same mineral in the region between Kotzebue Sound and Cape Barrow, and also in the tundra, between the rivers Kosksquim and Yukon. Most are cylindrical hammers, some as long as 20 cm. with a diameter of 8 cm.

Colour sometimes turning to neutral gray in spots that are also much less translucent. Hardness near that of quartz (7), greater than usual in pectolite (4–5). Also abnormal in not being dissolved in acids with separation of silica of jelly-like consistence; but in these two peculiarities, agreeing with pectolite from Knockdolian, Scotland. Optical qualities and cleavage normal.

The mineral is said, by the natives from Kotzebue Sound to Cape Barrow, to be obtained in the mountain chain which extends along that coast; one particular locality being the side of a mountain about twenty-five miles from Nulato, on the Yukon, another on one of the streams flowing into Kotzebue Sound, where a vein, or perhaps dyke, extends from the water up to the crest of the hill. The Innuits of Koviak Peninsula, near Bering Strait, make many tools of the same stone obtained from mountains in the immediate neighbourhood.

In southern Alaska, from Norton Sound to near Bristol Bay, the mineral is altogether, or nearly altogether, unknown to the natives. On Bristol Bay, however, fine pieces obtained by Mr. McKay, indicate another locality in that district.

On the Siberian shore of Bering Straits, fragments are rare, and were said to come from the American side.

Canadian Orthoptera.

By F. B. Caulfield.

To the order Orthoptera belong the insects known to us as Crickets, Grasshoppers, Locusts, Walking-sticks or Spectres, Cockroaches, and Earwigs. These insects are active during all their stages, the principal difference between the larva and adult insect being that of size, and in the greater number of species, the presence of wings. They are voracious eaters, and have the mouth parts highly developed, the mandibles being fitted for both cutting and grinding.

Under favourable conditions, such as a succession of hot and dry seasons, some species of locusts, (*Acrididæ*) multiplying to an almost inconceivable extent. Leaving their breeding grounds in vast swarms, and swept along by favouring winds, they at times travel to great distances, and wherever they alight, devour every green thing.

In general, however, orthopterous insects are timid insects and of feeble powers of flight. In fact, many species can only sustain their flight for a few yards, while some are entirely wingless.

If we examine an orthopterous insect, we will find it to be an apparently helpless creature, its mandibles not being sufficiently powerful to inflict a wound, and its means of defence, when captured, being limited to the discharge of a dark colored fluid from the mouth. A few kinds conceal themselves in holes and crevices, but the greater number live in the open fields, delighting to bask in the summer sunshine.

It is evident then that these creatures, being as a general rule possessed of limited powers of flight, and being unable to defend themselves, would, unless they could by some means escape observation, be entirely at the mercy of their enemies.

The facility of eluding observation which is common to many insects, and which attains great perfection in the orthoptera, is owing to the similarity of their colors to the surroundings amidst which they live, and is enhanced by the habit, which many species possess, of remaining motionless when danger appears to threaten them.

When walking through the fields during the summer months, we hear the songs of the orthoptera on every side, but we seldom see the insects themselves, until alarmed by our approach, they spring almost from beneath our feet. And how quickly we lose sight of them again when they alight, so wonderfully do their colors harmonize with the localities in which they live! A little observation will show us that differently colored species inhabit different localities. Thus, on bare, gravelly places and road-sides, we find the large dull colored locusts that rise with a spring, and hovering for a few seconds with a crackling noise, drop suddenly to the ground, and are as quickly lost to view. In dry fields and pastures, where the herbage is poor, we find species marked with lines and spots of pale yellow, and different shades of grey and brown, these subdued tints just matching the scanty growth, intermixed with the withered stalks of the previous year. In moist places, and upon shrubs and trees, species occur whose color is wholly green, and these are, perhaps, the most difficult of all to detect, their color assimilating so closely with the leaves. Thus, these insects, although seemingly at the mercy of their enemies, are in reality amply protected, and are able, not only to hold their own in the struggle for existence, but under favorable conditions, at times, to multiply to an almost incredible extent.

Another remarkable feature of the orthoptera, is the musical power with which many of them are endowed. They are instrumentalists, not vocalists, as the orthoptera, like all other insects, breathe through spiracles, and are, of course, voiceless. In reality, the song of an orthopterous insect is a sexual call, and is almost entirely confined to the males—entirely so in the crickets, some species of which go through quite an elaborate performance, as may be easily seen by watching the common striped cricket, *Nemobius vittatus.*

When a male of this species wishes to attract the notice of the female, he advances towards her, and raising the wings and wing-covers, rasps them together with a shrill creaking sound, now and again jerking himself forward with a convulsive movement, touching the female with the antenna, at times dancing around in a frantic manner. Should the female be pleased with his attentions, she turns around, and seizing him, draws him beneath her, when copulation takes place. Should his song prove unsuccessful. the little minstrel either stops shrilling, or turns his attention to another female. I have not observed the courtship of our other species, but it is probably much the same in all. Mr. W. H. Harrington, speaking of *Æcanthus niveus,* says, " An interesting feature of its concerts is one of which I have not been able to find any mention in books accessible. While the male is energetically shuffling together its wings, raised almost vertically, the female may be seen standing just behind it, and with her head applied to the base of the wings, evidently eager to get the full benefit of every note produced."

The courtship of *Ectobia germanica,* is very similar, but is unaccompanied by any sound, nor are the wings shuffled together. The male follows the female until her attention is attracted, when turning around, and raising the wings until they form a right angle with the body, backs up to, and seized by the female. I have only seen actual copulation take place in *Nemobius,* but have little doubt that in both *Blatidæ* and *Gryllidæ,* the male never takes possession of the female by force.

In preparing this sketch of our Canadian species, I have followed Mr. Scudder's classification, as given in Packard's "Guide." With regard to localities, dates of appearance, &c., unless otherwise stated, it is to be understood that they refer to the neighbourhood of Montreal.

Fam. 1. GRYLLIDÆE Latreille, CRICKETS.

The Crickets have a rather large head and thorax. The antennæ long and filli-form (thread-like.) The wings are laid flat on the body, the costal edge of the front pair being bent down so as to slightly overlap the body. The hind-most thighs are very stout and muscular, enabling them to make enormous leaps. The ovipositor is long and spear shaped. Packard says that "The *shrilling* of the male is a sexual call, made by raising the fore wings and rubbing them on the hind wings. The noise is due to the peculiar structure of the fore wings, the middle portion of which forms, by its transparent elastic surface, on which there are but few veinlets, a resonant drum, increasing the volume of sound emitted by the rubbing of the *file* on the upper surface of the hind pair of wings. This file is the modified internal vein, the surface of which is greatly thickened, rounded and covered closely with fine teeth. In the females, the wings are not thus modified, and they are silent."

The mole-crickets (*Gryllotalpa*) may be recognized by their powerful fore feet, which somewhat resemble those of a mole, being short, stout and flattened, and armed with tooth-like projections. They inhabit moist and soft earth, in which they drive burrows or tunnels in search of food. According to Packard, their eggs, from 300 to 400 in number, are laid in the spring in tough sacks in galleries.

Only one species—*Gryllotalpa borealis*, Burm—is recorded from Canada, where it appears to be very rare. Mr. William Brodie has taken a pair in Essex county, Ont. It probably does not occur in the Province of Quebec, as it is not given in the Abbé Provencher's list, nor have I met with it myself.

The large black crickets, so common in dry fields during the summer months, belong to the genus Gryllus. They are great lovers of heat, their favourite localities being sunny hillsides, where they live in holes and crevices in the soil, or beneath stones or clods of earth.

Harris in his "Insects Injurious to Vegetation," says:—"Where crickets abound, they do great injury to vegetation, eating the most tender parts of plants, and even devouring roots and fruits, whenever they can get at them. Melons, squashes, and even potatoes, are often eaten by them, and the quantity of grass that they destroy must be great, from the immense numbers of these insects which are sometimes seen in our meadows and fields."

Our largest species is *Gryllus luctuosus,* Serv. It may be easily distinguished from our other species "by the great length of the wings, which, surpassing in length the wing-covers, hang over the extremity of the abdomen." (Scudder.) It seems to be very rare in Canada; I found two females in August, on Montreal mountain, some years since. It is recorded from Nova Scotia by Walker.

Gryllus Neglectus, Scudder, is our commonest species. Specimens of it in the larval condition may be found under stones as soon as the snow has melted in spring, and towards the end of May many of them have attained the perfect condition and may be heard shrilling; but some individuals are later, as I have taken an adult female and a specimen in the pupa state beneath the same stone on June 4th, 1885.

I have not been able to ascertain whether these hybernated specimens live until the end of the season or deposit eggs during early summer and then die, but so far as I have observed, their shrilling entirely ceases during July. In the beginning of August a few may be heard, and by the middle of the month they are again in full chorus, appearing to be more numerous than in the earlier part of the season. Packard says that they have been known to lay 300 eggs, glued together in a common mass. I have examined freshly laid clusters but did not observe that they were glued together, but the moisture with which they are coated may act as a cement when dry.

Province of Quebec, very common.—Provancher. Montreal, abundant.—Caulfield. Toronto, very abundant.—Brodie.

Besides our native species of *Gryllus*, we have the well-known House-cricket, *Gryllus domesticus*, Oliv., which has been carried over in shipping from Europe. This creature loves warm quarters, being found in kitchens and bake-houses, where it feeds on crumbs and other scraps, not being particular as regards diet. During the day it hides in chinks and crevices, coming out at night in search of food. During the summer it sometimes takes up temporary quarters in the open air.

Quebec, common.—Provancher. Montreal, common.—Caulfield. Toronto, rare.—Brodie.

The small black crickets that swarm in our meadows belong to the genus *Nemobius*. They may be distinguished from the species of *Gryllus* by the last joint of the palpi being twice the length of the preceding joint, by their smaller size, and by the thorax being slightly hairy.

(*To be continued.*)

Height of Clouds.

By C. H. McLeod.

The table given below contains the results of some observations on the height of clouds during the months of May and June, 1886. The observers were J W. McOuat, B.A., and Francis Topp, B.A. The method of work consisted in simultaneous observations of altitude and azimuth. The stations—McGill College Observatory (A) and the roof of the City Hall (B)—gave a base of 6,300 feet. Communication between the observers was by the telephone. The observations were reduced graphically, and as each set of measurements gave two independent results, a gauge of accuracy was obtained and wrong results from errors in identification avoided. The precision with which such measurement may be made, depends mainly on the possibility of minutely describing the portion of cloud on which it is esired to make the pointing. Otherwise the lines of collimation of the instruments may not meet, and the results will be discordant.

The heights due to the angles of altitude at both stations are given in colums 3 and 4, and the mean of these quantities in the last column.

The small altitudes obtained for the cirrus clouds is especially worthy of notice.

Date.	Class.	Altitude in feet.		
		Station (A)	Station (B)	Average.
May, 17	Cumulus	1,160	1,065	1,112
" 19	"	1,240	1,460	1,350
June, 3	"	7,400	8,460	7,930
" 3	"	7,800	7,280	7,540
May, 19	Cumulo-Stratus ..	9,960	11.000	10,480
June, 3	" ..	6,460	6,400	6,430
June, 9	" ..	5,260	4,620	4,940
May, 18	Cirro-Cumulus ...	2,280	1,340	1,810
June, 9	Cirro-Stratus.....	11,600	9,560	10,580
May, 19	Cirrus	12,760	13,800	13,280
June, 10	"	12,080	9,620	10,850
" "	"	16,180	16,960	16,570
" "	"	13,620	17,500	14,560
" "	"	18,760	19,320	19,040
" "	"	18,400	16,060	17,230

McGill College Observatory,
December 15th, 1886.

Proceedings of the Natural History Society.

The first meeting of the session was held on Monday evening, November 29th, 1886, Sir J. Wm. Dawson in the chair.

The minutes of the last annual meeting were read and approved, and the minutes of the last Council meeting were also submitted to the meeting.

The Honorary Curator announced the following donations, viz.:—A young Harp Seal, from Rev. D. V. Lucas, and a Nest and Eggs of the American Robin, from Dr. Wanlass.

The Chairman of the Library Committee reported the receipt, from Sir Wm. Dawson, of a copy of the "President's Address, British Association, 1886," and a number of Periodicals and Journals from J. A. U. Beaudry, Esq.

Members proposed were R. R. Grindley, Esq., and A. F. Gault, Esq., and the following were duly elected ordinary members, viz.:—Messrs. James Slessor, Samuel Waddell, and Rev. John Nicholl. Master Bertie Nicholl was also elected a junior member of the Society.

The Honorary Curator, Alfred Henry Mason, F.R.M.S., F.C.S., called the attention of the Society to the lack of interest in the work of the "Ornithologists' Society" in our city, as the wearing of the wings of birds for decorative purposes was not by any means diminishing.

On motion of Mr. Mason, seconded by Major Latour, it was resolved to open the Museum free of charge to visitors during the Carnival week of 1887.

The action of Chairman of Council in granting the use of the Hall and Museum to the Victoria Rifles for Saturday, December 4th, was unanimously approved.

The question of adopting measures for holding a "Conversazione" during the session was referred to members of Council.

Sir William Dawson then reviewed some of the papers read before the Geological Section C of the British Association at Birmingham, and exhibited photographs of a portion of the subjects under consideration.

On motion of Dr. Edwards, the acting Chairman, a cordial vote of thanks was passed for the instructive address.

Mr. G. F. Matthew's paper was held over for additional notes on "New Pteraspedian Fish," and the respective papers on "Tendrils in the Virginia Creeper," by A. T. Drummond, and "Notes on the Tendrils of Cucurbitaceæ," by Prof. Penhallow, having been read, proved of special interest, and brought on a salutary discussion, in which several of the members engaged.

A vote of thanks was passed for each of the papers kindly prepared by Mr. Drummond and Prof. Penhallow.

The second monthly meeting took place on Monday evening, December 27th, 1886, Dr. T. Sterry Hunt, First Vice-President, in the chair.

Minutes of the previous meeting were read and confirmed, and the minutes of the last Council meeting were also read.

An important donation of books from the Smithsonian Institution was announced by Mr. Beaudry, Chairman of the Library Committee, and a detailed list of the different works was submitted by Mr. Robb, with an interim report on the condition of affairs in connection with the binding, classifying and cataloguing of the books in the Library.

On motion of Mr. Beaudry, seconded by Mr. Stevenson Brown, a vote of thanks was passed to the several donors referred to in the report, and on the recommendation of Mr. Robb, it was resolved that a special letter of thanks, signed by the President and officers, be transmitted to the Smithsonian Institute, through Spencer F. Baird, Esq., Secretary, who had kindly interested himself in the gift of so many valuable publications, numbering in all, over fifty volumes.

Mr. Mason presented a specimen of "Stropanthus Hispidus," which has attracted considerable attention amongst the medical profession in England as a cardiac stimulant.

The members proposed were Messrs J. W. Buckle, W. H. Chapman, and Dr. J. Lapthorne Smith, and Messrs. R. R. Grindley and A. F. Gault were elected ordinary members.

Dr. Harrington announced that an energetic committee had been formed, and that arrangements for the "Conversazione" were progressing most encouragingly. Mr. Stevenson Brown, the Secretary, presented a complete report of the proposed programme in connection therewith, the date having been fixed for Thursday, January 20th.

Dr. G. M. Dawson being present, gave a most interesting synopsis of his written paper on the Canadian Rocky Mountains, and in reply to a question by the Chairman, made a general statement on their geological formation, and in reply to an enquiry from Professor Mills, referred briefly to insect and bird life on the Rockies.

In the absence of Professor Penhallow, the second paper of the evening, on "The Occurence of Scolithus in Beds

Newer than the Potsdam," by Henri M. Ami, M.A., was held over for another meeting.

The Chairman of Council, John S. Shearer, Esq., reported the receipt of a remittance of $400.00 from the Quebec Government, in place of $600.00, the amount allotted during last session towards the cost of publishing the "Record of Science."

A cordial vote of thanks having been passed to Dr. G. M. Dawson, the meeting adjourned.

The third monthly meeting of the sessiou was held this (Monday) evening, January 31st, 1887, at eight o'clock, at which there was a good attendance.

Sir William Dawson in the chair.

Minutes of the previous meeting, and that of the last Council meeting, were read and approved.

Mr. J. Stevenson Brown presented a final report of the duties performed by the "Conversazione Committee," and on motion of Mr. Brown, seconded by Rev. Robt. Campbell a unanimous vote of thanks was passed to the numerous friends who had so kindly aided in bringing the entertainment to a most satisfactory conclusion, and the Recording Secretary was instructed to convey a copy of the resolution to each of the friends who had in any way assisted at the "Conversazione."

On motion of W. T. Costigan, seconded by Prof. Mills, a well merited vote of thanks was passed to the members of the "Conversazione Committee" for the exceptional manner in which they had carried out the work.

Members proposed at the last meeting, Messrs. J. W. Buckle, W. H. Chapman, and Dr. Lapthorn Smith, were duly elected.

Dr. Edwards recommended that the rules be suspended, and no objection being offered, the following gentlemen were proposed and elected by ballot, viz.: F. W. Blaiklock, Jas. A. Carnegie, F. W. Barnes, M.D., J. L. Lamplough, H. W. Thomas, T. A. Rodgers, M.D., T. L. Wanklyn, and Robert Harvie.

A letter was read from C. S. Minot, Esq., of Boston, intimating that a formal application was necessary to obtain the $200.00 granted by the "Elizabeth Thompson Science Fund Trustees," and it was resolved that Prof. Penhallow and the Chairman of Council, Mr. Shearer, be appointed a committee to take action thereon, and associate with them Prof. C. H. McLeod, of McGill University, in the work of investigating "underground temperatures."

Prof. Donald then read a valuable paper entitled, "Chemical Notes on Wheat and Flour," and the opinion was expressed that this important paper should be followed by others bearing on the further examination of the subject. Prof. Donald answered several questions submitted to him, and displayed a variety of samples of wheat and flour.

Prof. Mills followed with an interesting account of a visit to the Bahamas, describing "Life on the Islands," and gave a general outline, accompanied by diagrams on the blackboard, of the formation of coral reefs. At the close of the address, Mr. J. Stevenson Brown moved, seconded by Mr. Beaudry, that a vote of thanks be passed to both Prof. Donald and Prof. Mills for their respective papers.

Prof. Mills kindly promised to return to the subject again, and presented the Society with a number of specimens exhibited during the course of his address, for which the President expressed the thanks of the Society.

A committee was named by the President, consisting of John S. Shearer, Prof. Penhallow, J. A. U. Beaudry and the Recording Secretary, to prepare and present to the members of the Quebec Government a petition for the renewal of the original grant of $1000 per annum, to be used exclusively in the publication of the Record of Science.

Dr. Harrington, Chairman of the Lecture Committee, reported the following subjects for the Course of Somerville Lectures, 1887:—Thursday, February 17th, "The Bony System," by Francis J. Shepherd, M.D.; Thursday, February 24th, "The Muscular System," by George E. Armstrong, M.D.; Thursday, March 3rd, "The Nervous System," by James Stewart, M.D.; Thursday, March 10th, "The Circulatory System," by T. Wesley Mills, M.A., M.D.; Thursday, March 17th, "The Special Senses," by Frank

Buller, M.D.; Thursday, March 24th, "The Digestive System," by W. H. Hingston, M.D., D.C.L.

The regular monthly meeting took place on Monday evening, February 28th, 1887, Sir Wm. Dawson occupying the chair.

Minutes of previous meeting were read and approved, and the minutes of meeting of Council were also read.

Mr. Ernest Ingersoll was proposed for membership.

The Committee appointed to confer with the Local Government in regard to the annual grant, reported progress.

Mr. F. Bain's paper on "A Permian Moraine in Prince Edward Island" was read by Sir Wm. Dawson, and Mr. F. B. Caulfield followed with an extended account of "Canadian Orthoptera."

A vote of thanks having been passed to the author of each paper, the meeting adjourned.

Miscellaneous.

Bacteria in Drinking Water.—Mr. Meade Bolton has contributed an important paper on this subject to Koch and Pflüger's *Zeitschrift für Hygiene*. He finds that in ordinary spring water, bacteria are always present and are capable of multiplying in it. Among these may be specially mentioned *Micrococcus aquatilis*, occurring as cocci collected into small irregular heaps, and *Bacillus erythrosporus*, distinguished by its spores having a reddish brown sheen, and the presence of a greenish pigment without any deliquescence of the gelatine in which it was cultivated. Both these bacteria multiply with extraordinary rapidity in water, the quality of the water and the amount of organic and inorganic substances contained in it appearing to have no effect on the reproduction of the microbe, which is, however, materially promoted by a rise of temperature. It took place considerably quicker at 35° than at 20°. These bacteria are not pathogenic.

On the other hand, the author found that pathogenic bacteria, when introduced into spring water, never multiply, but disappear after a time varying in lengh according to the species and the temperature, and according as to whether the species produces resting spores or not. The spores of Bacillus antheracis had not lost their vitality in a year and a day; those of typhus fever were still active after a month but not after ten and a half months. The quality of the water appears to have no influence in prolonging the life of pathogenic bacteria.

The general conclusions drawn by the author are that the quantity of bacteria present in spring water is no guide whatever in determining the wholesomeness or otherwise of the water for drinking purposes, since they are most entirely harmless, and that it is impossible by chemical analysis to determine the presence of bacteria in larger or smaller numbers. The presence of specific pathogenic bacteria can only be determined by direct nicro-chemical observation.

How Myriapods are Affected by Light.—F. Plateau has recently investigated the extent to which Myriapods, both those that are blind and those possessed of eyes, can distinguish a lighted from a shaded spot. He resorted to various contrivances to graduate the quantity of light and shade, and to have the one sharply marked off from the other. It was also necessary to provide against the danger of fallacy from the influence of heat rays—which was accomplished by placing in the path of the incident rays a flat-sided glass vessel, containing water which absorbed the heat, but allowed the light to pass. After many experiments, he draws the following conclusions:

1. Myriapods which are blind, perceive the light of day and know how to discriminate between light and darkness.

2. In both those with and those without eyes, a certain time must elapse before they can perceive whether they are in shadow or in light.

3. The duration of this latent period is not longer in the blind than in those with eyes.

1. When a shaded area is relatively small to the lighted one, they do not practically distinguish between the two.

5. Myriapods like moisture, and this explains also why they seek shady places, habitually.

These conclusions are interesting, inasmuch as they show that animals may be affected by light apart from those sensations which are visual strictly so called, and that such changes as light thus produces so influence the nervous system that the animal gets information of a valuable kind as regards its life interests. Such experiments as these enable one to understand in some measure, perhaps, that beginning of vision which exists in creatures possessing only pigmented spots, as eyes, the pigment in some way retaining the light while it works changes, probably chemical, in the protoplasm.

Digestive Ferments in Plants and Animals.—It is very interesting to the physiologist to note how many processes, once thought to be characteristic of animals, are being shown to be common to plants and animals alike. The researches of Heidenhain and Langley had demonstrated the stages in the cells of digestive glands by which from the clear protoplasm the formation of the actual digestive ferment as a regular series of constructive and destructive processes, takes place. Recently, J. R. Green has shown that in the germinating seeds of plants, there is a ferment similar to the *proteolytic* ferment of the pancreas; it exists in resting seeds in the form of a zymogen or mother-ferment, but in the germination of seed, it becomes an active ferment.

The reserve proteid of the seed is converted probably into peptone, but the nitrogen is carried to the growing points of the young embryo as a crystalline amide, e. g. leucin, asparagin, etc.

Now, it is well known that the pancreatic ferment differs from the gastric in its power to carry the digestion of proteids on to the stage of formation of crystalline nitrogeneous bodies. (Proc. of Roy. Soc.)

Catalogue of Canadian Plants.—This important addition to Canadian Botany is issued by the Geological Society, and has been completed so far as to embrace I. Polypetalæ; II. Gamopetalæ; III. Apetalæ. This is the most important of the publications relating wholly to Canadian Botany since the appearance of Hooker's Flora Boreali Americana in 1840, and it supplies to the student a wealth of information which has long been a serious want.

From his extensive travels through a large part of the Dominion, and his intimate acquaintance with the flora from personal observation, Prof. Macoun has been able to "speak with accuracy and decision in many points which a more limited knowledge of distribution would preclude." But, as he says, "the present work is by no means final," and the co-operation of botanists in making known those species, which for any reason may have been overlooked, or in more exactly defining doubtful limits of distribution, would be a real service to Canadian Botany. The appearance of this catalogue gives promise that a complete Flora of Canada may be forthcoming before many years, the obstacles to the preparation of which have hitherto been many, but are now chiefly removed.

Isaac Lea, LL.D., the well-known publisher and naturalist, died, at Philadelphia, Dec. 8th, 1886, at the age of ninety-five years. He was born at Wilmington, Delaware, in 1792. From 1858 to 1863, he was president of the Academy of Natural Sciences, and in 1860, president of the American Association for the Advancement of Science. Dr. Lea's scientific work chiefly related to fresh water and land shells. He began a complete work on the *Unionidæ* of the United States, and prepared to expend much time and money in its elaboration, but a fire destroyed all his valuable plates and caused a termination of the work.

The Amount of Caffeine in Various Kinds of Coffee.—From the following quotations it will be seen that great discrepancies exist in the published statements as to the amount of caffeine in raw coffee:—

Robiquet	0.32 to 0.64	per cent.
Liebig	0.23 to 0.46	"
Zenneck	0.75	"
Graham, Stenhouse & Campbell	0.86 to 1.00	"
Dragendorf	0.99 to 1.22	"
Squibb	1.00 to 1.03	"
Bell	1.08 to 1.11	"
Allen	0.50 to 2.00	"

The discrepancy between the data given as applying to roasted coffee is still greater, and in the *Allgemeiner Kaffee Zeitung* for 1884, the amount of caffeine in roasted coffee is stated to range from 2.00 to 3.64 per cent. The first striking result obtained by Dr. Paul and Mr. Cownley on carrying out a number of experiments with several different samples of raw beans, was the very narrow range within which the amount of caffeine appeared to vary. Instead of being a varying amount, it was more nearly a constant quantity, as follows:—

Coorg	1.10	per cent.
Guatemala	1.18	"
Travancore	1.16	"
Liberian	1.20	"
Liberian	1.28	"

The above determinations were all made with undried, raw coffee, taken just as it came to hand and powdered. A difference in the amount of water might therefore alter, to some extent, the percentage of caffeine in the dry material, and a new set of determinations were made, with 14 different berries, all carefully dried at 212°, when the amount obtained varied from 1.20 per cent. in Coorg to 1.39 in Liberian; average for the 14 samples 1.26 per cent. It is evident from these results that the discordant statements hitherto published in reference to the amount of caffeine in coffee must be ascribed to defective methods of analysis, and that, in reality, the determination of the amount of caffeine in a sample of coffee would be one of the most conclusive data to rely upon in any question of adulteration, as, in experimenting with roasted coffee, a similar uniformity was found.

Dr. Paul stated that there was no loss of caffeine in roasting coffee. Roasters had stated that there was a considerable percentage of loss, and, if printed authority was to be taken, the loss was 18 per cent. In his experiments he had failed to detect any loss.

PH. S. J.

] YEAR 1886.

Obsɑude N. 45° 30′ 17″. Longitude 4^h 54^m $18^s.55$ W.

C. H. McLEOD, *Superintendent.*

Month		Number of days on which rain fell.	Inches of snow.	Number of days on which snow fell.	Inches of rain and snow melted.	No. of days on which rain *and* snow fell.	No. of days on which rain *or* snow fell.	Month.
January ..	)5	4	17.4	19	3.54	1	22	January ....
February ..	70	6	10.3	17	1.77	3	20	February.. ......
March	30	5	26.5	13	3.48	2	16	March ....
April	17	9	2.8	4	0.76	0	13	April....... .....
May	72	18	0.0	0	2.72	0	18	May ....
June.......	)2	15	0.0	0	2.92	0	15	June.............
July	71	13	0.0	0	3.71	0	13	July.............
August	79	16	0.0	0	4.79	0	16	August.... .....
September	35	14	0.0	0	3.85	0	14	September.......
October ...	79	10	0.5	2	1.84	2	10	October..........
November .	22	9	36.1	18	5.82	5	22	November.......
December .	)6	3	22.4	17	3.05	3	17	December. ......
Means for 18		....	....	....	....	..	...	Means for 1886...
Sums for 18	8	122	116.0	90	38.25	16	196	Sums for 1886 ...
Means for years end Dec. 31, 18	6	133	121.6	85	39.45	16	202	Means for 12 years ending Dec. 31, 1886.

* Bar perature has been *higher;* "—" that it has been *lower* than the average for 12 years hemometer and wind vane are on the summit of Mount Royal. To obtain bett ve sea level. The old position was 30 feet above the ground, and since August, 188

The g e of the thermometer in one day was 43.8 on Jan. 25th ; least range was 3.4 on Nov. barometer reading was 30.780 on Jan. 14th, the lowest 28.901 on Jan. 9th, giving a ran on Dec. 25th, and the greatest velocity in gusts was at the rate of 80 m. p. h. on d during the last six months 71,032, equal to an average hourly velocity of 16.1m. velocity, due to the change in exposure, noted above, is — on the supposition tha mileage — is S. 68° W., and the resultant mileage 56,300. Auroras were observed on hts. Lunar coronas on 4 nights. Solar halos on 2 days and Solar parhelia on 2 winter was on Nov. 7th.

METEOROLOGICAL ABSTRACT FOR THE YEAR 1886.

Observations made at McGill College Observatory, Montreal, Canada. — Height above sea level 187 ft. Latitude N. 45° 30′ 17″. Longitude 4h 54m 18s.55 W.

C. H. McLEOD, *Superintendent.*

Month.	Thermometer. Mean.	¶ Deviation from 12 year means.	Max	Min	Mean daily range.	* Barometer. Mean	Max	Min.	Mean daily range.	Mean pressure of vapour. †	Mean relative humidity. ‡	Mean dew point.	Wind. Resultant direction.	Mean velocity in miles per hour	Sky clouded per cent.	Bright sunshine per cent.	Inches of rain.	Number of days on which rain fell.	Inches of snow.	Number of days on which snow fell.	Inches of rain and snow melted.	No. of days on which rain *and* snow fell.	No. of days on which rain *or* snow fell.	Month.
January	12 18	+ 0.34	46 8	− 23 6	15 5	30 0645	30 780	28 901	.355	.0797	84 1	8 1	N. 71° W.	12 35	68 7	29 2	1 95	4	17 4	19	3 54	1	22	January
February	12 22	− 3 74	44 1	− 21 0	18 0	30 0350	30 638	29 187	.364	.0788	81 0	7 3	S. 61° W.	13 47	62 1	31 3	0 70	6	10.3	17	1 77	3	20	February
March	23 15	− 0 51	53 0	− 15.3	13 1	29 9018	30 539	29.299	.207	.1055	76.5	16 6	S. 80° W.	13 81	70.7	39 0	0 80	5	26.5	13	3 48	2	16	March
April	44 24	+ 4 40	71 6	15 8	17.9	30 0794	30 621	29 396	.171	.2055	68 0	33 5	N. 82° W.	10.74	53.2	49.9	0 47	9	2.8	4	0.76	0	13	April
May	51 58	+ 0 40	71 2	37.3	18.5	29 8514	30 242	29.461	.133	.2953	69.7	44 0	S. 67° W.	11.25	66.1	52 6	2.72	18	0 0	0	2 72	0	18	May
June	64 28	− 1.04	80 1	48.3	16 2	29 8846	30.216	29.296	.170	.42[illegible]8	72 2	53 5	S. 46° W.	9 13	63.4	45.7	2 92	15	0 0	0	2 92	0	15	June
July	67 75	− 1.08	87 3	48.4	16 7	29 8740	30 162	29 602	.115	.4977	73 2	58 2	S. 51° W.	13 80	53.1	55 9	3 71	13	0 0	0	3 71	0	13	July
August	66 67	− 0 95	86 3	48 6	17 7	29 [illegible]013	30 297	29 533	.148	.4780	73 1	57 2	S. 83° W.	14 70	56 4	61 4	4 71	16	0 0	0	4 79	0	16	August
September	57.33	− 1.55	82 7	34 5	15 9	30 0690	30 469	29 622	.187	.3678	75 9	49.3	S. 60° W.	14 95	46 8	55 5	3 85	14	0 0	0	3 85	0	14	September
October	40 65	+ 0 61	72.7	24.5	16 5	30 1[illegible]42	30 586	24 415	.243	.2517	75 7	39 0	S. 60° W.	16.43	51 5	55 8	1 79	10	0 5	2	1 84	2	10	October
November	33 42	+ 0 63	63.3	11 5	11.7	29 9183	30 457	29 007	.310	.1590	78 9	27 3	S. 65° W.	20.47	71 5	25 8	2 22	9	36 1	18	5.82	5	22	November
December	14 21	− 4 32	41 0	− 20 7	14.7	30.0646	30 713	29.176	.310	.0818	81 6	9.4	S. 65° W.	16.32	65 6	32.6	0 96	3	22 4	17	3 05	3	17	December
Means for 1886	41.31	− 0.49	....	....	16 0	29 9804	....	....	.226	.2518	75 8	33 6	....	13.95	60.8	45.4	....	....	....	....	..		..	Means for 1886
Sums for 1886	...	...	....	....	....	.	....	....	....	....		....	....	....	....	....	26.88	122	116 0	90	38 25	16	196	Sums for 1886
Means ¶ for 12 years ending Dec. 31, 1886	41 80	...	...		...	29 9734	....	.	...	.2510	74 4	...			60 9	§ 46 5	27 36	133	121 6	85	39 45	16	202	Means for 12 years ending Dec. 31, 1886.

* Barometer readings reduced to 32° Fah., and to sea level. † Inches of mercury. ‡ Saturation 100. § For 5 years only. ¶ "+" indicates that the temperature has been *higher*; "−" that it has been *lower* than the average for 12 years, inclusive of 1886. The monthly means are derived from readings taken every 4th hour, beginning with 3h. 0m, Eastern Standard time. The anemometer and wind vane are on the summit of Mount Royal. To obtain better exposure, their position was changed on June 30th. The new position is 29 feet N. E. of the old one: 57 feet above the ground and 810 feet above sea level. The old position was 30 feet above the ground, and since August, 1882, it has been somewhat sheltered from N. E. winds.

The greatest heat was 87.3 on July 5th; greatest cold 23.6 below zero on Jan. 12th; extreme range of temperature was therefore 110.9. Greatest range of the thermometer in one day was 43.8 on Jan. 25th; least range was 3.4 on Nov. 13th. The warmest day was July 5th, mean temperature 77.0. The coldest day was Jan. 12th, mean temperature 17.6 below zero. The highest barometer reading was 30.780 on Jan. 14th, the lowest 28.901 on Jan. 9th, giving a range of 1.879 for the month and year. The lowest relative humidity was 25, on May 1st. The greatest mileage of wind recorded in one hour was 54 on Dec. 25th, and the greatest velocity in gusts was at the rate of 80 m. p. h. on Nov. 18th. The total mileage of wind during the first six months of the year was 51,233, which is equal to an average hourly velocity of 11.8 m; and during the last six months 71,032, equal to an average hourly velocity of 16.1 m. The average hourly velocity during the past 10 years, in the first half of the year, was 11.85, and in the last half 9.95. The increase in the wind's velocity, due to the change in exposure, noted above, is — on the supposition that the average wind for the past six months has been normal — therefore 62 per cent. The resultant direction of the wind for the year — for mileage — is S. 68° W., and the resultant mileage 56,300. Auroras were observed on 42 nights. Fogs on 19 days. Hoarfrost on 8 days. Thunder storms on 15 days and lightning without thunder on one day. Lunar halos on 15 nights. Lunar coronas on 4 nights. Solar halos on 2 days and Solar parhelia on 2 days. The sleighing of the winter closed on April 8th. The first appreciable snowfall of the autumn was on Oct. 17th. The first sleighing of the winter was on Nov. 7th.

THE

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Canadian Orthoptera.

By F. B. Caulfield.

(*Concluded.*)

Nemobius vittatus, Harris, is our most abundant species. Its colour is greyish-brown, marked with lines of black. It is of social habits, being found in swarms in the fields during the summer months. I have not heard them shrilling earlier than the beginning of August. Should the season be fine, individuals may be heard as late as the beginning of November. Quebec, common.—Provancher. Montreal, common.—Caulfield. Toronto, common.—Brodie.

Nemobius fasciatus, De Geer. May be distinguished from our other *Nemobii* by the length of its wings. Montreal, not common: also given in the Quebec and Toronto lists.

Nemobius (*Anexipha*) *septentrionalis*, Scudd. Is also on our list. Provancher records one specimen from Quebec, and it is recorded from Rat Portage by Brodie.

All the foregoing species live on the ground, but we have another kind of cricket which spends its life among the leaves and branches of tall weeds and shrubs. It is the ivory climbing cricket, *Æcanthus niveus,* Sew. The male is ivory white, with very broad, transparent wing-covers, crossed by from three to five oblique raised lines. In the female the wing-covers are longer and narrower, and of a pale green color. The antennæ and legs are long and slender, the hind thighs not being so stout as in the ground crickets. The shrilling of the species is more sustained than that of *Gryllus,* the notes running together like the roll of a drum, swelling and decreasing alternately. They commence shrilling about the first of August, and continue until the frosts of Octobər put an end to their existence.

The eggs are deposited in the stems of plants. The insect is sometimes very injurious to raspberry canes and grape vines, on account of its piercing them with its ovipositor, causing them to wither and die.

Grasshoppers (Locustariæ).

These insects may, with few exceptions, be recognised by their long and slender legs, and by their extremely long bristle-formed antennæ. In the winged species, the wing-covers slope downwards at the sides of the body and overlap a little on the back near the thorax. The ovipositor is generally long, flattened at the sides, and curved like a cimiter.

The shrilling of some of the southern species is quite powerful, and where the insects are very abundant the noise is sometimes unpleasantly loud; but in these northern regions the notes of our grasshoppers are weak, nor are the insects sufficiently numerous to attract much attention.

At the head of the family, systematists place a group of wingless forms represented in Canada by two species, one restricted to the North-West, the other apparently common in Ontario and Quebec.

Centhophilus maculatus, Harris. This curious insect is rather strongly built, with stout hind thighs; the back is arched and has a smooth, shiny appearance, as if varnished. Its general color is brown, thickly covered with spots of a lighter color. Wings entirely absent, ovipositor rather long and nearly straight. Lives in communities under stones in damp woods, and beneath the loose bark of dead trees. It appears to be carnivorous, as I have taken it in cans baited with meat.

Anticosti, Gulf of St. Lawrence, Verrill.; Quebec, common, Provancher; Montreal, common, Caulfield; Ontario, generally, to north of Lake Superior, Brodie.

Udeopsylla nigra, Scudd. Resembles in form the preceding species, but is shining black, and is heavier and stouter. The ovipositor is rather short and thick at the base.

Common in Manitoba, Brodie and Scudder.

The next group contains the typical insects of the family, the green grasshoppers or Katydids. Most of these possess ample wings and can fly well. Some spend their lives on trees and shrubs, while others inhabit meadows and pastures. They are pretty and inoffensive creatures, not being numerous enough to be injurious, and owing to their retiring habits, and the similarity of their color to the leaves and grasses amidst which they live, are but seldom seen, even in the localities where they are most abundant.

The narrow-winged Katydid, *Phaneroptera curvicauda,* De Geer, is not uncommon in Canada, and during the latter part of summer, may often be observed resting on shrubs and young trees, occasionally taking a short flight from tree to tree. It may be recognised by its narrow and straight wing-covers, and by the male having a cylindrical style curving from below upwards, and resting in the forks of a furcate appendage which projects from the end of the abdomen.

The ovipositor of the female is rather short and curved abruptly upward, the extremity toothed on both sides. The female deposits her eggs in the edges of leaves of trees. I have never seen this species shrilling, although I believe that I have often heard it. Prof. Riley describes its note as a soft *zeep-zeep,* sometimes uttered singly, but generally thrice in succession. The call is occasionally responded to by a faint chirrup from the females, produced by stretching out their wings as if for flight, and is as often heard in the day as at night.

While passing through its earlier stages, this species wears a more varied dress than the simple green of the adult insect. In the *larva*, the colors are purplish, black and white, arranged in minute squares on the head and body, the antennæ and legs being marked with rings of the same colors. The *pupa* is green, varied with purple on the sides, and adorned with a double row of crimson spots on the dorsal surface. The mature insect is wholly green. It may be found during August and September. My earliest date for it is, August 1885. Province of Quebec, common in August and September, Provancher. Montreal, common, Caulfield. Toronto, common in Ontario generally to north of Lake Superior, Brodie. Red River Settlements, Scudder. A. ♂ Rosseare River, August 30th, and a ♀ the vicinity of Souris River, G. M. Dawson.

The oblong-winged Katydid, *Phylloptera* (*Amblyconypha*) *oblongifolia*, De Geer, is green like the preceding species, but may be distinguished from it by its larger size, and by the oval form of its wing covers. It appears to be rare in eastern Canada, and is not on Provancher list. The only specimens that I have seen are a male and female, given to me by the late Mr. W. D. Shaw (taken, I believe, at Montreal), and three males taken by myself at Montreal, September, 1883. I found them amongst some willow bushes, and in each instance, my attention was attracted by seeing them fly from one bush to another. Dr. Harris states that, when flying, they make a whizzing noise, somewhat like a weaver's shuttle. I was not close enough to hear any sound, nor did I hear them shrilling.

According to Harris, the note of the male, although grating, is feeble. I have not seen any account of the earlier stages of this insect, but in the latter end of June, 1885, I found two larvæ which I think must belong to this species, as they were entirely pale green, and on August 1st, 1885, I found two pupæ, also green (*curicauda* is varied with purple and white, when in nature, and we have no other arboreal species in eastern Canada). Montreal: rare, Caulfield.—Toronto: common, and Ontario generally to north of Lake Superior, Brodie.

The genus *Conocephalus* may be recognized by the head being conical and extending to a point between the eyes, and by the long, straight ovipositor of the female. *Conocephalus ensiger*, Harris, is the only species recorded from Canada. It is of a pale, green color, the head whitish, and the legs and abdomen brownish green; it measures from an inch and three-quarters to two inches in length.

The female has been observed, by Prof. S. I. Smith, with its ovipositor forced down between the root leaves and the stalk of a species of *Andropogon,* where the eggs are probably deposited. Toronto, common, and Ontario, general, Brodie. Not recorded from the Province of Quebec.

During the latter part of summer, numbers of small fragile-looking grasshoppers may be found in damp fields. They belong to the genus *Xiphidium*, of which we have three species in Canada.

Xiphidium fasciatum, Sew. The general color of this species is green, with a brown stripe on top of the head, and its thorax bordered on each side with darker brown. The dorsal surface is brown, with a yellow stripe on each side, and below this again is a narrow brown strip.

The ovipositor bends abruptly down at the base and is then straight to the tip. Length, three-quarters of an inch from head to tip of the wings, which are a little longer than the wing-covers. Recorded by Provancher as very common in August and September in Province of Quebec; Montreal, common, Caulfield; Toronto, common, and Ontario, generally, to north of Lake Superior, Brodie.

Xiphidium brevipennis, Scudder, is now generally believed to be only a variety of *fasciatum.* Common in same localities as preceding species.

I have not heard either of these species shrilling. According to Mr. Scudder, "*Xiphidium* makes a note very similar to *Orchelimum*, but so faint as to be barely perceptible even close at hand."

Prof. Riley states that *X. fasciatum* oviposits in the cone like willow gall (*Salicis strobiloides.*)

Xiphidium saltans, Scudder, is our rarest species, and appears to be confined to the North-West. Souris River. G. M. Dawson.

The species of *Orchelimum* are almost identical with *Xiphidium* in general appearance and color, but are larger, measuring about an inch and one-tenth in length from head to tip of wing-covers.

O. Vulgare, Harris. The note of this species is described by Mr. Scudder as a trill, followed by a series of very short staccato notes sounding like jip! Toronto, common; Ontario, everywhere, Brodie.

Orchelimum agile, De Geer. This species is common in the neighborhood of Montreal, and may be found in almost every damp field where there are tufts of rank grass or clumps of tall weeds. Concealed in one of these, the male takes his stand and trills his simple love song, which is merely a weak wheezy trill, only audible for the distance of a few feet. When shrilling, the insect slightly raises its wing-covers, and shuffles them together with a shivering motion. It sings in the bright sunshine, and it was by observing the play of light on the wings while in motion that I discovered the insect, as when sitting still it is almost impossible to detect it, so effectively does its green dress conceal it. Montreal, common, end of July to end of September, Caulfield; Toronto, common; Ontario, generally, to north of Lake Superior, Brodie.

Anabrus purpurascens, Uhl., is a large, thick-bodied insect, of a dark purplish-brown color, mottled with yellow. The wings are very small and quite useless for the purpose of flight. A western species. West Butte, July 29th. In the vicinity of Woody Mountain, between June 15 and July 7th, and in the neighborhood of the Souris River. G. M. Dawson.

We are now come to the typical family of the order, the locusts. ACRIDIDÆ. In these insects the antennæ are much shorter and thicker than in the preceding families. The wing-covers are generally long and narrow, and slope downwards on the sides like a roof. The under wings are broadly triangular, and when at rest are folded in plaits like a fan. The hind legs are formed for leaping, being stout and muscular. Instead of a long exserted ovipositor like the crickets and grasshoppers, the female is provided with four wedge-like pieces, placed in pairs above and below, and opening and shutting opposite to each other. When about to deposit her eggs, the female forces these wedges into the earth, these being opened and withdrawn enlarge the opening; the operation being repeated until a hole is formed large and deep enough to admit nearly the whole of the body. The eggs of locusts are generally deposited in the ground; those of the Rocky Mountain locust *Caloptenus spretus*, according to Prof. Riley, are voided in a glistening and glutinous fluid which holds them together and binds them into a cylindrical pod.

Prof. Thomas states that he has obtained the eggs of *Caloptenus femur-rubrum* in rotten wood, in which they were placed without any apparent regularity, and without any connection by any glutinous secretion.

The sounds made by locusts are produced in two ways. First, by rubbing the hind thighs up and down on the wing-covers; and second, by snapping together the edges of the wings and wing-covers during flight.

Our Canadian locusts fall into two sub-families, *Acridinæ* and *Tetiginæ.* To the first belong all the species in which the pronotum (upper surface of thorax) extends only to the base of the wing-covers. This group contains the greater number of our species. To the second belong a small group of species in which the wing-covers are aborted, appearing as small pads, while the pronotum extends as far as, or past, the extremity of the abdomen.

As regards the time of appearance of our locusts, there is a constant succession of species from early spring until late in the fall. A few species (Tetix) hibernate as imago or perfect insects, a few others as larvæ, and some as pupæ, but the greater number pass the winter in the egg, not attaining the perfect condition until August or September.

The first to appear are the species of *Tetix,* which having hibernated in the adult form, may be found as soon as the snow has melted. About the same time, specimens of *Tragocephala infuscata,* and its variety *viridifasciata* in the larval condition, make their appearance, attaining the perfect form by the middle or end of May; and with them may be found *Hippiscus phœnicoptera*, a large species, with red underwings. By the middle of July these have passed away, their places being filled by swarms of *Camenula pellucida*, associated with *Trimerotropis verriculata*, and one or two others. During August and September the fields fairly swarm with locusts, prominent amongst them being *Melonoplus femur-rubrum*, *Stenobothrus curtipennis*, *Encoptolophus sordida*, while on dry bank and roadsides, *Dissosteira carolina* may be found in equal abundance. By the middle of October nearly all have disappeared, but a few specimens of *Melanoplus* and *Stenobothrus* linger until the autumnal frosts put an end to their existence.

The following are all the locusts known to me as occurring in Canada:—

Chrysocraon conspersum, Harris. Rat Portage, Man., Brodie; Eastern shore of Lake Winnipeg, five specimens, Scudder.

Chlœaltis (*Amblytropidia*) *subhyalina*, Scudder. Province of Quebec, Provancher.

Stenobothrus curtipennis, Harris. Abundant and generally distributed in Canada. Quebec, Provancher; Montreal, Caulfield; Ottawa, Harrington; Ontario, generally, to north of Lake Superior, Brodie.

Stenobothrus propinquans, Scudder. Cap Rouge, Quebec, Provancher.

Arcyptera lineata, Scudder. Province of Quebec, Provancher.

Tragocephala infuscata, Harris, and var. *viridifasciata*. Common and widely distributed. Quebec, Provancher; Montreal, Caulfield; Ontario, generally, to north of Lake Superior, Brodie.

Gomphocerus clepsydra, Scudder. Souris River, G. M. Dawson.

Ædipoda (*Arphia*) *sulphurea*, Burm. Quebec, very rare, Provancher; Toronto, common, and Ontario, generally, in sand hills, Brodie.

Ædipoda (*Arphia*) *terrebrosa*, Scudder. Souris, G. M. Dawson.

Ædipoda (*Arphia*) *frigida*, Scudder. Taken near Wood End in June, G. M. Dawson.

Ædipoda (*Hippiscus*) *phænicoptera*, Germ. Quebec, common, Provancher; Montreal, rare, Caulfield; Toronto, rare, Brodie; Dufferin, June 13 and 14, G. M. Dawson.

Ædipoda (*Dissosteira*) *carolina*, Linn. Common and generally distributed in Canada. Quebec, Provancher; Montreal, Caulfield; Ontario, generally, to Lake Superior, Brodie; Vancouver's Island, Packard.

Ædipoda (Trimerotropis) verriculata, Scudder. Quebec, common, Provancher; Montreal, common, Caulfield; Ontario, generally, to Lake Superior, Brodie; Dufferin, G. M. Dawson.

Ædipoda (Encoptolopha) sordida, Burm. Quebec, very common Montreal, common, Caulfield.

Ædipoda (Camnula) pellucida, Scudder. Province of Quebec, Provancher; Montreal, common, Caulfield. Variety *atrox,* Scudder; Victoria, Vancouver's Island, Packard.

Ædipoda æqualis, Say. Red River Settlement, Scudder.

Ædipoda trifasciata, Say. Wood End in June, G. M. Dawson.

Pezzotetix borealis, Scudder. A single pair, vicinity of Lake of the Woods, G. M. Dawson.

Pezzotetix Dawsonii, Scudder. Souris River, G. M. Dawson.

Pezzotetix septentrionalis, Saus. Labrador, Saussure.

Caloptenus (Melanoplus) scriptus, Walk. Vancouver's Island, Walker.

Caloptenus (Melanoplus) bilituratus, Walk. Souris River, G. M. Dawson; Vancouver's Island, Walker.

Caloptenus (Melanoplus) repletus, Walk. Vancouver's Island, Walker.

Caloptenus (Melanoplus) femur-rubrum, Burn. Common and widely distributed in Canada. Quebec, Provancher; Montreal, Caulfield; Ottawa, Harrington; Ontario, generally, to north of Lake Superior, Brodie.

Caloptenus (Melanoplus) parvus, Provan. Cap Rouge, Quebec; Provancher.

Caloptenus (Melanoplus) femoratus, Burn. Common and widely distributed in Canada. Quebec, Provancher; Montreal, Caulfield; Ontario, everywhere, Brodie; Lake of the Woods, G. M. Dawson.

Caloptenus spretus, Uhler. Dufferin, Souris River, vicinity of the Lake of the Woods, and the east fork of Milk River, G. M. Dawson.

Caloptenus atlanis, Riley. Quebec, Provancher; Victoria, Vancouver's Island, Packard.

Caloptenus fasciatus, Walk. St. Martin's Falls, Albany River, Hudson's Bay, Walker.

Caloptenus extremus, Walk. Arctic America, Walker.

Caloptenus arcticus, Walk. Arctic America, Walker.

Caloptenus borealis, Feiber. Labrador, Feiber.

Acridium appendiculatum, Uhler. Quebec, Provancher.

Tetix granulata, Kirby. Common, and widely distributed in Canada. Quebec, Provancher; Montreal, Caulfield; Ottawa, Harrington; Ontario, generally, to Lake Superior, Brodie; Vancouver's Island, Packard; Arctic America, Kirby.

Tetix ornata, Say. Quebec, common, Provancher; Ontario, generally, rare, Brodie.

Tetix cuculata, Scudder. Toronto, common; Ontario, generally, rare, Brodie.

Tetix triangularis, Scudder. Quebec, rare, Provancher; Montreal, rare, Caulfield; Ottawa, Harrington; Ontario, generally, to Lake Superior, Brodie.

Tetigidea lateralis, Say. Common and widely distributed in Canada. Quebec, Provancher; Montreal, Caulfield; Ottawa, Harrington; Ontario, generally, to Lake Superior, Brodie.

Tetigidea polymorpha, Burm. Common in same localities as preceding species.

Tetigidea acadica, Scudder. Lake of the Woods, G. M. Dawson.

Batrachidea cristata, Harris. Toronto, rare, Brodie.

The PHASMIDÆ or spectres are represented in Canada by only one species, the well known Walking-stick insect, *Diapheromera femorata* Say, but in tropical countries are numerous and assume strange forms, resembling leaves, thorny branches, &c. Our species is entirely wingless, and looks very much like a small twig. The body is long and cylindrical, and the antennæ and legs are very long and slender. It lives altogether on trees, being generally found on oak and basswood. According to Packard, the egg-sac is flattened elliptical, with a lid in front which can be pushed open by the embryo when about to hatch, and is deposited in the autumn.

Montreal, Caulfield: Ottawa, Harrington: Kingston, Rogers: Ontario, generally, Brodie: Red River Settlements, Scudder.

The COCKROACHES. BLATARIÆ are flattened ovate insects, generally of a dingy brown color, and have an oily and disagreeable smell. The egg capsules are dropped at random, the females not depositing or concealing them in any particular place or manner. Cockroaches are nocturnal insects, hiding during the day in holes and crevices. They are omnivorous creatures, feeding on almost any substance, animal or vegetable.

We have on our lists five genera with seven species. Two of these are European, but have been carried by commerce to various parts of the world. The large, black species, common in houses, and familiar to housewives under the name of "Black Beetle," is the *Stylophyga orientalis*, Linneus. It is an imported species, infesting houses and shipping. Quebec, Provancher: Montreal, common, Caulfield: Toronto, Brodie.

The other imported species is the small, reddish-brown Cockroach, *Ectobia germanica*, Stephens, commonly known in the New England States as the "Croton Bug." It infests houses, and is even more troublesome than the large species, taking up its quarters in wooden partitions and cracks in furniture, soon becoming unpleasantly numerous. Chaudiere Curve, Quebec, Fyles: Montreal, Caulfield: Toronto, Brodie.

Our native species are found under stones and beneath the bark of stumps, and appear to be rare. *Ectobia lithophila*, Harr. Welland and westward, Brodie. *Periplaneta americana*, Linn. Essex County, Ont., Brodie. *Ischnoptera pennsylvanica*, De Geer. This species is light brown, has the wings much longer than the body, and is extremely active. I found a specimen under the bark of an old stump, June 1876, and on the Natural History Society's Field Day to Abbotsford, on June 4th, 1885, I took three specimens, also under bark of a stump. Toronto, not common, Brodie. *Temnopteryx marginata* is a smaller insect, with much shorter wings. I found two specimens under bark of a fallen tree, on Montreal Mountain, June 1876. It has not been taken elsewhere in Canada, so far as known to me.

The Earwigs. Forficulidæ may be distinguished from all other orthoptera, by their narrow, flattened body, short wing-covers, and by the extremity of the abdomen being provided with a forceps, which, in some species, equals the body in length. During the day earwigs generally conceal themselves in holes and crevices, flying actively at night. A few of the smaller species fly during the day. They feed on vegetable matter, and in Europe, where they are numerous, often do much damage by eating the blossoms of Carnations, Dahlias, &c. In this country they are generally rare insects, only one species being recorded from Canada, the *Labia minor* of Linnæus, common to both Europe and America. Cap Rouge and Portneuf, 3 specimens, Provancher: Ottawa, Harrington.

Besides the foregoing species of Orthoptera, there are others on our lists. Some of these are, however, synonyms, while the occurrence of others within our limits is still doubtful.

Additional species will undoubtedly be discovered when more attention has been given to the order, and the remoter districts thoroughly worked up.

On the Correlation of the Geological Structure of the Maritime Provinces of Canada with that of Western Europe.

By Sir Wm. Dawson, F.R.S., etc.

(Abstract.)

As early as 1855, in the first edition of Acadian Geology, the author had indicated the close resemblance in structure and mineral productions of Nova Scotia and New Brunswick with the British Islands, and in subsequent editions of the same work, further illustrations were given of this fact. Recent researches by Bailey, Matthew, Fletcher, Ells and others, had still more distinctively indicated this resemblance, as well as the distinctness of the Maritime Geology from that of the great interior plateau of Canada and the United States. In short, as argued by the author in his recent address before the British Association, the geology of the Atlantic margins of America and Europe is substantially the same, and distinct from that found west of the Apalachians in America and in Central and Eastern Europe. In this fact has originated much of the difficulty experienced in correlating the geological formations of Eastern Canada with those of Ontario, of New York and Ohio, as well as similar difficulties in Europe which have led to much controversy and difference of classification and nomenclature. One object of the present communication was to show that the system of classification of Palæozic sediments, employed for the interior plateau of the American continent, required very important modifications when applied to the Atlantic

coast, and that neglect of this had led to serious misconceptions.

The rugged islands of Laurentian and Huronian rocks correspond on both sides of the Atlantic, and show an identity of succession in deposits as well as a sychronism of the great folds and lateral pressures which have disturbed these old formations. The Cambrian sediments and fossils as originally described by Hartt, and more recently and in so great detail by Matthew, are in close correspondence with those of Wales and not identical with those of internal America. The recent paper of Lapworth on the Graptolites affords evidence of the same kind, and shows that these were Atlantic animals in their time. It also throws much additional light on the Quebec group of Logan considered as an Atlantic marginal formation, representing a great lapse of time in the Cambrian and Ordovician periods. The anthor had long ago shown that the Siluro-Cambrian or Ordovician of Nova Scotia conformed more nearly to that of Cumberland and Wales than to the great limestone formations of Quebec, Ontario and New York. The Upper Siiurian also is of the type of that of England and Wales, a fact very marked in its fossil remains as well as in its sediments.

The parallelism in the Erian or Devonian in both countries is most marked, both in rocks and fossils, and while this is apparent in the fishes, as worked up by Mr. Whiteeaves, it is no less manifest in the fossil plants as described by the author.

The Carboniferous, in its limited troughs, the character of its beds, and its fossil animals and plants, also points to a closer relationship in that period between the two shores of the Atlantic than between the Atlantic coast and the inland area. This was evidenced by comparative lists of species.

The Trias of Nova Scotia and of Prince Edward Island, as the author had shown in 1868,[1] resembles that of England very closely, in its aqueous deposits and in its associated trappean rocks.

[1] Journal of Geol. Society of London, Vol. VI.

Beyond this the Geology of the Maritime Provinces presents no materials for comparison till we arrive at the boulder drift and other pleistocene deposits. In regard to these, without entering into disputed questions any farther than to say that the observations of the author, as well as those more recently made by Mr. Chalmers, conclusively prove that submergence and local ice-drift were dominant as causes of distribution of boulders and other material, there was evidence of great similarity. The marine beds described by Mr. Matthew at St. John were precise equivalents of the Clyde beds of Scotland, as were the upper shell-bearing beds of Prince Edward Island and Bay de Chaleurs of those in Aberdeenshire and other parts of Scotland, and the Uddevalla beds of Sweden. The boulders drifted from Labrador to Nova Scotia were the representatives of those in Europe scattered southward from Scandinavia, and the local drift in various directions from the hills was the counterpart of that observed in Great Britain. The survival of *Mastodon giganteus* in Cape Breton, to the close of the Pleistocene, is a decided American feature, and so is the absence of any evidence of Pleistocene man.

The conclusion of the author was that, in so far as palæontology and the subdivisions of systems of formations is concerned, the geology of the Maritime Provinces is European, or perhaps more properly Atlantic, rather than American, and is to be correlated rather with the British Islands and Scandinavia than with interior Canada and the United States. The latter country, even on its eastern coast, possesses a much less perfect representation of these Atlantic deposits than that in the Maritime Provinces and Newfoundland, though the recent studies of Crosby, Dale and others, are developing new points of this kind in the geology of New England, and Hitchcock and others have shown that the New Brunswick Geology extends in Maine.

The paper further discusses the bearing of these facts on the successive stages of the physical geography of Eastern America in the Cambrian, Silurian, Erian, Carboniferous and Triassic periods.

THE RETENTION AND THE LOSS OF THE HAIR FROM A PHYSIOLOGICAL STANDPOINT.

BY T. WESLEY MILLS, M.A., M.D.
Professor of Physiology, McGill University.

In the *Popular Science Monthly* for October last, Mr. Eaton, in a paper entitled "A Bald and Toothless Future," states that as a result of years of observation of public assemblages of people, he is forced to conclude that there is, among men, relatively to women, a very disproportionate amount of baldness; that there may be deficiency of the hair of the head in the male sex to the extent of forty-six per cent.; and that it is more marked the higher the average culture of the assembly examined. This writer attributes the growing tendency to loss of hair prematurely to wearing tightly-fitting hair coverings, living within doors, and keeping the hair closely cropped. The condition is exaggerated by the influence of heredity. Mr. Eaton says:—"There is no reason why bald heads should not yield to the laws of heredity as much as curly heads or red heads." He further thinks that the early failure of the teeth has an analogous explanation with the loss of hair, viz.: decay from lack of use. The changes of conditions affected by modern civilization have rendered both comparatively useless to man.

Mr. Gouinlock, in the same magazine for May of the current year, under the title, "Hats as a Cause for Baldness," while agreeing that we are drifting towards that future indicated by Mr. Eaton, takes much narrower ground, and even combats several of the latter's conclusions. He believes that the common form of baldness is due entirely to the high hat and the hard felt hat that constrict the blood-vessels which nourish the hair bulbs. He also refers to the peculiar circumstances under which the blood-vessels of the head are distributed, so that they are especially exposed to pressure; and to a certain extent he reasons correctly, and, it may be added, zealously, to establish his thesis; but as I shall have occasion to show, his reasoning is partial and his explanation inadequate. Both these writers have indicated the direction in which the truth lies, but neither gets at it wholly, as I shall now endeavour to show.

That Mr. Eaton is correct in believing that exposure of the body to the sun and air has something to do with hair production, any man may prove to his own satisfaction by leaving his arms or other portions of his body uncovered much more than usual, during a holiday season at the seaside or in the country. But Mr. Eaton states the case altogether too strongly for the influence of heredity. The degree to which such peculiarities as baldness are inherited is one of the most disputed matters; though unquestionably something must be allowed to such tendency, perhaps a good deal.

There can be no doubt that the loss of hair and of teeth prematurely are related in fact. Have such losses a common cause? Mr. Eaton's explanation is *disuse*. Professor Cope would explain the fact stated by dentists, that the last molar (wisdom) tooth and the lateral incisor of the upper jaw frequently do not appear, by what he calls "retardation" of the growth of the jaws, and to successively prolonged delay in the appearance of the teeth; while these again are related to an enlargement of the upper part of the head and of the brain. Is it not possible that all of these causes and perhaps others may combine to effect this result?

Taking up the case against the stiff hat, Mr. Gouinlock explains how readily the arteries can be compressed, especially when the hair is cropped close; he thinks the fact that below the line of pressure the hair remains, while it disappears above it, is quite clear upon his theory; and to account for the presence of hair over the temporal region when absent on the crown, he insists that here the temporal muscle acts as a cushion, preventing pressure. But this writer seems to forget that there are superficial and middle temporal arterial branches as well as deep ones, and that it is just these superficial ones (liable to pressure) that have most to do with supplying blood to the hair bulbs. He also takes no account of other methods besides pressure by which blood can be cut off from a certain region. The familiar phenomena of blushing and pallor show that the nervous system has a controlling influence over the size of small arteries; and the fact that the hair may become grey in a few hours under violent emotion, carries with it the lesson that in some way the nutrition of the hair is regulated by this same nervous system.

To understand the physiological bearings of this subject, the somewhat complex relations of the blood-vessels of the brain, the face, the bones and muscles of the head, and of the scalp must be borne in mind. The arteries of the brain find an outlet for their blood, when it has passed through the capillaries and done its work, in those peculiar venous channels lying on the inner tables of the skull known as "sinuses"; these communicate with the veins of the softer osseous tissue (diploe) lying between the main tables of the cranial bones, which again have connections with the veins on the outside of the head. Now it is plain from this series of connections, that pressure on the scalp must influence the whole vascular system of the head back to the arteries of the brain, unless in some way counteracted. Pressure generally affects veins, from their superficial position, much more than arteries. The bad effects of venous dilation are seen in the slow-healing ulcers on the limbs of those with dilated (varicose) veins. Throughout his paper Mr. Gouinlock has directed his attention almost wholly to arteries rather than to veins. He has nowhere mentioned, what is commonly enough seen by the physician, that anastomotic arterial connections are especially opened up under the exigencies of disease, as from the pressure of tumours, &c.

Would nature refuse to combat the hard hat? Could she not adapt to it in a greater degree than Mr. Gouinlock's theory supposes? In looking at a plate portraying the course of the arteries of the head, it will be noticed that the terminal branches mount to the vertex of the skull and anastomose with their fellows of the opposite side by *very small* offshoots. As it is the smaller branches of arteries that are the most susceptible to changes in calibre,—can in fact be most readily influenced by the nervous mechanism, it is easy to understand why that part of the scalp, with its hair bulbs supplied by them should, either from pressure or from lessening of calibre in response to nervous influence, be the area most to suffer. Hence the explanation of the fact that baldness of the vertex is the most marked. This must be so, however we account for the mal-nutrition, from the anatomical relations of the various blood-vessels.

The anthropological bearings of the hair are not without interest and importance. We find all varieties of hair, all degrees of hairiness, and great dissimilarity as to distribution over the body in different races of men.

The North American Indians have an abundance of hair on the head, with but little on the face or the rest of the body, while the hairiness of the Ainos has been remarked upon by many observers. Mr. Dickins writing in *Nature* for April 7th of the current year, states that the hair is most abundant in this latter race just where it would be most useful, as over the sternal, inter-scapular and gluteal regions, where, it may be remarked, the related epidermis itself is also thick. Professor Penhallow,[1] who has published several papers in this journal on the Ainos, states, in answer to specific enquiry, that the variety found among the Ainos in respect to relative hairiness, is probably explicable by associated climatic differences. If any large civilized community of the present day be examined, the race differences of men will all be found illustrated in this respect. Thus it is to be noticed that individuals and whole families have, like the Indian, abundance of hair on the head with but little elsewhere, while others are generally hairy like the Ainos. As one might expect from their both being dermal structures, an early development of hair &c., from sexual maturity is associated, I am told by a member of the dental profession of this city, with a correspondingly premature appearance of the wisdom teeth. Perhaps, however, such instances ought to be regarded as illustrations of general acceleration of maturity of the whole organization. It still remains to explain the early baldness of men and the exemption of women. Even if we accede to all that the

[1] Can. Rec. of Sc. II, 119.

writers in *Popular Science* claim, it does not suffice to explain the subject at all adequately. The great increase in the prevalence of all forms of nervous disease, and the modifications wrought in old forms of disease by the greater prominence of the nervous type of human being, points to the fact that our civilization makes calls upon the organization which tell especially on the nervous system. The strain of life falls in general, it will be conceded, most upon men. Man is the bread-winner; his anxieties, struggles, and disappointments, are both many and severe; and man is often prematurely bald for the same reason that he is prematurely old in other respects. Woman is less so because brain stress less frequently falls to her lot. But in connection with this must be taken, to complete the explanation, the fact that as with some races and some males of our own race, the vitality and persistence of the hair of the head in woman is specially marked. That overwork of the brain may influence the cephalic circulation (and so the hair) unfavorably, is evident enough from the dark circles beneath the eyes, owing to venous congestion, on the morning after unduly severe mental exercise, not to mention the headache from a similar cause; and it is not surprising that the vertex of the head, with its relatively variable and feeble blood supply, should suffer most—in a word, that the overworked or overworried man should be bald—unless, as in most women, there is unusual vitality of his hair bulbs. Baldness is one more of the many warnings of our day—one of Nature's protests against the irregular and excessive activity maintained in this restless age.

The Royal Society of Canada is actively forwarding the movement suggested by Sir William Dawson, for an Imperial Union of Geological Surveys and Societies. This is an effort which promises large benefits, and should be heartily supported.

The Distribution and Physical and Past-Geological Relations of British North American Plants.

By A. T. Drummond.

Some years since I had occasion to refer, in some detail, in this journal, to the leading features in the distribution of plants in Ontario and Quebec. Since that time, not only has a federal union of the whole country, from the Atlantic to the Pacific, been consummated, but our knowledge of its flora has been greatly extended, and it is now possible with some reasonable degree of accuracy, to trace the range of most of the phænogamous or flowering plants, and of the horsetails and ferns. The carices and grasses will still need considerable attention from botanical explorers before it will be possible to speak with confidence of their range.

The great breadth here of the continent, extending from Nova Scotia to British Columbia, and its varied physical features and the climatic effects resulting from these, have developed remarkable differences in the flora. There are vast mountain ranges with numerous peaks of great height, enormous stretches of wooded country, extending northward to the extreme limit of trees, great areas of prairie land and of park-like country, extensive inland seas of fresh water, and a coast line of some thousands of miles, not only within the northern temperate zone, but extending even more largely within the Arctic circle. Such marked physical conditions have necessarily given rise to differences in circumstances and climate, and have developed distinctive floras, whilst the present connection of the Dominion, along its southern boundary, with the northern United States, and the past geological history of the northern parts of the continent, have led to marked relations with the floras of foreign countries. It will be the object of this paper to trace the connection of the general flora of the Dominion with the floras of some foreign countries, to illustrate the distinctive floras of the different parts of the Dominion, and to indicate the relations of these distinctive floras to associated physical and past geological conditions.

The considerable resemblance between the floras of Japan and the River Amur on the one hand and the Northern United States and Canada on the other, has before now attracted attention. A large number of species are identical, whilst some others in America are represented in Japan and the Amur country by varieties which, no doubt, all have more or less their origin in the changed conditions under which the plants in their new homes exist. The more complete knowledge we now have of the range of these species in Canada, has thrown some new light on the interesting problems which arise in tracing the origin of this identity, and the relations of our flora to that of Europe. Messrs. A. Franchet and Lud. Savatier have in their "Enumeratio Plantarum in Japonia," (Paris, 1879), considerably extended our knowledge of the Japanese flora, and I have taken them as the authority for the occurrence of plants in Japan, whilst Maximowicz is my authority for the plants of the Amur. In a list which I have compiled from Franchet and Savatier's volumes, and which excludes all naturalized plants and garden escapes, there are 221 species common to Japan and Canada. The list will be increased, no doubt, as Japan becomes botanically better known. Of this number of identical species, 150 are found in Europe and 85 are also in Alaska. The range of these 221 identical species in Canada, however, suggests some interesting questions. The occurrence of very many European plants in Arctic and temperate America had long ago attracted attention, and had given rise to various hypotheses, that generally accepted being that in some comparatively recent epoch there had been a connection between America and Europe which had resulted in an intermingling of the plants of the two continents. In recent years Prof. Asa Gray has suggested the probability of the migration of European plants to America having been across the continent of Asia, and this suggestion he was led to make by finding in Japan many European and American species. After a careful analysis of the range in Canada of these identical species, I have not been able to fully follow out the conclusions of others. The analysis may be summarized thus:—

Distribution in Canada.	*Total Identical Species.*	*Also in Europe.*	*Also in Alaska.*
1. Generally distributed from Atlantic to Pacific	89	75	44
2. Somewhat general from Atlantic west to Rockies	42	31	3
3. Not west of Province of Ontario...........	38	17	1
4. Northern and Arctic in range.............	32	23	23
5. British Columbia exclusively, but almost entirely northern.....................	11	2	10
6. British Columbia and north-eastward.....	4	1	3
7. British Columbia, but eastern in United States though not so in Canada........	3	1	1
8. Rocky Mountains only..................	1	0	0
	221	150	85

There is sufficient interest attached to this table to warrant the enumeration of those plants which do not range west of the Province of Ontario, and of those which are exclusively British Columbian.

The letter E affixed to the name of a plant in the accompanying lists indicates that it is also European, the letter A that it is also Alaskan.

I.—Plants not West of the Province of Ontario.

Hepatica triloba, Chaix. [E.] [A.]
Caulophyllum thalictroides, Mx.
Brasenia peltata, Psh.
Viola rostrata, Psh.
V. Canadensis, L.
Geranium Robertianum, L. [E.]
Vicia Cracca, L. [E.]

Waldstenia fragrarioides, Trat.
Penthorum sedoides, L.
Myriophyllum verticellatum, L. [E.]
Lythrum salicaria, L. [E.]
Viburnum lantanoides, Mx.
Cryptotænia Canadensis, D. C.
Galium asprellum, Mx.
Monotropa uniflora, L.
M. Hypopitys, L. [E.]
Polygonum maritimum, L. [E.]
Pilea pumila, Gray.
Betula alba, L. var. [E.]
B. lenta, L.
Symplocarpus foetidus, Salisb.
Zostera marina, L. [E.]
Potamogeton hybridus, Mx.
P. crispus, L. [E.]
Pogonia ophioglossoides, Nutt.
Lipparis liliifolia, Rich.
Trillium erectum, L.
Carex filiformis, L. [E.]
C. vulgaris, Fries. [E.]
C. rostrata, Mx.
Agrostis perennans, Tuck.
Millium effusum, L. [E.]
Scolopendrium vulgare, Smith. [E.]
Athyrium thelypterioides, Mx.
Dryopteris thelypteris, Swartz. [E.]
Polystichum filixmas, Swartz. [E.]
Osmunda cinnamomea, L.
Ophioglossum vulgatum, L. [E.]

II.—Plants Only Found in British Columbia in Canada.

Geranium erianthum, D C. [A.]
Rubus spectabilis, Psh. [A.]
Geum calthifolium, Menz. [A.]
Ribes laxiflorum, Psh. [A.]
Cassiope lycopodioides, Don. [A.]
Rhododendron Kamtschaticum, Pall. [A.]
Trientalis Europea, L. A. [E.]
Swertia perennis, L. A. [E.]
Menyanthes crista-galli, Menz. [A.]
Fritillaria Kamtschatcensis, L. [A.]
Calystegia soldanella, R. Br.

Erythronium grandiflorum, Psh., and *Epipactis gigantea*, Hook., occur in Oregon and Washington Territory and Japan, and may yet be found in British Columbia. *Geum calthifolium*, Menzies, *Geranium erianthum*, D.C., and *Swertia perennis*, L., are recorded from the "north-west coast" and are not yet distinctly localized as from British Columbia. *Menzesia ferruginea*, Smith, *Trautvetterea palmata*, F. & M., and *Spiræa Aruncus*, L., in Canada, belong to the west coast flora, but are also eastern in the United States, and have therefore not been added to the list.

On the Amur there are 78 species not included in Japanese lists, but which also occur in Canada, making in all 299 phænogamous plants, ferns and equisetums common to Canada, and Japan or the Amur. Of these 78 Amur plants, 57 are European and 30 are also Alaskan. Carrying the analysis still further there are seven species not in Japan but common to the Amur and Canada, and which in Canada do not extend, so far as yet known, west of Ontario, and of these seven all are European. Again, of these 78 Amur and Canadian plants, there are four species exclusively in British Columbia in Canada, but all northern in that province and occurring in Alaska, whilst none of them are European.

Considerable interest centres in these brief lists, the one carrying us back to prehistoric times, the other illustrating the influence, among other forces, of currents operating in past ages as well as at the present day. The first list indicates thirty-eight species found to be identical in Japan and Canada, but which in Canada do not range west of the Province of Ontario, and are chiefly not west of Lake Superior, leaving thus an immense gap where they are absent. Two other species, *Phyllodice taxifolia*, Salisb., and *Diapensia Lapponica*, L., which in Canada are northern in range, are not, as yet, known west of Hudson Bay, and may be added to the list of eastern species, making with the Amur species the number forty-seven. Of these, thus common to the eastern side of this continent and Japan and the Amur, only one, *Hepatica triloba*, Chaix, occurs in Alaska, and even there it is not known north of Sitcha. Now, if the migration of European plants was eastward across Asia and thence to America, can this immense gap be accounted for? Or, are we to draw the conclusion that the migration was not eastward across Asia, but westward to America by connecting stretches of land and by currents, existing in post-pliocene and earlier times, but which subsequent geological changes have effaced? Or, which I think is a more reasonable hypothesis, were there not, to some extent, facilities for migration in both ways, with, it may even be, Canada as the country of origin of many species which afterwards distributed themselves in both Asia and Europe. I shall discuss these three considerations separately.

With regard to the first consideration that, if it is conceded that the migration of plants from Europe took place across Asia, can it be explained why there is such an immense gap in the range of numbers of these European plants, it is to be observed that they are absent from Alaska, from British Columbia, and from the prairies and the vast wooded country to the north of them. The near proximity of Alaska to Siberia, the shallow seas immediately surrounding the Aleutian Islands, the Kurile Islands and the Kamtschatcan coast, and the peculiar lie of these islands, all tend to convey the idea of a probable connection between Asia and America in tertiary times. This connection, a more moderate climate than now exists would have made an effective highway by means of which Siberian, Japanese, and American plants would have intermingled, and such milder climate did exist in early tertiary times there. The Japanese current—the larger branch of which crosses the Pacific Ocean from Japan and skirts the Alaskan and British Columbian coasts—would have also lent its aid during the great lapse of time since, in carrying seeds from the Asiatic to the American coast. It is, however, a singular fact that there are (see list already given) only eleven species which in Canada are exclusively British Columbian, and which at the same time are found in Japan, and that, of these, nine are not only exclusively northern in British Columbia, but are likewise Alaskan, whilst the other two are coast forms. Two only of these eleven species, *Trientalis Europæa* and *Swertia perennis*, are European. This would at first appear to indicate that the immigration had an eastward flow from Asia rather than a mingling of both American and Asiatic floras. It might, however, be supposed to prove that the migration was only from Japan and the Siberian coast, and was entirely by the Japan current, the direction of which is towards Alaska and then down the Alaskan and British Columbian coasts, any exceptions to the course of this migration being due to exceptional causes. Or, when the fact is considered that out of towards four hundred species, which in Canada do not range east of the Rockies, and most of which do not extend north into Alaska, the two coast forms already referred to, *Calystegia soldanella* R. Br., and *Rubus spectabilis*, Psh., and a rare few, which like *Erythronium grandiflorum*, Psh., and *Epipactis gigantea*, Hook, will no doubt be found in British Columbia, alone likewise occur in Japan, it may rather indicate that the British Columbian flora is of more recent age than the general and northern floras of the Dominion, or, at any rate, that its occurrence in British Columbia is of more recent date than the period when the intermingling of American and Asiatic plants took place. British Columbia is, geologically speaking, recent. The Rocky Mountain region has, at least in the United States, considerable thicknesses of both Miocene and Pliocene strata, and it is therefore certain that the great disturbances which resulted in the final elevation to their present height of these huge mountain ridges which parallel the western coast of North America, took place about or after the close of the Tertiary period. We can even conceive it possible that some of the same great convulsions which produced these mountain chains—one of which extends to the extremity of the Alaskan peninsula—may also have resulted in the severing of the connection between Asia and America, and the creation of the Aleutian and neighbouring islands, where formerly mainland existed. That the present flora of the northern part of this continent was in existence at the close of the Tertiary period, there is little doubt. It was well established at the deposition of the Leda clays of Quebec, and at that time there were many representatives there of the present European flora. As far back as even the Lignite Tertiary of Eocene age, there were in the New England States and Manitoba, representatives of the modern genera *Populus, Cinnamomum, Fagus, Quercus, Platanus, Sassafras, Nyssa, Carpinus, Aristolochia, Onoclea, Illicium* and *Sapindus*, indicating a somewhat more southern climate than now exists, and some of the species were apparently specifically identical with plants in Canada at the present day. If the view can then be entertained that the intermingling of Asiatic and American species took place prior to the elevation of the Rocky Mountains to their present height, and prior, therefore, to the appearance of British Columbia at that period, it will fully explain the more recent establishment in that province of its present flora and the absence of representatives of that flora in Japan.

The Rocky Mountains, as well as the prairies, would be effective barriers to the spread of many species across the continent. The mountains would present high elevations, special climatic conditions, and a rugged character, whilst the prairies with their vast, open, level, generally treeless stretches of country, would afford constant exposure to drying winds and the sun's rays, and in certain sections, to the not infrequent recurrence of drought. Each of these conditions would, in its turn, prove fatal to the progress of certain trees and plants, and thus, collectively, large numbers would have barriers raised to their range. The prairies have been formed since the elevation of the Rocky Mountains, and are, in some places, still in process of formation. Plants and trees which had not, prior to the formation of these prairies, spread themselves across the continent, would not now be able to extend their range, if the physical and climatic conditions presented by these prairies were unfavourable to progress.

With regard to the second consideration that the migration has been westward from Europe, there is some argument to support it, difficult as it may be from the present relative condition of land and water, to trace any connecting lines of communication. In a paper in this Journal (Canadian Naturalist, vol. 7, p. 221,) when discussing the marine origin of the Erie clays, so widely distributed in Ontario, I showed that there was some ground for the conclusion that the Alpine flora of the White Mountains of New England, the boreal colonies of plants on the headlands of Lake Superior, the sea-shore species now spread around the Great Lakes, and the fossil plants of the Leda clays near Ottawa had, probably, all—with regard to their present localities—a contemporaneous origin, and were likewise contemporaneous with the formation of the Erie clays. Now, when it is observed that a very large majority of these species, including all recognized in the Leda clays excepting *Potentilla Canadensis* and *Populus balsamifera*, are also found in Europe, the conclusion is inevitable that this intermingling of the floras of the two continents of America and Europe, must have taken place at or prior to the formation of the Leda clays, unless Eastern Canada is to be regarded as the centre of dispersion, and that the general flora of the two continents can date back its origin to or anterior to that time. The identity in species in Europe and America is not, however, confined to certain of the plants hitherto referred to, and to certain of the Arctic plants. There are numerous others of temperate range not found in Japan, which are common to the two continents of America and Europe. Many of them have a general range from the Atlantic to the Pacific, others again do not cross the Rocky Mountains, whilst some, among them the following, do not extend westward beyond Ontario and Quebec :—

Drosera longifolia, L., (in Manitoba also.)
Sagina procumbens, L.
Spergularia rubra, Presl.
Potentilla argentea, L.
Circæa Lutetiana L.
Myriophyllum verticillatum, L.
Scrophularia nodosa, L.
Veronica officinalis, L.
Stachys palustris, L.
Salsola Kali, L.
Typha angustifolia, L.
Naias flexilis, Rostk.
Potamogeton gramineus, L.

Microstylis monophyllos, Lindl.
Juncus articulatus, L.
J. Stygius, L.

These facts clearly prove that if Europe is to be regarded as the point of origin of these various species, their course of distribution must have been westward to Eastern America over some connecting links of communication. If this distribution had been eastward across Asia to this continent, there would have been found full traces of its course not only in Asia but in the vast area of country lying between Ontario and Quebec and the Pacific coast. And yet there are about sixty European species which are not found in Canada west of the Province of Ontario, and a considerable number of these are not in Japan.

The large proportion of these identical species which are arctic, antarctic, alpine, or high northern, would imply means of communication between the two continents in high latitudes or at high elevations, and the full representation of aquatic plants, especially among the *Typhaceæ*, *Lemnaceæ*, *Naidaceæ*, and *Juncaceæ*, would indicate ample facilities for the natural distribution of fresh water plants, as well as a coast line for the maritime plants. Currents, no doubt, frequently account for eccentricities in range, but in this case, the present gulf stream flows in the reverse direction to the hitherto received notion of the course of the migration.

The third consideration that there were facilities for migration, both eastward across Asia and westward to America, and that Canada may even have been the point of origin of many species now apparently native in both Europe and America, is the most reasonable view to take. It has been already shown that there are numerous European species at present thoroughly established throughout the eastern half of Canada, though unknown in the western, which have no representatives in Asia, whilst, on the other hand, there are many European plants limited to the same side of the American continent, which are found native in Japan as well. The conclusion seems inevitable that there must have been facilities for range in both directions.

Another circumstance would seem to show that the migration may have been across America into Asia. The tendency to variation in plants, will result from or be facilitated by the application of new conditions, and once a variation is permanently established, the plant is unlikely to return to its original form under the influence of a still newer set of conditions. The tendency would rather be to further variation. Now, if a species originating in Europe, migrated to America by way of Asia, and variation should take place in Asia, under the influence of the new set of circumstances which its progress across that continent would present, we would hardly expect to find the plant when it, in the long lapse of time, reached America, returning to the original form which it still possesses in Europe. It is much more probable that the American plant, as we now find it, must have come direct from Europe, and that the Asiatic variety was the result of the further migration of the American immigrant into Asia under new conditions which assisted variation, or that the European plant migrated both eastward and westward, undergoing change in the one route and preserving its originality in the other. A third hypothesis is that America was the centre of dispersion. To illustrate these ideas, I give two lists of plants occurring, some on the Amur River, and all in Japan, the one list of species found in both Europe and America, the other of species exclusively American, but each species showing a variation in Japan. My authority for the Japanese varieties are Messrs. Franchet and Savatier.

American and European.

Species in America.	*Represented in Japan by*
Caltha palustris, L.	C. palustris v. Sibirica, Reg.
Cerastium vulgatum, L.	C. vulgatum v. glandulosa, Koch.
Honckenya peploides, Ehrh.	H. peploides v. oblongifolia, Gray.
Vicia cracca, L.	V. cracca v. canescens, Max., and v. Japonica, Mig.
Linum perenne, L.	L. perenne v. Sibirica, Mig.
Humulus Lupulus, L.	H. Lupulus v. cordifolia, Max.
Alnus viridis, D.C.	A. viridis v. Sibirica, Reg.
A. incana, Willd.	A. incana v. glauca, Ait.
Betula alba, L., in Europe, and v. populifolia, Spach, in Canada	B. alba v. vulgaris, Reg.

Veratrum album, in Europe, and v. Eschscholtzia, Gray, in Canada	V. album v. grandiflorum, Max.
Chrysoplenium alternifolium, L.	C. alternifolium v. Japonicum, Max.

AMERICAN.

Species in America.	*Represented in Japan by*
Viola pubescens, Ait	V. pubescens v. brevistipulata, Fran.
Potentilla Pennsylvanica, L.	P. Pennsylvanica v. hypoleuca, Eeg.
Thuja gigantea, Nutt	T. gigantea v. Japonica, Max. Under cultivation only.
Scirpus eriophorum, Max	S. eriophorum v. Nipponica, Fr.
Acer spicatum, Lam	A. spicatum v. Ukurunduense, Midd.

These examples would appear to establish that taking the plants in Europe in the one case and those in Canada in the other, as the types of the species, the variation has taken place with the progress of the plant westward.

Variation has taken place even in the migration of species to British Columbia. Thus, *Actœa spicata*, L., of Europe, has become *Actœa spicata* v. *rubra*, Ait, in Ontario and Quebec, and *A. spicata* v. *arguta*, Torr, in British Columbia and Alaska. *Potentilla anserina*, L., in Europe and Eastern Canada has become *P. anserina* v. *grandis*, Lehm., in British Columbia, and *Sambucus pubens*, Mx., of our eastern provinces has become *S. pubens* v. *arborescens*, T. G., in British Columbia and Alaska.

That there has also been an eastward migration of plants from Asia into America is illustrated by the following plants among others, which occur in both Japan and Alaska, but do not range beyond Alaska eastward or southward into Canada.

Anemone narcissiflora, L.
Potentilla fragiformis, Willd.
Saxifraga Dahurica, Pallas.
Epilobium affine, Bong.
Cnicus Kamtschaticus, Maxion.
Cassiope stelleriana, D. C.
Phyllodice Pallasiana, Don.
Primula cuneifolia, Ledeb.
Gentiana frigida, Hoenke.

(*To be continued.*)

The Royal Society of Canada.

The Sixth Annual Meeting of the Royal Society of Canada was held at Ottawa on the 20th of May. The attendance was fairly large, Section IV. being most strongly represented both by papers presented and by members attending. Among the general measures introduced, it is gratifying to note that initial steps were taken, looking to the establishment of a Society Library.

The address of the President, Rev. T. E. Hamel, which was delivered at the opening of the Wednesday evening meeting, dealt chiefly with the present condition of scientific education and the choice of suitable vocations by young men. Referring to the opportunities for scientific education in Canada, he urged the necessity of giving this important question much more attention than has been bestowed upon it in the past.

The officers elected for the following year were :—

President—Dr. G. Lawson, of Halifax.

Vice-President—Sandford Fleming, C.E., of Ottawa.

Secretary—Dr. J. G. Bourinot, of Ottawa.

Treasurer—Dr. J. A. Grant.

Of the Sections, the presidents elected were :—

I, M. Faucher de St. Maurice, of Quebec; II, Rev. Dr. G. M. Grant, of Kingston; III, Dr. T. Sterry Hunt, of Montreal; IV, Dr. Robert Bell, of Ottawa.

In opening Section III, the President, Mr. Thos. Macfarlane, read an address on "The Utilization of Waste." He referred particularly to improvements made during the last twenty-five years at the Friburg Iron Works, where all arsenical, sulphurous and other fumes are now condensed and converted into merchantable articles, which yield a fair return on the cost of production. The lands surrounding these works are now cropped profitably, whereas in former years the iron masters were obliged to pay heavy sums for damage done by the wasted and noxious vapors. The separation of phosphorus from iron and the direct application of the phosphated slag as a fertilizer, as now being done at Middleburgh, was mentioned as an instance both of improved manipulation and the profitable application of an inferior element. The sulphur residues of soda works, and the manganese and calcium chloride waste of the bleach manufacture, were also considered.

Several papers of value were read. Among them we may note the following:—

In dealing with milk analysis, Dr. Ellis, of Toronto, gave a *resumé* of the various processes employed, and exhibited a table showing comparative results obtained by each method. Mr. Thos. Macfarlane, of Ottawa, pointed out the advantages of the asbestos method of milk analysis, which seems to possess special merits over the older processes. A known quantity of milk is poured upon the asbestos, dried, weighed and percolated with petroleum ether, the operation being conducted in tubes specially made for the purpose. Expedition and accuracy are advantages gained by this method—a dozen samples being operated upon at once.

Mr. A. McGill, of Ottawa, presented "Notes on the Analysis of Coffee," and among other things showed that the extent of adulteration with chicory, can be readily determined by exhausting with boiling water and taking the specific gravity of the solution at 60° F.

Dr. B. J. Harrington, of Montreal, dealt with "The Sap of the Ash-leaved Maple (*Negundo aceroides*). This paper gave the details of an examination of the sap of the ash-leaved maple, carried out in the month of April last. Two trees, thirteen years old, and grown at Montreal from the seed, were tapped early in April. The sap was examined daily until the 20th of the month, after which the flow ceased entirely. Tables were given, showing the daily variations in the flow and density of the sap, as well as the percentage of sugar, &c. From the results stated, it appears that the average proportion of sugar in the sap of one tree was 2.33 per cent., and in that of the other 2.42 per cent. The mineral constituents of the sap were found to consist chiefly of calcium salts, including a considerable proportion of calcium phosphate. The interest of these determinations is increased from the fact that the sugar obtained was of a very fine flavor and quality, while the ease and rapidity with which the trees can be grown, renders this a somewhat important source of sugar. The paper also contained determinations of sugar in the sap of the true sugar maple (*Acer saccharinum*), the red maple (*Acer rubrum*) and the butternut (*Juglans cinerea*).

The most important paper of the section related to "The Digestibility of Certain Varieties of Bread," by Dr. R. F. Ruttan, of Montreal. The results stated were derived from a series of experiments on bread made with yeast, baking powder, &c., and included statements relative to the retarding influence of several mineral salts upon digestion.

Other papers of this section were as follows:—

"On a Specimen of Canadian Native Platinum from British Columbia," by Dr. G. C. Hoffmann; "Stelliform Snow Crystals, in Relation to Stellate Crystallizations Generally," by Prof. E. J. Chapman; "The Indirect Analysis of Phosphate Samples, as a Check on Commercial Analyses," by Prof. E. J. Chapman; "Extension of the Use of Oblique Co-ordinates in Geometry of Three Dimensions," by Dr. Johnson, and "Investigation as to Maximum Bending Movements at Points of Support of Continuous Girders of *n* Equal Bends," by Prof. H. T. Bovey.

In Section IV. papers of very great interest and value, and embracing more than the usual range of subjects, were presented. Those by Sir Wm. Dawson "On the Correlation of the Geological Structure of the Maritime Provinces of Canada with that of Western Europe," and "Notes on Fossil Woods from the Western Territories of Canada," are printed elsewhere in abstract.

The address by the President of the Section, the Abbé Laflamme, specially related to Dr. Sarrasin as one of the most eminent of the earlier scientists of Canada. Dr. Sarrasin was Royal Physician at Quebec in the early part of the 18th century. He was deeply interested in the study of natural history, but although he discovered our common pitcher plant, which was named in his honor by Tournefort *Sarracenia*, and made several collections of plants, his interest was chiefly in Zoology. In this department of science he did some very valuable work, which was embodied in memoirs to the Academie des Sciences. Of all those who labored to advance the cause of science in the earlier period of Canadian history, Sarrasin occupies the first place.

Of the botanical papers we note the following:—

The "Marine Algæ of New Brunswick," by Dr. G. U. Hay, referred to the more important species of Marine Algæ found on the eastern and southern coasts of New Brunswick, with notes on their distribution and economic uses. The occurrence of rare forms, such as *Fucus serratus* and *Polysiphonia fibrillosa* were mentioned, with particular reference to the localities in which they are found. To the paper was appended a list of the Marine Algæ of the Maritime Provinces, enumerating with notes, some eighty-four species.

In his paper on the Canadian Species of *Picea*, Dr. George Lawson pointed out that descriptions of three species of *Picea*, natives of Canada, have long existed in botanical works. Lumbermen have also commonly recognized as distinct, the white, red and black spruces, and the real or supposed differences that exist in the qualities of their timber. Yet the specific limits of these three important forest trees have not been clearly defined, and some botanists of unquestionable authority, doubt whether they are not all forms of one species, passing into each other through intermediate variations. The object of this paper was to define with more precision the specific limits of these trees, and their relations to each other. Attention was called to characters, hitherto overlooked, whereby these species may be more clearly distinguished. An attempt was also made to refer to their proper species, the several names used by the numerous writers who have described these trees.

In a contribution to our knowledge of "Arctic Plants Occurring in New Brunswick, with Notes on Their Distribution," by Rev. James Fowler, the author shows that the laws governing the geographical distribution of plants are not fully understood. Their limits are not determined by parallels of latitude, nor altogether by isothermal lines.

The Lapland flora is very rich, the Siberian excessively poor in the same latitude. Before the glacial period a homogeneous flora covered the Arctic regions. It was driven south by the cold and at the return of a higher temperature followed the retreating snows to the north, whence it had originally migrated. During their homeward journey, many forms found congenial retreats in New Brunswick, and they linger there still. The causes that have secured this result are considered in the following aspects :—

I. Geographical position and surface contour. The Province is divided into three geographical sections, each of which possesses characteristics fitting it for the abode of Arctic plants.

II. The Arctic current and its fogs cool the temperature along the sea coast, causing cold rains and sea-breezes in spring. The cold water and fogs of the Bay of Fundy are favorable to the growth of Arctic plants. The average temperature of the seasons along the coast, according to the meteorological reports, shows a cold area.

III. Division of the Arctic regions into five districts. List of Arctic plants in New Brunswick in tabular form, showing the Arctic district in which each occurs.

In "A Review of Canadian Botany from the First Settlement of New France to the year 1800," by Professor D. P. Penhallow, the author brings together the most important facts relating to the general history of the early Canadian botanists. It is shown that, during the long period from the time of Jacques Cartier to the beginning of the present century, the botanists who took any active part in developing the flora of Canada, were very few, and of these none were native born. A just tribute is paid to the early missionaries, whose work in botany, though limited, was often of a valuable character. It was not until a comparatively late period that explorers manifested any special interest in such work, so that prior to the advent of Peter Kalm such progress as was made, depended wholly upon the missionaries and a few resident officers or physicians, whose names, like those of Sarrasin and Gaultier, find a permanent place in the history of botanical progress. Several important points receive additional light, and facts of interest in various directions connected with the early flora and history of the country are stated. The paper is the first part of that which, at a later date, will present a complete outline of Canadian botany. It is, therefore, appropriate that it should embrace a list of all the botanical writers for the period named, together with brief biographical data, and a list of each author's publications so far as they relate to the botany of Canada.

In an account of "The Flora of Hudson Strait, with Remarks on the General Distribution of Plants on the Northern Shores of America," Dr. Lawson states that the northern plants form an element of interest in the Canadian flora, and have received special attention from Sir John Richardson, Sir Joseph Hooker, and other writers. Collections have been made from time to time and lists published, as in Myer's "Labrador Flora" and the reports of the Arctic expeditions. But our knowledge of these plants is still necessarily imperfect. Recent collections have been made by Dr. Bell and others at stations in Hudson Strait, and lists published from determinations made by Prof. Macoun. These have been supplemented by additional material and information obtained in the summer of 1886, by Mr. Payne, of the Meteorological Service, and Mr. J. W. Tyrrell, F.L.S.

Mr. Payne made careful observations on the nature of the special localities or habitats where the plants were picked, as regards nature of soil, elevation, protection, &c.; also of the periodical phenomena, dates of budding or sprouting, leafing, flowering, seed ripening and autumn withering. These observations are tabulated. One object of this paper is to assist in removing the hindrance to the collection of material and information of this desirable kind, due to the circumstance that many of our northern plants are imperfectly described under a multiplicity of names through scattered and rare or inaccessible works.

The geological papers were numerous and embraced several of importance. "The Utica Formation in Canada," by H. M. Ami, gave a sketch of that division of the 'Cambrian Silurian' or 'Ordovician System,' in which new facts in regard to its stratigraphy and palæontology are recorded.

In "Notes on the Physiography and Geology of Aroostook County, Maine," Professor L. W. Bailey, gives a paper supplementary to that published in the Transactions of last year, on "The Geology of Maine, New Brunswick and Quebec." It treats more particularly of that portion of Aroostook County, Maine, which lies along the frontier of New Brunswick, and is included between the St. John River and its tributaries, the Fish River, and the Aroostook. The strata exposed along the last named stream, between Ashland and Presque Isle, are compared with those previously described about Square and Eagle Lakes, on the east branch of Fish River; and additional evidence, derived both from stratigraphy and fossils, is furnished, tending to show that, within the area referred to, the rocks previously regarded as Devonian are really of Silurian age. Indirectly, the facts detailed are of interest as bearing on the geology of Carleton, Victoria and Madawaska counties, New Brunswick, and the region of Lake Temiscouata, in Quebec, in each of which similar relations have been observed.

"Some Recent Developments in Archæan Geology," by Andrew C. Lawson, deals with such recent work in Archæan geology, particularly in the Lake Superior region, as tends to modify commonly accepted notions of rock metamorphism. The various kinds of crystalline rocks which, under the old theory, were regarded as typically metamorphic, are considered briefly, and their true origin and history, as revealed by microscope methods of investigation, are stated. It is held by the writer that the term metamorphic can at present be applied only to a small portion of the rock formerly so designated, and that even this limited application will probably be still further restricted when the rocks become better known.

The stratigraphical and petrographical work of Professor Irving of the U. S. Geological Survey is next briefly reviewed, the principal results of which are the correlation of the Huronian with the Animike and its equivalents on the south shore of Lake Superior; the establishment of the unconformity of these formations to the older rocks, and the reclaiming of the Huronian in its various geographical groups from the more distinctly crystalline complex rocks which may properly be called Archæan. The rocks of the Archæan complex thus simplified by the removal of the Huronian, are next considered in the light of observations made by the writer in the Lake of the Woods and Rainy Lake regions, and the origin of the rocks commonly called Laurentian, together with their age relatively to other rocks of the Archæan complex, is discussed.

In "Rock Stretching," by the same author, the writer refers briefly to the interesting observations and conclusions of Lehmann, Baltnzer, Reusch and other investigators in Europe on the phenomena of the stretching and squeezing of crystalline rocks under the enormons pressures which have effected the folding of the earth's crust. Instances of stretching are described in rocks from the Rainy Lake region as observed not only in the field, but also, more particularly, in thin sections, under the microscope. Diabases and quartz-porphyries are dealt with more especially, and examples of the shattering and tearing asunder of their constituent minerals are given. An attempt is also made to reduce to measurement the extent to which such stretching may go without the complete obliteration of the original structure of the rock.

In a communication "On the Classification of the Trilobites," Professor. E. J. Chapman, proposes a new grouping of these indistinct crustaceans; one based essentially on structural in place of stratigraphic affinities. Since the very general rejection of Barrande's classification—the leading subdivisions of which are based on a single special character—stratigraphic considerations have unduly influenced, it is contended, the proposed collocations of these types. Many forced and arbitrary groupings have thus been made; and forms, on the other hand, closely related by general structure, have been widely separated. Lines of evolutionary descent, where traceable, become thus obscured. In the proposed classification, four leading sections, with thirteen groups and twenty-three families, are adopted.

A paper by G. F. Matthew on "Illustrations of the Fauna of the St. John Group. No. IV. On the Smaller Eyed Trilobites of Division I, with a Few Remarks on the Species of the Higher Divisions of the Group," deals with trilobites including representaiives of the genera Ellipsocephalus, Agnostus, Liostracus, Ptychoparia and Solenoplura. The author proposes to avoid some of the confusion as to descriptions of trilobites, by limiting the characters by which the several genera are defined. The classifications of the English, German, Scandinavian and American palæontologists are reviewed. Different genera are compared by tabulating their leading characters. The author points out the difference in the young stages, and traces their development. The necessity of recognizing the changes which take place during growth is pointed out. Comparatively little is yet known of the origin of the primordial fauna, and it is shown to be unlikely that the variety of types found at the base of the Cambrian system, all had their beginning then. It may be surmised that the ancestors of the primordial forms had their origin in some hitherto unexplored part of the earth—perhaps the bed of the Atlantic Ocean.

The second part of the paper refers to the higher Cambrian faunas of the Acadian region. The St. John group appears to represent nearly the whole Cambrian age. A collection of fossils from Cape Breton, examined by the author, throws some light on the life of this group of rocks. The fauna of the Potsdam sandstone is considered equivalent to that of the shallow-water deposits of the St. John group.

A paper of considerable interest was that presented by Mr. Amos Bowman, of the Geological Survey, "On the Gold-bearing Rocks of British Columbia." The author described the formations represented in the Cariboo district, with their characteristic localities and subdivisions. The unconsolidated tertiary deposits of Cariboo, better known as its deep-placer mining ground, was also considered, after which followed descriptions of other mining districts in British Columbia, less noted than Cariboo; the middle and lower Fraser River districts; the Fraser River gold-bearing slates of palæozoic age; the mesozoic and tertiary rocks yielding gold; the later tertiary auriferous deposits generally; the post-tertiary auriferous deposits in the districts described; and finally, an account is given of the discovery of the hidden wealth. It was always a question of enrichment in gold to a stage for profitable mining. The conditions of practicable placer-mining were elucidated, as well as the first gathering of the gold into quartz veins. The paper concludes with a brief description of the orography and the rocks of the Cordilleran system in Canadian territory, their character as compared with the Laurentian-Appallachian system, and the significance of some of the geological features in relation to national development.

Some additional facts relative to glacial action are contributed by Dr. J. W. Spencer, in "Notes on the Erosive Power of Glaciers as seen in Norway." The three principal glaciers of Norway were visited by the author in 1886. It has hitherto been supposed that stones and boulders are always held in the bottom of the glacier with sufficient firmness to cause them to grind or groove the surface of the rock on which the glacier moves, but the author questions this in cases where the temperature is near the melting point, and gives examples of what he saw. Owing to its viscous or plastic nature, the ice then flows around obstacles, instead of abraiding them as a rigid body would do. At low temperatures, ice is capable of holding stones and sand like graver's tools, and when its mass is much mixed with them, it no doubt planes, scratches and polishes the rock-surface. The action of glacier-ice on meeting with solid obstructions, and in ploughing up loose materials, is described from the author's own observations. The tendency of his notes is to show that the erosive power of former glaciers in excavating lake-basins, etc., has, perhaps, been overrated, and he supplies a plea in favour of the action of ice carried forward with greater velocity by ocean currents. The observations of other writers, who agree with him in this view, are quoted, and the conclusion is reached that the action of land ice is not sufficient to account for our so-called glacial phenomena.

"Illustrations of the Fauna of the St. John Group. No. V. On the Great Acadian Trilobite, Paradoxides Regina," by G. F. Matthew, contains a description of the largest known animal of the Cambrian age. About 1745-40 Linnæus described the *Paradoxides Tessini*, and in 1759 a second species. Two other large species are found in Northern Europe. A Paradoxides was first found in America in 1834, and others have since been discovered on this continent and in Europe. Some of them are very large. They belong to both the first and the second Fauna of Barrande. *Paradoxides Regina* is described, and it is supposed to be the largest known trilobite, one complete specimen measuring fifteen inches in length by twelve in width, while fragments of others indicate still greater proportions. It is closely allied to two other species, but is probably distinct from them.

In "The Diurnal Motion of the Earth in Its Relation to Geological Phenomena," by W. A. Ashe, the author points out the possible connection between the lines of folding or upheavel of the crust of the earth, and the effect of the rotation of the planet on the rigid as compared with the fluid portions, and of the necessity of the solid parts accommodating themselves to the ever-contracting fluid portion. He shows that the area of present active volcanoes ought to be limited by a zone of 45° on either side of the equator, and that the greatest activity ought to be about latitudes 36° 20′ N. and S.; also that the highest mountains should be found about these parallels. The probable flow of ocean currents at different geological periods is indicated. The author maintains that the earth is made up of three distinct elements in equilibrium; first, the solid nucleus, in which the polar diameter is to the equatorial, as 299 is to 300; second, the waters, with a greater difference between their diameters; and third, the atmosphere, with a still greater difference. We would, therefore, have less water and much less atmosphere at the poles than at the equator, but their physical properties and other causes modify this apparently inevitable result. He then treats of cataclysmal floods, and shows that they are not within the limits of possibility.

Dr. A. P. Coleman contributes a valuable paper on the "Microscopic Petrography of the Drift of Central Ontario." After giving a general description of the drift in Central Ontario, the author enumerates the microscopic characters of the various crystalline rocks (chiefly Laurentian) found in these deposits in the vicinity of Cobourg. He then proceeds to classify them according to Rosenbusch's method under the two classes—acid and basic rocks, distinguishing a massive and a schistose series in each. The drift of Cobourg, which is derived from the north-eastward, is shown to contain a large variety of the older archæan rocks. Hornblende proved to be present in the greater number of specimens examined. The presence of a considerable group of rocks, characterized by containing scapolite as an essential mineral, is the most interesting point brought out in the investigation. This paper is illustrated by six coloured plates of microscopic sections of rocks.

Mr. C. H. Merriam appeared before the Society in behalf of the United States Department of Agriculture, and presented an address relative to economic ornithology. He laid special stress upon the ravages of the rice bird, and indicated the steps that were being taken by the United States authorities to check it. He also dwelt at some length upon the English sparrow in its relation to insects, and its value as a game bird. He also read a paper on the "Migration of Birds," in which he pointed out that their annual increase, which would otherwise reach enormous proportions, was controlled by the conditions attending their passage from one country to another, by reason of which great numbers were killed.

Mr. Ernest E. Thompson discussed a question of much interest in his "Notes on the English Sparrow, *Passer Domesticus.*" Reference was made to the extraordinary rate at which this imported bird is multiplying in North America and spreading over the continent, to the exclusion of some of our native sparrows. Its influence on agriculture must be great, and it is very desirable to ascertain as soon as possible, whether this influence is for good or evil. The experience of the farmers in Britain and other countries is cited, also that of Canadian agriculturists as far as it has gone. The recent invasion of the Muskoka and Nipissing districts by this sparrow, is descrided in connection with its steady progress westward. The author's personal observations on its encroachment on the domains of the native birds is given. He showed the bird to be essentially a grain-feeder, although the young destroy many grasshoppers. On the other hand, our native birds, as a class, are eminently beneficial to agriculture, and therefore should not be suffered to retreat before the invader. In conclusion, the author gives a table showing the results of his dissection of over 100 gizzards of English sparrows, shot in the vicinity of Toronto.

A paper by Mr. Andrew Downs, "On the Birds and Mammals of Nova Scotia," contains a list of the birds found in Nova Scotia, whether permanent or migratory. Notes are given of their observed distribution in the province, the nature of the localities frequented by them, their food, breeding and habits generally, with the times of arrival and departure of the migratory species. A list is also given of species that have been found, from time to time, in the province, but which are not residents nor regular visitors.

Dr. G. M. Dawson continues his ethnological studies in "Notes and Observations of the Kwakiool People of the Northern Part of Vancouver Island." This paper enumerates the tribal subdivisions of the Kwakiool people, stating the places inhabited by each, and giving particulars as to migrations, changes in village sites, etc., in so far as these can be ascertained. Notes on the mode of life and customs of the people are then given, together with folk-lore, religious ideas, superstitions respecting "medicine" or "sorcery" and traditions attaching to particular localities. The custom of the "potlatch" or "donation feast," as practised by these people and other tribes of the coast of British Columbia, is explained, and some suggestions offered as to the mode to be adopted in bettering the condition of the Indians of the North-West Coast. To the paper is appended a vocabulary of about 700 words of the language of the tribes referred to in its different dialects.

The meeting as a whole was a successful one, the attendance being fairly large; of the thirty papers in Section IV—not counting those presented by special delegates—one-half were by persons not members of the Society, a number far in excess of former years. This is a tendency which should be promptly discouraged. While it may be desirable to admit the papers of non-members on application, and under snitable restrictions, their solicitation, or their unlimited admission, is an indication which can be viewed only with apprehension. Only an injurious influence can result, since the admission of such papers not only places the regular members at a disadvantage, by consuming time which would otherwise be devoted to discussion, but it reduces the advantage of membership to its lowest terms. The final result must be either an expansion of the Society much beyond its present limits, or a sensible decrease in membership.

Reviews and Book Notices.

The Ainos.

Conspicuous among the exceedingly creditable memoirs issued by the Imperial University of Japan, is a recently issued number—the first from the College of Literature—by Prof. B. H. Chamberlain, on "The Language, Mythology and Geographical Nomenclature of Japan, Viewed in the Light of Aino Studies, including an Ainu Grammar." Although not dealing with the Ainos exhaustively, this memoir covers the ground indicated by the title, very thoroughly and conscientiously, and it is by far the most important recent contribution to our knowledge of these people, that has appeared.

Prof. Chamberlain has been fortunate in securing the cooperation of Mr. Batchelor. This gentleman was intimately associated with the present writer, a few years since, in studying the Ainos. His familiarity with their language and also with the Japanese language, as well as frequent and continued residence among the Ainos, enables him to present work of the highest value. His "Ainu Grammar" is a most welcome and important contribution, and he is able to speak with an authority no one else can claim.

The experience of Prof. Chamberlain in gaining trustworthy testimony, appears to have been that of all his predecessors, for "As a warning to others who might be inclined to accept statements of fact made by the Ainos with regard to their own history, the present writer would remark that, such statements made by an uncultured people are quite untrustworthy, unless supported by extraneous evidence. Tests of Aino inconsistency and unreliableness, crop up whenever proof can be applied." This will doubtless apply to all barbarous or semi-barbarous people whose moral sense is not yet raised to that level which enables them to distinguish between the value of truth and falsehood; and in the case of the Ainos, this may apply with greater force, on account of the extent to which, for centuries, they have been accustomed to dissimulate in their relations with the Japanese. Our own experience has repeatedly shown that constant and more than ordinarily frequent verification was needed.

The author deals with the physical characteristics of the Ainos very briefly, and only incidentally. He inclines to the view which has so often been expressed, that extreme hairiness is a peculiarity of the people, and refers to ancient Chinese accounts which speak of them as the "Hairy Men." In the absence of exact data, however, we hardly feel satisfied with his explanation that smoothness of skin is the result of crossing with the Japanese. To be sure he notes that such half-breeds are usually smooth, but then he does not attempt to show that the pure type are never otherwise than hairy. While this may be an important factor, our own observations would lead us to believe there are other causes, as already pointed out.[1]

[1] Can. Rec. Sc. II. 119.

The Aryan origin of the Ainos has been insisted upon by several ethnologists, and is indeed the view most generally held at the present time. It is therefore a matter of great interest to find that certain affinities of language are now pointed out, offering as they do, additional proof of the probable correctness of this view.

Resemblances between the Japanese and Aino languages, are very properly shown to be only apparent. Every one familiar with these people, knows that they use many Japanese words and expressions, and from this the inference has more than once been hastily drawn, that there is an intimate relation between the two people. It would be quite as correct, on similar grounds, to establish an affinity between the European and North American Indian. Prof. Chamberlain, however, shows very clearly, that while these languages are fundamentally distinct, they have become more or less blended as a natural consequence of the intimate relations of the two people. Nor could we look for any other result, when such relations have extended over a period of twenty-five centuries. Borrowings from one to the other were frequently made, and thus on the one hand we get the Japanese form in the Aino language, while on the other, Aino names persist wherever these people have once had a habitation. Such names thus become a part of the Japanese language, although, usually, in a perverted form; sometimes the modification is carried so far as to render the original form of the word very obscure and hard to determine. These changes, occurring as they are at the present day, afford a most important clue to similar changes in the past, and thus, as we shall see later, serve a most important purpose in tracing the original distribution of the Ainos. Of familiar examples we may give the following:

Atkesh becomes *Akkeshi*; *Shikot* has been changed to *Chitose*; *Poronai* is *Horonai*, and a most modern example, since the change has been made within fifteen years, is the conversion of Satsuporo into Sapporo. That these changes have, on the whole, been effected rapidly, and, as in the last case often without any special transitional forms, is well shown by the fact that in the province of Aomori—

the last province in northern Honshiu from which the Ainos were displaced, on their retreat into Yezo—only 5 to 10 per cent. of Aino names are now preserved. Yet the displacement from that province, has been effected only within the last hundred years. The well recognized persistence of Aino names, however, is very properly taken advantage of to determine the former dispersion of the people. This persistence of place names for many centuries, again gives rise to the pertinent query, if certain of them of obscure meaning may not similarly have been derived from the predecessors of the Ainos? for that predecessors there were, is accepted as probable by the best ethnologists, in spite of a few efforts to show that the various kitchen middens with their pottery, originated at the hands of the Ainos.

The most important question involved in the present memoir, is the former distribution of the Ainos, and the evidence directed toward its solution is of great value. The view most generally held is,[1] that they descended from the north and gradually dispersed over the whole of Japan, being afterward gradually driven back by the Japanese. Historical evidence shows that the Ainos were at least as far south as Tokyo, and within recent periods, they have occupied the north of Honshiu. At present, they are exclusively confined to Yezo and the islands to the north, but their range of distribution, like that of the North American Indian, is being continually reduced.

But to the solution of this question, Prof. Chamberlain directs the evidence of place names with such success as to leave little room for doubt. Traces of them are thus found to the extreme southern limits of Japan, and on the islands of Ikē and Tsushima; so that these people were undoubtedly the predecessors of the Japanese all over the Archipelago. And again, the author directs attention to the probability that, since the surnames of ancient families were often derived from villages and places, the names of many families of the present day, doubtless represent the influence of the Aino upon the Japanese language.

[1] Can. Rec. Sc. I, 11.

The distinctive purity of the Aino and Japanese has often been remarked upon as peculiar, in view of the well known inter-marriages occurring all along the lines of contact. This is explained upon the ground that the offspring of the second generation, not only become few in number, but that they are barren or so poorly developed as to terminate the cross—an explanation which appears to meet the case very satisfactorily. Pure races thus continue dominant, while the weaker is continually being thrust more and more toward the extreme limits of existence.

The author concludes his memoir with an extended bibliography, embracing 465 titles. These are chiefly derived from native authors, and in several instances include writings by foreigners.

VEGETABLE MORPHOLOGY.—The Clarendon Press have recently issued a translation of Goebel's "Outlines of Classification and Special Morphology," by H. E. F. Garnsey. This is one of the most welcome of recent botanical works, and gives the student the results of the most recent researches. The style is admirable—the expressions are direct and clear. A particularly commendable feature is the effort to reduce our discouragingly confused terminology to something like uniformity. The result is not as complete as might be desired,—nor is that altogether possible at present—but a vast improvement has been made; homologous structures being designated by the same term throughout. The antiquated distinction of Cryptogam and Phænogam is here done away with, and the intimate relations between the Vascular Cryptogams and the Gymnosperms is more clearly developed. The division of all plants into—I. Thallophytes; II. Bryophytes; III. Pteridophytes; IV. Spermaphytes, is one which commends itself strongly to the modern botanist. The Myxomycetes and Diatomaceœ are very properly placed in separate groups of uncertain affinity; while the old groups, Algæ and Fungi, are here restored. The book should be in possession of every student of botany.

FROST REPORT.—Volume VII. of the *Journal of the Royal*

Horticultural Society is wholly devoted to a report by the Rev. Geo. Henslow on the effects of the severe frost which visited Great Britain in the winters of 1879-80 and 1880-81. The report contains a very large number of facts derived from reports sent in from various parts of Great Britain. In summing up the more important results obtained from these data, Mr. Henslow chiefly points out the fact that age and maturity of structure for any season are most important factors in the ability of plants to resist severe cold. Plants which continue their growth late in the season, are much more susceptible to cold than those which ripen their structure earlier.

Proceedings of the Society.

The fifth monthly meeting of the Society was held on Monday, March 28th, the President, Sir Wm. Dawson, in the chair.

A letter from Mr. Thos. Macfarlane was read relative to the death of Mr. Charles Robb, C.E., when the following resolution was adopted:—

"That this Society has learned with regret, of the decease of Mr. Charles Robb, C.E., who was for a long time one of the most useful members of the Society, and one of its officers, as well as the author of valuable papers contributed to its meetings." It was further resolved that a notice of Mr. Robb's life be published in the Record of Science.

Mr. Joseph Bemrose was elected a delegate to represent this Society at the annual meeting of the Royal Society of Canada.

Mr. Ernest Ingersoll was duly elected a member of the Society.

Specimens of Canadian mica, having garnets and other minerals imbedded in it, were exhibited by Mr. J. A. U. Beaudry.

The President presented a paper, by Dr. G. M. Dawson, on "The Occurrence of Jade in British Columbia," and exhibited several interesting specimens of Jade implements from that locality.

Prof. J. T. Donald then read a paper on "Chemical Notes," wherein he referred particularly to the action of organic matter on iron, and touched upon the value of peat for fuel purposes, as prepared under a new process invented by Mr. Aikman. He also submitted several samples of the prepared fuel.

Sir Wm. Dawson referred to the popular meetings of the Somerville course of lectures, which had been even more interesting than on former occasions, and it was resolved that the thanks of the Society be specially tendered to each of the gentlemen who had contributed to their success.

The sixth monthly meeting was held on Monday, April 25th, Sir Wm. Dawson in the chair.

The minutes of the previous meeting were read and confirmed, when Mr. W. D. Lighthall was nominated to ordinary membership.

The Librarian announced the receipt of several donations to the Library. Prof. Penhallow submitted a biographical sketch of the late Charles Robb.

Dr. J. Baker Edwards, John S. Shearer, Geo. Sumner, A. H. Mason, Prof. Penhallow, A. T. Drummond and W. T. Costigan were appointed a "Field Day Committee" with power to add to their numbers. John S. Shearer, A. T. Drummond and the Recording Secretary, were appointed auditors for the present session.

Prof. Penhallow presented some notes on the Aino which elicited an interesting discussion. Sir Wm. Dawson then presented the outlines of a project, prepared for the Royal Society of Canada, for a union of geological surveys and societies throughout the Empire. This proposition drew forth a number of interesting remarks from several of those present.

The Annual Meeting of the Society was held on Monday, May 30th, the President, Sir Wm. Dawson, in the chair.

The minutes of the last annual meeting and the previous monthly meeting of the Society were read and confirmed.

Mr. Robert Reford and Dean Carmichael were proposed for membership, and under suspension of the rules, these gentlemen and Mr. W. D. Lighthall were duly elected.

In his annual address the President, Sir Wm. Dawson, referred to the good and useful work done by the Society in the past year, in maintaining and increasing its museum; in providing an interesting and instructive course of free lectures in physiological subjects by eminent specialists, and of a character likely to be most beneficial to the large audiences which had assembled to hear them; in the continued publication of the RECORD OF SCIENCE, and in the commencement of a series of observations on underground temperatures. He then referred to fourteen original papers which had been read and discussed at the meetings. Of these five had been geological, the others had related to botany, zoology, ethnology and chemistry, and ten subjects of a general character. These papers had been published in the RECORD OF SCIENCE and constituted an important contribution to scientific progress in this country. They showed that the original work of members had been distributed somewhat generally over the field cultivated by the society. He noticed the contents of these papers, and showed that while adding new facts to our knowledge of nature, several of them were of a very practical and useful character. In concluding this part of his remarks, he thanked the Provincial Government for the aid given to the publication of the RECORD OF SCIENCE, which he characterized as one of the most useful and creditable exponents of Canadian scientific work. He then referred to the movement for an Imperial geological union, which he had explained in one of the meetings of the Society, which had been sanctioned by many of the most eminent men in Great Britain and its dependencies, and had been adopted by the Royal Society of Canada at its recent meeting. He hoped it would form the beginning of a new era in the geological work of Great Britain and her colonies, and through them would prove a great benefit to the scientific progress of the world. The society proposed to begin its new year with an excursion to the Laurentian hills of St. Jerome, and he hoped that this and all its other operations for the ensuing session would be eminently successful, and would be characterized by the same harmony and earnest spirit which had prevailed in the past year.

Mr. John S. Shearer next submitted his report as Chairman of the Council.

Report of Chairman of Council.

The Council of the Natural History Society, in submitting for the consideration of the members of this institution, the Annual Report of the work transacted since the last annual meeting, are pleased to be able to state, that the session just closed has been one of the most successful and instructive in the annals of the Society. Not only has it been one of much valuable research and study, but several features introduced into the proceedings during the course of the year, have tended to give it a popular character that cannot fail in commending it more generally to the public and resulting ultimately in benefit to the Society.

The usual amount of routine business has been regularly performed during the year. The Council has held its monthly meetings to the number of eleven, and there have been six regular meetings of the Society, at which valuable and instructive papers were read.

The progress of the Society, as far as membership is concerned, has been on the whole satisfactory, seventeen new members having been elected during the year.

The Museum has been well patronized, having been visited by a total of eighteen hundred persons. During carnival week, it was thrown open free to visitors, when five hundred and eighty-two availed themselves of the privilege.

The Library has received considerable attention during the year and is in a satisfactory condition. The society suffered the loss of an earnest worker in this connection by the death of Mr. Chas. Robb, who devoted much time to arranging the books with Mr. Beaudry, the chairman. The Council is pleased to be able to acknowledge a donation of valuable books from the Smithsonian Institute of Washington, D.C.

The building of the Society is in good order—further improvements having been made during the year to the ventilation of the hall by the House Committee. The hall has been again leased to Mr. Baynes's congregation for another year, on the same terms as last.

The Council regrets to state that the Provincial Government saw fit last year to reduce the grant from $600 to $400, thus greatly retarding the efforts of the Editing Committee, who, however, are deserving of praise for the manner in which they have issued the Record, notwithstanding much difficulty.

In the early part of the present year, the Council appointed a committee to urge upon the Quebec Government the renewal of the original grant of $1000. A petition was drawn up on behalf of the Society, and forwarded to the Hon. James McShane, Minister of Agriculture and Public Works. In answer to the petition, a telegram has been received from the Hon. Minister, stating that $800 would be given to the Society.

The effort made by the Corresponding Secretary to obtain a grant from the Elizabeth Thompson Science Fund, for the purpose of investigating underground temperatures, has been successful, and the sum of $200 placed in the hands of the Society for that purpose. The Council has appointed a committee to carry out the work.

The Annual Field Day, which has always been looked forward to with great interest by the members and friends of the Society, was held at St. Hilaire, on the 5th June last, and the occasion was one of the utmost success and enjoyment. About 140 ladies and gentlemen, under the direction of the Field Day Committee, visited this beautiful spot. Upon their arrival at the hotel (as is customary on these occasions) the excursionists dispersed in parties, some for botanical and entomological research, others to enjoy the beauties of the lake and the surrounding woods, and a number, among whom where Dean Carmichael, Dr. Harrington and Dr. J. Baker Edwards, ascended to the summit of the mountain. Addresses were delivered on the mountain top, by Dean Carmichael and Dr. Edwards, after which they all returned to the hotel for lunch. About 3 o'clock, the whole party assembled on the veranda, when Dr. Hunt gave an instructive address on the geological history of the mountain and surrounding country, at the close of which Prof. Penhallow awarded the botanical and entomological prizes as follows:—

Named Plants, 1st, Miss Van Horne.
Unnamed " 1st, Miss O. G. Ritchie.
" " 2nd, Miss Burland.
" Insects, 1st, Mr. Albert Holden.
" " 2nd, Miss Maud Brewster.

The following received honorable mention for their collections: Miss McLea, Miss Reid, Master Eric Harrington and Master Herbert W. Shearer.

The Somerville lectures were more than usually interesting this year, and the attendance was very large and much interest manifested. The lectures, six in number, were delivered in the following order:—

Feb. 17—The Bony System, by Francis J. Shepherd, M.D.
" 24—The Muscular System, by Geo. E. Armstrong, M.D.
Mar. 3—The Nervous System, by James Stewart, M.D.
" 10—The Circulatory System, by T. W. Mills, M.A., M.D.
" 17—The Special Senses, by Frank Butler, M.D.
" 25—The Digestive System, by W. H. Hingston, M.D., D.C.L.

The thanks of the Society have been deservedly tendered to the distinguished lecturers who generously gave their valuable time for the advancement of its interests.

A novel and most pleasing event in the proceedings of the year just closed, was the Conversazione given by the members in their hall and museum on the 20th January last. The suggestion when once made, was taken hold of with great earnestness by some of the more active members, and the result was a most enjoyable reunion which was attended, not only by members, but by a number of prominent citizens, and the evening passed off most successfully. The success of the event was largely owing to the excellence of the arrangements, and special praise is due to the

Microscopical Society, Dr. Harrington, Prof. Penhallow, Dr. Johnson, Dr. Barnes, Dr. Edwards, Prof. McLeod, Mr. J. Stevenson Brown, J. A. U. Beaudry, Dr. Wanless and the Electric Light Company, for the great assistance they rendered in making the entertainment a success.

The Council is proud to be able to acknowledge the honor conferred by the British Association for the Advancement of Science, on our esteemed President, Sir J. Wm. Dawson, in electing him to preside over their annual meeting, which took place at Birmingham, and was attended with marked success. The valuable address of the President has been published in the Record of the Society, and well repays perusal.

The Council appointed Mr. J. Bemrose as the representative of the Society, to the annual meeting of the Royal Society of Canada, which took place at Ottawa, on the 25th instant.

The Field Day of the Society will be held this year at St. Jerome, P.Q., on Saturday, the 4th day of June, when it is hoped the members will unite in making it a success.

The Council, in conclusion, ventures to express the hope that the coming year may be marked by increased prosperity and even greater usefulness, and that the members will endeavour to secure for the Society the hearty support to which it is entitled.

Mr. Joseph Bemrose, as special delegate to the Royal Society of Canada, then presented his report.

The report of the Editorial Committee, submitted by Prof. Penhallow, showed a gratifying progress, during the past year, in making the RECORD OF SCIENCE an exponent of original scientific work in Canada, and in extending the list of exchanges, which now embrace a large number of great value.

The Curator, Mr. A. H. Mason, submitted his report on the Museum, as follows:—

CURATOR'S REPORT.

The work of the Museum has continued steadily during the Session, and there is evidence of marked improvement;

the re-arrangement of specimens, lettering of cases, etc., has helped to make it more attractive to visitors, and Mr. Caulfield has rendered valuable service in accomplishing this.

The collection of birds' eggs, which has become scattered and disarranged, it is proposed to collect and arrange for exhibition. Much remains to be done, and it is hoped the Council will make a grant to meet the necessary incidental expenses. The general catalogue of objects in the Museum is in course of compilation, and proofs will be submitted that it may be completed by next session.

The donations during the Session comprise a young harp seal, *Phoca* (Tagophilas) *Greenlandicus,* Fat, presented by the Rev. D. V. Lucas; nest and eggs of the American robin, *Turdus migratorius,* Linn. (taken at Côte St. Antoine), presented by Dr. Wanless; specimen Strophanthus hispidus, presented by Alfred H. Mason; several specimens from the Bahama Islands, comprising one Millepore and several Madrepore corals; several Alcynoid corals; two peculiar crabs; a large, dried rock-lobster; a Strombus gigas, and several other shells of that family, presented by Prof. T. Wesley Mills.

Upwards of 600 visitors to the Carnival availed themselves of the invitation of the Council to visit the Museum. The general public who attended the Somerville Lectures availed themselves of the opportunity to visit the Museum. It is estimated that upwards of 1800 visitors and students have availed themselves of the advantages afforded by the Museum during the past session. Of these, only 100 paid the admission fee of 10c., and 34 parties of three paid 25c., so that the use of the Museum is practically offered free to the majority of visitors. Hence, we appeal to our members and the general public for assistance, by donating specimens and funds to assist in its further development and improvement.

Our collection of British birds and animals could be considerably improved and enlarged, and we would solicit donations of this nature, suggesting the importation of such specimens in the skin, that they may be mounted by our own taxidermist.

The Librarian, Mr. J. A. U. Beaudry, presented a gratifying report of progress made in additions to the library, and in changes which would greatly aid the members in gaining more ready access to the books.

The Treasurer, Mr. P. S. Ross, submitted a financial statement setting forth the liabilities and assets of the Society to date, as shown on the following page.

The following officers were elected for the ensuing year:

President—Sir William Dawson.

Vice-Presidents—Dr. T. Sterry Hunt, Sir Donald A. Smith, J. H. R. Molson, J. H. Joseph, Edward Murphy, Dr. B. J. Harrington, Dr. W. H. Hingston, Dr. J. B. Edwards, Major L. A. H. Latour.

Members of Council—John S. Shearer (Chairman), W. T. Costigan, Joseph Bemrose, Dr. T. W. Mills, Samuel Finlay, A. T. Drummond, J. T. Donald, A. Holden, Rev. Robert Campbell.

Honorary Curator—A. H. Mason.

Honorary Treasurer—P. S. Ross.

Corresponding Secretary—D. P. Penhallow.

Recording Secretary—J. S. Brown.

Library Committee—J. A. U. Beaudry, H. R. Ives, E. P. Chambers, F. B. Caulfield, M. H. Brissette.

Lecture Committee—Dr. B. J. Harrington, P. S. Ross, A. H. Mason, Rev. Robert Campbell, Dr. J. B. Edwards.

Editing Committee—D. P. Penhallow, Dr. Harrington, J. Bemrose, Dr. T. W. Mills, A. T. Drummond, E. Ingersoll.

House Committee—J. S. Shearer, J. A. U. Beaudry, J. H. Joseph.

Membership Committee—J. S. Shearer, S. Finlay, W. T. Costigan, J. S. Brown, P. S. Ross, A. H. Mason, Dr. T. W. Mills.

Annual Field Day, 1887.

The Annual Field Day of the Society was held on Saturday, the fourth of June, the thriving village of St. Jerome having been selected as the place to be visited. This town

NATURAL HISTORY SOCIETY OF MONTREAL.

In account with

PHILIP S. ROSS, Treasurer, 1886-87.

Cr.

By Balance in Treasurer's hands, May 1886		232.44	
" Annual Subscriptions, 1886-87		464.00	
" Rents collected, 1886-87		679.50	
" Government Grant		400.00	
" Field day excursion		48.43	
" Grant for underground temperatures	200.00		
Less expended to date	12.90		
		187.10	
			2011.47

Dr.

To Salaries and Commissions		368 28	
" Taxes and Water		144 55	
" Fuel and Light		209.63	
" Caretaker and Incidental Expenses		180 25	
" Insurance		26.00	
" Printing and Advertising		251.17	
" Furniture and Fixings		67.83	
" Repairs		78.50	
" Museum		44.65	
" Advance to Caretaker		10.00	
" Record of Science	401.98		
Less Advertising	32.00		
		369.98	
" Library	242.79		
Less sale Books & donations	88.68		
		154.11	
			1904.95
Balance due by Treasurer			$106.52

Montreal, 1st May, 1887.

Assets.

Real Estate.		
Land donated by McGill University	2000.00	
Building at Original Cost	10629.87	
Furniture, Busts, etc	250.00	
Library	5760.00	
Contents Museum	5000.00	
Fixings for do	500.00	
Caretaker advance	35.00	
Museum Fees	18.65	
Rent due 1st May	125.00	
Cash on hand	106.52	
		24365.04

Liabilities.

Sommerville Lecture Fund	4000 00	
Life Memberships existing 29	1450.00	
Outstanding accounts sundries	100.00	
Underground temperatures	187.10	
Record of Science	200.00	
Conversazione Deficit	45.00	
		5982.10
Surplus Assets over Liabilities		$18382.94

JOHN S. SHEARER, }
WM. T. COSTIGAN, } Auditors.

Montreal, 1st May, 1887.

is situated at the foot of the Laurentian hills, just where the North River is precipitated over a steep and rocky bed, to the level of the bottom lands in the St. Lawrence valley, about thirty-three miles from Montreal. In the early morning, the weather was dull and threatening, and no doubt kept back many who would otherwise have attended, but one hundred and ten, all told, assembled on the platform at Quebec Gate depot, having either faith in the coming of brighter weather or sufficient courage to face the wet, if rain should come. Among those present were Sir William Dawson, president; Mr. J. S. Shearer, Prof. Penhallow, Dr. J. Baker Edwards, Messrs. Alf. H. Masson, A. Holden, Hollis Shorey, W. T. Costigan, J. H. R. Molson, James Slessor, J. A. Robertson, J. Beattie, J. Gowdie, Chas. Gibb, Messrs. Rolland, De Bellefuille, Dunlop, Archambault, S. C. Dawson, Walter Drake, Rev. J. H. Evans, T. B. Caulfield, R. White, and others.

Under the able management of Conductor Dickson, the excursionists were all on board punctually to time, and the train steamed steadily and rapidly away.

Drawing up at the platform of St. Jerome depot, the naturalists were met by Mr. LeClaire (mayor), Mr. Rolland (*fils*), Mr. T. Davis and Mr. Scott, who welcomed them to the town, and informed them that the various works and mills of the neighborhood would be freely open to the inspection of the party. The beautiful park belonging to the manor, known as the " Domain," was also placed at the disposal of the excursionists. Sir William Dawson then sketched out a programme for the day, as follows:—

Geologists, under the direction of Sir William, to walk to the river and study the geology of the district. Botanists, under command of Prof. Penhallow, assisted in the geological department by Mr. Evans, to ride to the Cascades and there search for specimens. Entomologists to hunt up the Domain. As soon as the above programme was mapped out, the different parties proceeded at once to their assigned hunting grounds. Those for the Cascades (including three-fourths of the party) were provided with buggies, carts, omnibuses, hacks, etc., and, in fact, no two vehicles were alike, and everything that runs on wheels was pressed into the service. The clouds of the morning had by this time rolled by and the heat of the mid-day sun was tempered by a deliciously cool breeze, making a perfect day. The road to the Cascades runs through the main, in fact, *the* street of the town, and the keen eyes of the visitors were quick to notice every point of interest, and they were many, that passed under their view. At the first turn, the Rivière du Nord was seen running close alongside the street, but at a depth of many yards below. At this point, the broad, shallow, rapid-running stream was literally covered, almost choked, with logs in most admirable disorder—crossed, re-crossed and interlaced—as if piled there by the irresistible force of a terrible cyclone. At this point are situated the woollen mills of Mr. Scott, whose motive power is derived from the stream. The street itself is of fair width, and the sidewalks are clean and in good order. The buildings are more picturesque than imposing. few of the houses being more than two stories in height. The leafy verdure of the shade trees, with which the street is liberally supplied, was as grateful to the eye as the refreshing breeze was pleasant to the cheeks of the delighted visitors. Passing the quaint parish church, the bells, ten in number, which are ranged in a row *on the street*, attracted much notice. These bells are destined for churches in parishes settled along the North River under the enterprising guidance of the Curé Labelle. The wooden sidewalk extends for about two miles outside the town proper, and the road is lined with comfortable and picturesque looking wooden cottages, which are mostly as bright and clean as paint and the persistent use of the scrubbing-brush could make them.

The Cascades are about four miles from the railway depôt, and on arrival at this delightful spot the party commenced to scatter. some going to inspect the paper and wood pulp mills situated at the foot of the fall, some seeking out sheltered spots for a mid-day lunch, and some, with all the ardor of enthusiasts, tapping at stones with the heavy geological hammer or digging up strange ferns or roots, or chasing moths or butterflies. The Cascades themselves defy alike description and criticism. Imagine if you can a steep hill of water, seemingly a mile in length, rushing towards you all the time. The whole river is churned into white foam with violent dashing on the picturesque boulders which are strewn with such profusion in the bed. "The white horses of the sea" charging down in one solid body. Word-painting and color-painting equally fail in giving an idea of a scene where the chief impression is that of measureless velocity and irresistible power. Go spend an hour there yourself and acknowledge that spots of picturesque beauty are to be found without travel to foreign lands, or even to great distances in your own. Looking up the stream, the whole scene is as wild and untouched by the hand of man as it was in the days of Jacques Cartier.

The whole party greatly appreciated from different points of view, the eligibility of the ground chosen, and enjoyed themselves to their heart's content in their several ways. In the afternoon, the procession of carriages re-conveyed the botanists to the depot, with baskets lightened of provisions and cold tea, but weighty with samples of minerals, stones and plants intended for competition. It had been decided to offer prizes for certain subjects, and a few minutes spent in canvassing on the outward journey had realized twenty-seven dollars for this purpose. At the depôt, the specimens were turned over to the Committee to be judged, and after careful inspection the prizes were awarded as follows:—

1st, Plants; named specimens; Miss Van Horne.

1st, unnamed specimens; Miss H. Y. Reid.

2nd, do, Master Pearcie Penhallow.

3rd, do, Master Eric Harrington.

1st, Insects; unnamed specimens; Miss Edwards.

2nd, J. F. Hausen.

3rd, Master Walter Adams.

4th, Master Bertie Holden.

Best collection minerals, unnamed: Miss B. B. Evans.

The work of inspection over, Curé Labelle drove his carriage to the edge of the platform and received quite an enthusiatic greeting. At the request of Dr. Baker Edwards, he rose in his carriage and commenced an address in French. "Speak in English, father," said Mr. Scott. "Why, you know very well that I can hardly speak in French," replied the curé, laughingly. "No, you must excuse me that I continue in French." He then proceeded to express how much St. Jerome felt honored by the presence of the distinguished party before him. "The name of Sir William Dawson," he said, "was not only known and honored in Montreal, but in all Canada; farther than that, in the great United States, and farther still, in England and all Europe. They could not but feel gratified at the presence of such a man in their town, and his name as President gave a scientific standing to the society. At college he (the speaker) had not been much grounded in geology, but he had found time to study since, and though his knowledge was limited, it had been practical, and the results might be now seen in various industries established in their thriving and busy little town. Now that communication was being made easier and more rapidly between Montreal and St. Jerome, he hoped more frequently to see their scientific men exploring that district, and felt sure they would there find plenty to repay their research. Speaking for himself and his fellow townsmen, he welcomed Sir William Dawson and his friends with all his heart."

Sir Wm. Dawson made a brief reply, and, alluding to the various works now established at St. Jerome, said he hoped yet to live to see that neighborhood a second Birmingham, and trusted that when Montreal would be a comparatively small place, though useful as a shipping port for the products of the St. Jerome district, in the neighborhood of which were great deposits of iron ores, that they, the inhabitants of St. Jerome, would remember old friendships and not look down too much on Montrealers.

Mr. Burgess, with an able staff of assistants, had fitted up a baggage car as an impromptu dining-room. The car was tastefully decorated, and the long table laid out very prettily; a very plentiful cold collation was served, and the excursionists were invited to partake of the hospitality of the Canadian Pacific Company. Although the quarters were somewhat close, the dexterity of Mr. Burgess's well trained staff enabled every one to obtain a plentiful supply of the good things placed before them, and well earned the encomiums of the pleased guests.

The run back to Montreal was accomplished in remarkably good time, and on arriving, Sir William Dawson requested the excursionists to stay for a few minutes on the platform, while Prof. Penhallow read a short resolution to the following effect:—

"The Natural History Society of Montreal desire to extend their most cordial thanks to Mr. Tuttle and other officers of the Canadian Pacific Railway for the courteous and hospitable treatment received at their hands, all of which has contributed to make this one of the most enjoyable and profitable excursions ever held."

The resolution was seconded by Mr. Shearer and carried by acclamation. Three hearty cheers were given for the C. P. R. and one for Mr. Burgess, and the meeting separated, every one delighted with the day's outing.

At a meeting of the Council held on June 9th, the following resolution was unanimously adopted:—

W. C. VAN HORNE, ESQ.,

Vice-President and General Manager of the C. P. Railway.

DEAR SIR:—

The Natural History Society of Montreal beg to extend to you, and to Mr. L. Tuttle and other officers of your Company, their most cordial thanks for the courtesies extended on the occasion of their recent annual excursion to St. Jerome. In doing so, they are pleased to state that the promptness and efficiency which marked all the arrangements on your part, the considerate and courteous attentions of the various employes, and the most hospitable provision of a bountiful and judiciously selected repast which won the special approbation of the ladies, were all features of the occasion which contributed, in a very large measure, to make the Annual Field Day of this year one of the most profitable and enjoyable in the history of this Society.

THE

CANADIAN RECORD

OF SCIENCE.

VOL. II. OCTOBER, 1887. NO. 8.

The Distribution and Physical and Past-Geological Relations of British North American Plants.

By A. T. Drummond.

(*Continuvd from page* 423.)

It is difficult to resist the thought, that many of the plants thus common to Europe and America have had their point of origin and centre of dispersion on the eastern side of this continent. Many interesting geological questions arise in this connection. America has an older look about it than Europe. Eastern Canada has afforded the earliest traces of the dawn of life on the earth. To come down to later times, the floras of the continent in the later Cretaceous and in the Eocene ages afford the first traces of resemblance to the flora of to-day. Some genera then appeared which have representatives at the present time, though, with rare exceptions, specifically different. The American Eocene flora is found to have a resemblance, not so much to the Eocene of Europe, as to the later Miocene there, as if America were the starting-point of that phase of the vegetation, which, in its later developments, became the flora of to-day on both continents. Again, the first undoubted evidences of the flora of to-day, on any considerable scale, are found in the Leda clays of the Ottawa valley.

The geological structure of Ontario, Quebec and Labrador indicates that much of the areas included within their boundaries has been dry land for vast periods of time prior to the glacial epoch, and that within these areas are the oldest portions of the continent. We can then readily conceive that in tertiary times, this portion of the continent, being even somewhat warmer than now, was the home of vast numbers of the plants of the period. The American species, now represented in Europe, we cannot in Canada trace backward beyond the period of the Leda clays; but it is also clear that none of these identical species have as yet been met with in the tertiary deposits of Europe, nor have any, found in the Leda clays, been as yet observed in the European post-tertiary deposits. Seeing, then, that North-Eastern America, having been for so long a time dry land, has always been an available home for vegetation, that the Upper Cretaceous and the Eocene of America, in the resemblance of their flora to that of northern temperate America of to-day, are older than the European Cretaceous and Eocene, that it is only in later epochs in Europe that the generic identity with North American plants became so very distinctly marked, and that in Europe many of the genera of the Pliocene, identical with those of to-day, have since become extinct, there seems a possible presumption, quite apart from that derivable from their present range, that some of these identical European and American plants may be older in America, and, being chiefly northern temperate in range, may have originated in northern temperate America.

There are other interesting questions in this connection. The rounded or smoothed, often striated, character of the rocks, and the presence of the boulder clay and its accompanying boulders, would, if we admit the action of glaciers in the work, appear to prove the higher altitude of, perhaps all of the Laurentian area in Canada, as well as of considerable portions of adjoining areas. I think it the most reasonable conclusion that the whole of this part of the country was of a similar character to what, speaking generally, British Columbia is at the present day, but on a greater scale,—mountainous and rugged, with everywhere high peaks and deep valleys, with frequent plateaus, and with lines of summits so continuous and so connected as to form extended ranges of mountains,—and that, with a somewhat colder climate, individual glaciers occurred everywhere on these mountains, and in their descent carried with them débris and boulders to the valleys beneath. Some of these glaciers would, as in the Rocky Mountains now, be of comparatively short length, and their action on the rocks beneath them and on the fragments displaced would be correspondingly light; others would, as in Greenland at the present day, be on an immense scale, extending for very many miles, and be often of great thickness. A universal ice cap over the whole country seems to me an untenable hypothesis, whilst a general mountainous character, with high peaks and ranges, down which glaciers would flow, would explain the phenomena met with at the present day, which are properly ascribed to glacial action. Even at this later day, the whole Laurentian country to the north and south of the St. Lawrence is of this rugged, mountainous character, with indications, as at the Thousand Islands at the outlet of Lake Ontario, that at one time there was a much greater elevation than now. In fact, the whole inner country lying between the estuary of the St. Lawrence and Hudson Bay is described by explorers as being of an extremely mountainous character—broken, rugged and impassable, as if the subject of some exceptional convulsion in former ages.

There are some of the phenomena of glacial action in Canada which go far to show that there also have been, subsequent to, but perhaps before the close of, the glacial epoch, extensive areas of depression, more particularly along and south of the Middle and Lower St. Lawrence and up the Ottawa River, and, perhaps contemporaneously, in the lake region, and again, towards probably the close of the glacial epoch, and subsequently, over the vast country east of the Rocky Mountains, now occupied by the prairies, and extending as far as the shores of Lake Winnipeg. The eastern side of this lake, as I have shown in a previous number of this journal, probably formed the eastern coast of a vast inland fresh water sea. There are ample evidences on the prairies of more than one elevation and depression and of the existence of vegetation, during the former. Boulders, some of great size, have been transported immense distances, and this can only be explained by the action of icebergs floating, as at the present day, under the influence of winds and currents. We can even now trace the direction of the currents and of the prevailing winds in those far distant times, as well as of the force which gradually raised the land to its present level. In the great prairie country occupying the southern central portion of Canada, the greatest depression was at the base of the Rocky Mountains, whilst the existence of great boulders there of eastern origin, brought undoubtedly by icebergs, the great areas of sand at and south of the sources of the River Qu'Appelle, and the stretches of sand and the gravel ridges southwest and west of Lake Manitoba, all prove that the winds most prevalent, and probably the currents, were in a direction somewhat south of west. The elevation of the land to its present level was greatest at the Rocky Mountains and least towards Lake Winnipeg, and this has resulted in the flow of great rivers like the Saskatchewan and Qu'Appelle being at the present day in a general easterly direction. The great depth of soil over such a vast area as the north-west prairies, indicates either an immensely longer period during which the mountains and valleys to the northward were the subjects of erosion, or that the process of erosion was of a more severe character than in Ontario and Quebec, or that, in the latter provinces, subsequent depression under the ocean and inland seas has resulted in the carrying away of much of the soil. That there were inter-periods when the land was raised to some extent from beneath the sea, and vegetation appeared upon it, is evidenced by the rings of black vegetable loam which appear in excavations made at Winnipeg for tanks and wells. It does not, however, appear to me necessary to assume that these were milder inter-periods. A northern temperate vegetation was already in Canada, I cannot avoid concluding. There is also some evidence of more than one depression during or after the glacial epoch in the Lower St. Lawrence valley, or of the renewed action of glaciers on the rising of the land there.

The hypothesis of a universal ice cap throughout Canada almost dispels the notion of any phænogamous flora in northern temperate America, or, at least, of any vegetation short of an extremely Arctic type. It assumes the gradual extermination of all northern and middle temperate plants in their native habitats, and the crowding of the species into a very circumscribed area to the southward, presently occupied by the south-temperate vegetation of the continent, of which crowding we have no evidence left, and which is hardly in accordance with existing possibilities. It also assumes the migration of the Arctic flora southward to at least northern temperate countries. Does not, however, the comparatively limited flora of the summits of the White Mountains and other considerable heights in New England and New York, comprising chiefly four or five really arctic and a few sub-arctic and boreal plants, nearly all also found on the coast of the Lower St. Lawrence, of the Gulf of St. Lawrence or of Labrador, show that the true Arctic flora had hardly reached as far south as these points? If, however, as I believe, there were only individual glaciers everywhere over the Laurentian and immediately surrounding country, on the high peaks and mountain ranges of that period, perhaps all of which are at much lower elevations now, it by no means follows that vegetation was entirely driven southward at this time. There could be a cold sufficient to produce glaciers on the mountain sides, and their resultant icebergs where, farther north, these glaciers met the sea, and these icebergs might be found even as far south as the New England States, for the cold Labrador current now existing would, without doubt, have been diverted inward over the then or subsequently depressed New England area; but this cold, and even the added presence of this current, would not preclude the idea of vegetation. Judging from the analogies of to-day in Switzerland, in the Rocky Mountains, and along the Lower St. Lawrence, it would be quite within the range of likelihood that northern temperate and sub-arctic and arctic plants would be found in Canada at this early time, in those places most suited to them, and just as they at this later day occur even alongside of glaciers. Though glaciers may have been near at hand, it does not behoove us to too readily draw conclusions from them as to the climate and surrounding vegetation. There are glaciers in the Rocky Mountains in British Columbia, but they are not associated there with a general arctic climate, nor has the general flora of the mountains an arctic or even sub-arctic aspect. During the deposition of the Leda clays, which took place before, or on, the close of the glacial epoch—for their relative position seems still uncertain—and contemporaneously with the encroachments of the sea far up the St. Lawrence and Ottawa valleys, the vegetation had a northern temperate aspect. The marine fauna around Montreal, near Ottawa, and elsewhere, had, it is true, a northern, almost boreal, look, implying cold sea currents; and the presence of boulders in these great river valleys would indicate that glaciers flowed through or into them at this or an earlier period, or that icebergs had then found their way as far inland as these points. The presence of cold sea currents, or of even icebergs, was not, however, associated with arctic or even sub-arctic plants. In the Leda clays we have such species as *Drosera rotundifolia*, *Potentilla Norvegica*, *P. tridentata*, *P. Canadensis*, *Arctostaphylos uva-ursi*, *Populus balsamifera*, *Thuja occidentalis*, *Potamogeton perfoliatus* and *P. natans*—all species occurring now in the latitude of Montreal, and all but one in the latitude of Lake Ontario.

It does not, then, seem to me difficult to imagine the vast Laurentian country in Canada,—broken and rugged everywhere as it now is, and rising often to very considerable heights—elevated in these distant aud somewhat colder times to far greater heights, forming extensive and numerous lofty mountain ranges everywhere, with successions of invividual peaks, on perhaps all of which ranges and peaks were glaciers. Nothing short of this will explain the results of glacier action, whilst, at the same time, it admits of there being a northern temperate flora in the valleys and on the plateaus, just as we now find occurs, though on a smaller scale and under somewhat different circumstances, in central and southern British Columbia and in Switzerland to-day. The sub-arctic and arctic plants would be on the higher summits and on suitable situations farther north, where the temperature was lower and the summers shorter, or on the lake and sea shores in lower latitudes, where the more equable temperature and cold sea levels would lead them.

The phænogamous plants common to Europe and Canada number 419, and adding to these the horsetails aud ferns, the number is increased to 450. Prof. Asa Gray gives 320 species as the flowering plants common to the Northern United States and Europe. This number, however, presently includes *Lythrum hyssopifolia*, L., *Salicornia fruticosa*, L., *Narthecium ossifragum*, Huds., nine carices and grasses, and *Asplenium ruta-muraria*, none of which have been detected thus far in Canada. This indicates that there are about 112 species, chiefly arctic and sub-arctic, confined, in their American range, to Canada. An analysis of the Canadian species indicates how the following leading orders are represented :—

	Species.		Species.
Ranunculaceæ	18	Scrophulariaceæ	14
Cruciferæ	24	Naidaceæ	15
Caryophyllaceæ	23	Juncaceæ	16
Rosaceæ	19	Cyperaceæ	56
Compositæ	21	Graminæ	40
Ericaceæ	22	Filices	23

The representation of species is very disproportionate to the importance, at this later day, of the orders. The great order Compositæ, which now embraces about 390 species in Canada, has only 21 of these represented in Europe, but this is in partial keeping with the fact that in the preceding Tertiary period, this order does not appear to have been even known. Leguminosæ—also an order of apparently no antiquity—which has 147 species in Canada, includes in these only 6 common to Europe. On the other hand, Caryophyllaceæ, out of 72 species in Canada, has 23 identical with European species, Naidaceæ out of 27 has 15, and Juncaceæ ont of 35 has 16 identical.

These species thus identical in Europe and America are, on the evidence we have, the oldest flora still existing in America. They undoubtedly existed in post-pliocene times, but to account for the migration of the species from one continent to another, it is necessary to have connecting links of land, and, at the same time there, a suitable climate for the distribution of northern-temperate as well as arctic and sub-arctic forms. To find a union of these two conditions, it is requisite to go back to pre-glacial times when a climate warmer than now existed in northern-temperate and arctic America and Europe, and when the relations of land and water in northern-temperate Europe, and possibly arctic America, presented more favourable facilities for migration.

General Causes of Distribution.

The general causes, still in force, which have affected distribution are well known. River, lake, and ocean currents, play their part in every section of the globe, not only in dispersing the seeds of aquatic plants, but also those of land species, which constantly come into connection with the water. Particularly would this be the case in Canada where the water communications are on such an extraordinary scale, both on the coast line and in the interior of the country. Birds form a constant source of distribution, going on for ages past. That seeds and fruits are the especial food of birds, that birds not only traverse great distances in search of food, but large numbers of them have semi-annual migrations, that the peculiar habits of birds lead them into situations where seeds may adhere to their feathers or in mud to their legs and feet, and that great numbers of seeds are for the purpose of diffusion supplied by nature with means of adhesion to objects, whether birds or quadrupeds, with which they are brought into contact—are all of them circumstances, in progress for long centuries past, the one fitting into the other, which have been instrumental in the gradual and wide dispersion of many plants. The popular view of the economic purposes of fruits is that they are provided by nature as food for man and the lower animals. Perhaps an even more immediate purpose in their colour and flavour, is that they may attract birds and quadrupeds—as the colours of flowers do insects—and that the seeds, by being carried great distances in the crops and stomachs of these creatures, should thus have an important means of diffusion.

Wind is, however, the most important factor in distribution. Many plants have their seeds furnished with appendages to be utilized in connection with the wind, and such plants have a generally wider distribution than those not so furnished. The different species of maple, ash and pine, have what might be termed wings attached to their seeds, and these are undoubtedly thus provided that in falling at maturity, the seeds may be carried by the wind beyond the parent tree. The seeds of most of the Compositæ are supplied with plumes or awns which form an important means by which they are distributed, and thus this, in America, most extensive of the phænogamous orders is, though geologically recent, of wide diffusion. Whilst, however, the ordinary winds have their local effects in scattering seeds, it is to hurricanes and tornadoes, and even ordinary high winds, that we must look for the carrying of them to great distances. It is not difficult to suppose that most seeds can be so carried. Where the fruit is heavy, as in the case of the oaks, hickories, walnut, butternut, chestnut, plum and cherries, the range of the species is relatively circumscribed. The seeds of herbaceous plants generally are, however, light, almost feathery, in weight—a circumstance which like the awns and wings provided as appendages to many of them, has been without doubt so arranged by nature that they may be readily distributed at maturity by the wind. The power of the wind as a distributor of the lighter class of seeds has been underrated. The rapidity with which new railroad tracks, extending into newly settled as well as old settled country, have become tenanted, not by plants from the neighborhood but by roving introduced plants, is a striking evidence of the action of winds. Most of these introduced plants, so common in cultivated fields, on roadsides and on compost heaps, as well as on railroad tracks, have seeds relatively light in weight, and provided in many instances with appendages to facilitate their dissemination. In districts where the forests have been burned over, the native plants with which the burned area is soon peopled, are generally of two classes—berry-bearing shrubs, the seeds of which have been deposited by passing birds, and plants like the Epilobium, birch trees and willows, whose seeds have wings or awn attachments, which not only prevent them from too quickly reaching the ground when they fall at maturity, but also afford a better opportunity to the wind to carry them to great distances. And these distances are not to be measured necessarily by an acre lot or by even the breadth of a township. Recent investigation has shown that volcanic dust, forced from a volcano during eruption, may float through the atmosphere for many hundreds of miles before descending. What may not be possible with light seeds when a gale of wind prevails! I can conceive it probable that the seeds of even arctic and sub-arctic, as well as other plants, may have found themselves occasionally by this means carried over great distances to high peaks, mountain ranges and plains, to the southward, where, on finding once more a favorable climate, soil and physical surroundings, they would, each in its appropriate place, germinate and develop. To the same cause would probably be attributable the occurrence, on the White Mountains, of plants like *Geum radiatum* and *Paronychia argyrocoma*, which belong properly to the alpine flora of the mountain ranges far to the southward. The great range of so many sub-arctic and boreal lichens, also found on most high summits in middle and even southern temperate countries, seem to me, likewise, an evidence of the power of the winds in carrying spores to enormous distances.

Many of the special causes which have operated in Canada to influence distribution have been of a physical character—as, ocean currents, the enormous coast line with its peculiar configuration and its effects on climate, the lie of the mountain ranges, the vast stretches of prairie country quite divested of trees, and over a considerable extent of which the annual rain-fall is limited, the breadth and the cooling effects of the immense bodies of fresh water embraced in the inland lakes, and the general prevalence of fogs on the eastern coasts. All of these causes and others will be referred to in detail in their special places.

Divisions of the Flora.

Taking a general view of the whole flora of the Dominion, we can readily distinguish the following groups:—

Canadian Group.—Embracing numerous species very generally distributed over the whole country from the Atlantic to the Pacific, and northward more or less to the limit of growth of trees. They also occur in the Northern United States, but probably the great mass of the individuals of each species is rather in Canada than the United States.

Forest Group.—Comprising numerous species which range more or less from Nova Scotia and New Brunswick to the Rocky Mountains or towards there, but which appear to affect the forest country and to avoid the prairie, unless in those sections where there are extensive bluffs of trees, or in the river valleys. The species of this group do not cross the Rocky Mountains.

Maritime Group.—Species confined to the immediate sea shore, though several of them are also found along the Great Lakes and in the neighbourhood of saline ground farther inland.

Eastern Coast Group.—Comprising plants confined in range to the eastern portions of the Province of Quebec and to the Maritime Provinces of Nova Scotia and New Brunswick, though this large area is more conspicuous by the absence of numerous species common in Ontario and Western Quebec than by the presence of a distinctive flora.

Erie Group.—Including the large number of middle temperate plants found in the south-western peninsula of Ontario, and common to that area and to south-western New York, and to Ohio, Pennsylvania and other Middle States of the Union.

St. Lawrence Group.—Embracing numerous species distributed generally throughout the St. Lawrence valley and lake region, but not ranging west of the wooded country immediately beyond Lake Superior and Lake of the Woods.

Boreal Group.—Including in this those northern species which occur near the shores of the Lower St. Lawrence, around the coasts of Northern Michigan and Lake Superior and north-westward, and in many cases also found on the coasts and among the mountains, of British Columbia. Though intermingling sometimes with them, they are not sub-arctic plants, but generally occur where the deep waters of the sea or lakes or sufficient altitude supply a moderately low temperature.

Ontario Group.—Representing a considerable class having its maximum development in Canada in the Province of Ontario, but also occurring in the eastern and middle sections of the Province of Quebec, and southward in the New England and Middle States.

Prairie Group.—Embracing species familiar more or less over the whole of the prairies of Manitoba and north-westward, but probably limited in range over the dry prairies of the western and south-western sections of Assiniboia.

Western Prairie Group.—Including species belonging to the dry prairies to the west of Manitoba where the rainfall is limited, and extending thence westward almost to the foothills of the Rocky Mountains.

Western Central Group.—Including a very considerable number of species which range from Middle and Southern British Columbia to, more or less, the eastern confines of Manitoba.

Rocky Mountain Group.—Embracing the numerous plants, not alpine, which in our present knowledge of their range are confined to the valleys and foothills of the Rocky Mountains.

British Columbia Group. — Comprehending all those species which are distributed somewhat generally over, and are confined to, the Province of British Columbia

Oregonian Group.—Including under this the more southern plants found in British Columbia, and whose range northward, from Oregon and Washington Territory, has been facilitated by the general direction of the valleys in the Rocky, Selkirk, and other mountain ranges there.

Western Coast Group.—Including in this, not the shore plants, but those species which probably the rain-fall and other causes have confined to the neighbourhood of the coast and the adjoining islands, in British Columbia.

Sub-arctic Group.—Comprising species found on the higher hills and mountains in Eastern Canada and British Columbia, on Anticosti and the northerly coasts of the St. Lawrence estuary, on the more exposed points of Lake Superior and northward, and often intermingling far to the northward with the true arctic species.

Arctic Group.—Comprising a few rare representatives in the Alpine districts of New England, and on the Mingan Islands and Island of Anticosti and neighbouring coasts, but as a rule confined to the high northern coasts of Labrador and Hudson Bay, and to Greenland, the shores of Baffin's Bay, the Arctic islands and Lower Mackenzie River country.

(*To be continued.*)

Invaporation.

By W. L. Goodwin, D. Sc.

Professor of Chemistry and Mineralogy, Queen's University, Kingston.

The experiments noticed in the Record of Science, Vol. II., No. 4, Oct. 1885 (p. 259), have been continued since that date, and new experiments of the same sort are in progress. As explained in the previous notice, the object of these experiments is to determine the relative force with which different soluble substances attract water. The process is the reverse of that of evaporation, water vapour being very slowly condensed from a nearly saturated atmosphere by substances soluble in water. Of course, condensation goes on more and more slowly as the solutions become dilute, so that at length, in some cases, years are required for the completion of the experiment. At present we are working with three salts, viz.: sodium, potassium, and lithium chlorides. In Series A, sodium and potassium chlorides are put in molecular proportions into small glass tubes, which are enclosed in a stoppered bottle along with a third small tube containing a weighed quantity of water. The proportion of water is varied for different experiments. The salts soon deliquesce, the sodium chloride more rapidly than the potassium chloride, and when the proportion of water is small, the water-tube soon becomes dry. It will be interesting to trace the progress of a few experiments of this series. *Experiment I.*, sodium chloride, 1.1672 grm.; potassium chloride, 1.4882 grm.; water, 1.44 grm. After 56 days, the sodium chloride has gained 0.8058 grm. of water, the potassium chloride 0.6292 grm. and the water-tube is dry. After 159 days the sodium chloride is found to have increased its quantity of water at the expense of the potassium chloride, and this process continues, until at the end of 314 days the potassium chloride is very nearly dry. A glance at the following statement will show the progress of invaporation in this case:—

	Days.	Water.	Days.	Water.	Days.	Water.	Days.	Water.	Days.	Water.
Sodium Chloride...1.1672g	56	0.8058	159	1.1978	172	1.2392	314	1.4207	410	1.4183
Potassium " ...1.4882g		0.6292		0.2332		0.1900		0.0072		0.0076

This experiment illustrates the decrease in the rate of invaporation as the solution becomes diluter.

In Experiment 2 of this series the proportion of water is doubled.

Series A., Experiment 2.

	Days.	Water.	Days.	Water.	Days.	Water.	Days.	Water.	Days.	Water.
Sodium Chloride....0.5836	111	0.9516	155	1.1160	276	1.3331	290	1.3386	431	1.3523
Potassium " 0.7441		0.4866		0.3166		0.0991		0.0976		0.0841

The potassium chloride still holds an appreciable quantity of water, and in all probability will continue to do so. Experiment 3, in which the proportion of water is again doubled, is still in progress. After 286 days the water is divided in the ratio of about 5 to 1. In Experiment 4, after 404 days, the salts have divided the water (again doubled) into approximately equal parts. We are watching this and Experiment 5 with considerable interest, and we expect that the latter will show a reversal in the invaporating power of the saline solutions, since very dilute sodium chloride solutions may have less invaporating power than corresponding potassium chloride solutions.

During the past year, we tried a series of invaporation experiments with the so-called "gem" and "crown" jars, hoping that they would be found to be air-tight. Two interesting results followed from experiments with these jars. They were carefully selected from a large stock, but only a small percentage of those selected were found to be air-tight. Of course the slightest leakage alters the conditions of the experiment. In the second place, it was found that the large space enclosed by these jars (large as compared with that enclosed by the narrow tubes and bottles before used) made invaporation exceedingly slow.

Series B is for the purpose of showing the effect of increasing the ratio of sodium chloride. The effect, as seen by comparing Experiment 1 with Experiment 2 of Series A, is twofold, (1) to increase slightly the rate of invaporation by the sodium chloride, and (2) to dry the potassium chloride more completely.

Series C will show the effect of increasing the ratio of potassium chloride. There are indications that potassium chloride cannot be completely dried by means of sodium chloride, but these experiments are still in their first stages.

A single experiment, made for the purpose of bringing to light any causes of variation not taken into account, has proved interesting. Equal quantities of sodium chloride were put into two small tubes and enclosed with water as usual. The invaporation was noted from time to time. Of course, under the same conditions the two quantities of salt, should invaporate at the same rate. As a matter of fact, the two quantities gained water at very nearly the same rate, but, while at first the weight of one tube increased slightly faster, after some time the second tube began to gain weight a little more rapidly than the first. In seeking an explanation of this variation, we noticed that the inside of the first tube was covered with small drops of liquid, while that of the second was dry. This evidently arose from the presence on the former of fine particles of salt exposing a large invaporating surface. Rapid dilution of the salt solution, thus formed, soon destroyed this temporary advantage, and then came into play a second but less marked cause of variation. Tube No. 2 was slightly wider than No. 1, and thus gave a somewhat larger invaporating surface.

"The Plague of Mice" in Nova Scotia and P. E. Island.

By the Rev. George Patterson, D.D., New Glasgow, N. S.

In the early settlement of Nova Scotia and P. E. Island, mention is not infrequently made of mice appearing in such swarms as to become a real plague, entirely destroying the crops of the new settlers over considerable areas. Diereville, a French writer, in a work published in 1699, says: "The Island of St. John (Prince Edward Island) is stated to be visited every seven years by swarms of locusts or field mice alternately—never together. After they ravage the land, they precipitate themselves into the sea." There is no evidence of any such regularity in the visitation of mice, but later writers speak of it as occurring on Prince Edward Island at longer or shorter intervals, and on the main land it has not been unknown. We have, however, authentic information of two instances of the kind, one in Prince Edward Island, in the year 1775, and the other in Nova Scotia, in the year 1815. I do not know that in either case the facts were noted by any scientific observer. It may therefore be of interest, and also render some service to science, to gather up what information we can obtain regarding these rather remarkable events, from men of ordinary intelligence, who were witnesses of them.

The former of these visitations is now only a matter of tradition, but some years ago I conversed with aged persons, who in early years had passed through the troubles of that period, and from them gleaned the following particulars. In the year 1774 a number of families emigrated from Dumfries or its neighbourhood, in the south of Scotland, and commenced a settlement at Georgetown, or Three Rivers, as it was called. They raised some crop that season, and, if my memory serves me right, in autumn they found the mice a little troublesome. But at all events, the next season they swarmed in such numbers as to become a real plague. They consumed all the crop, even the potatoes in the ground. They boldly entered the dwellings of the settlers, and, when they could get no other food, they even gnawed the leather in the binding of books.

The consequence of this was that the settlers were brought to the verge of starvation, and would undoubtedly have perished but for a French settlement at some distance, from which they received supplies of potatoes. What that settlement was, and its distance from the place where they were located, I have not ascertained. But from their being able to save their crop of potatoes at least, I would be disposed to conclude that the mice had not reached them, and that the plague was, therefore, of very limited area. But the French settlement was much older, and had much more land under cultivation, and thus might have saved a part of its crop. Still I believe that the mice could not have been as destructive as where the new-comers were.*

Of the visitation in Eastern Nova Scotia, in 1815, commonly known there as "the year of the mice," we possess fuller information. The Rev. Hugh Graham, then ministering in Stewiacke, thus writes to a friend in Scotland, under date 21st July of that year:

"This last winter was the coldest that ever I saw. The spring was also very cold and late. Appearances are now promising, only the field mice have become so numerous as to threaten the destruction of a great part of the crop. We have not had such a visitation for more than forty years past. They began to multiply last year, and did some damage."

The next year he writes under date, August 1:

"The plague of the mice is so far removed, that there is scarcely a mouse to be seen in house or field, or the woods, where they swarmed. But we feel the effects of it still. The grass, as well as grain, being greatly cut off, the farmers had to sell off a great part of their stock at low prices before winter, to bring their stock to their provender. But the winter was severe, and the spring uncommonly cold and late, which occasioned a great mortality in the remainder of their stock. And now breadstuffs have to be brought from afar, and at a high price, and many are very straitened as to the means."

This is the only contemporary record I possess of this visitation, but some years ago I made enquiries on the subject of persons who remembered it, and recently I have conversed with persons still alive, who though advanced in years are still, from recollection, able to give an intelligent account of it. These all agree in their testimony as to the main facts, and if they vary slightly in the details, these variations represent the differences which existed at different places. From these sources I am able to furnish the following particulars:—

1. *The area of their ravages.*—This included, we may say,

* It is probable that it was from some visitation of this kind that they gave the name Souris to a harbour about twenty-five miles to the North-East.

the whole of the Counties of Antigonish, Pictou and Colchester, and part of the County of Cumberland along the north shore to the north-west, and some small portions of the Counties of Guysborough and Halifax to the south; being a district about 80 miles in length by about an average of 50 miles in breadth, with a superficies of about 4,000 square miles. We may observe that, at this time, settlers had generally occupied the land both along the shores of the Straits of Northumberland on the north, and of the Basin of Minas on the south, and also along the principal rivers for some distance into the interior. But the central portions were still covered with the primeval forest, consisting largely of deciduous trees; and even where settlement was most advanced, the major part of the land was still under wood.

2. *The species.*—All the persons with whom I have conversed in the County of Pictou, agree that the creature by which the mischief was done was what is commonly known as the large, burrowing or short-tailed, field mouse, sometimes called the meadow mouse (*Arvicola riparia*, Ord);[1] but others say that other species were more abundant than usual. Mr. Roderick McKay, of St. Mary's, says that having set a large pot, partially filled with water, and a trap by which they fell into it, he found it in the morning filled with all the species known in the country. Mr. Samuel Waugh, of Tatamagouche, then over 19 years of age, says that there the jumping mouse was also numerous, and manifested its powers of destruction, but not nearly to the same extent as the other. And Dr. J. N. McDonald, who writes the history of Antigonish County, describes it as the meadow mouse, which he calls *Arvicola agrestis*, a term now applied by naturalists to a different species, but he adds

[1] In a paper by Sir Wm. Dawson on the "Species of Arvicola and Meriones, found in Nova Scotia," (Ed. Phil. Journal, 1856), he indicates the species as *A. Pennsylvanica*, Ord. This is, however, regarded by Baird as probably a synomym for *A. riparia.* A smaller Arvicole, *A.* (*Hypudaeus*) *Tupperi*, has been found by Downs, in Nova Scotia, and there are two varieties of *Jaculus Hudsonius*, the jumping mouse. One of them is the variety *Acadicus* of Dawson.—Ed.

that about a month after its appearance a smaller kind appeared, and that then a deadly feud arose in which many of the larger kind were killed. But none of my informants in the County of Pictou know anything of this second species.

3. *Rise and progress of the plague.*—Mr. Graham says that they began to multiply the previous year and did some damage. But in the County of Pictou, my informants generally state that they did not appear in such numbers as to excite notice. Probably in particular places, such as Stewiacke, which was situated, it might be said, in the midst of a large hardwood forest, they appeared sooner than in others.

But toward the end of winter they began to arrest attention. Those engaged in making maple sugar were troubled by their fouling their troughs for gathering sap. At this time, Dr. McDonald says that they were so numerous that a fall of two or three inches of snow was literally packed down by their feet in a short time; and before planting was over, the woods and fields alike swarmed with them. Generally their appearance in the clearings was sudden. One day they might not appear in a field, and the next they might be found in dozens or in hundreds. The seed grain, sown early, generally escaped them, but the later sown and the seed potatoes suffered from them. A story is told of a man who had made a clearing in the woods and carried out a quantity of oats to sow upon it. But on commencing his work they came in such swarms around him, eating the grain as he sowed it, that after continuing a while he threw the whole to them and returned home in disgust.

4. *Their numbers and ravages.*—By midsummer they swarmed everywhere. Every observer speaks of them as being in prodigious numbers—"in millions" was the common expression. In mowing, a cut of the scythe would not be made without killing some. They were bold too, and actually fierce. If pursued, when hard pressed, they would stand at bay, sitting upon their haunches, setting their teeth and squealing viciously. The males fought like little terriers. On passing a field one might hear them squealing

in these contests, and when killed, their skins might be found torn as the result. Boys sometimes caught them and for their amusement set them fighting. They seemed almost amphibious, readily taking to the water, and swimming small streams. An intelligent man on the East River of Pictou, told me that one of the places where they were most abundant was an island in the river, though whether this great increase was the result of migration or of the rapid multiplication of those formerly on the island I am unable to say. Cats, dogs, martens and foxes, gorged themselves upon them to repletion, but with little apparent diminution of their numbers. An old man, then a boy, told me that, where he lived, a cat had kittens in an outhouse, and used to hunt for them at night. In the morning he used to amuse himself counting the number of mice she would bring in, and on one occasion found it over 60. It was noticed that the wild animals became very plenty, but rather I should say were attracted from the woods by the abundance of prey. One man told me that he has seen as many as a dozen foxes on an intervale at one time. On the other hand, the Hon. Samuel Creelman, of Stewiacke, mentioned to me that in that settlement the domestic cats assumed a ferile condition and multiplied so that the next year they became a nuisance. They were so wild that they were a terror to children, and were hunted and killed in great numbers.

The hay crop was much damaged. The mice cut so much of it that lay withered, that the scythe catching upon it, would sometimes slide over the rest without cutting. But it was when the grain began to ripen that their destructiveness became especially manifest. They then attacked it in such numbers that all means were unavailing to arrest their progress. They have been known to cut down an acre in three days, so that whole fields were destroyed in a a short time. The jumping mice would spring at the ear and thus bring it to the ground, but the others were in the habit, as the country people expressed it, of junking it. They would nip a stalk off a little above the ground, and if instead of falling over, the end sank to the ground, leaving it still upright, they would bite it off further up, until it fell over, or the end came within their reach, when they would either devour the grain or draw it to their nests, which were commonly under the roots of stumps. Over acres on acres they left not a stalk standing nor a grain of wheat, to reward the labours of the farmer. Trenches were dug, and when it could be done, filled with water, but they formed only a slight barrier to their ravages. When the grain was consumed, they so far burrowed in the ground as to attack the potatoes.

The result was that while in the older settlements, where the clearings were large, people by great effort managed to save a small part of their crops, in the back settlements and in clearings near the woods, all their crops were destroyed, with the exception of the hay, and that was much damaged.

5. *Their departure.*—As described to me by residents in the county of Pictou, they passed away as rapidly as they came. In the autumn, as the weather became colder, they became languid, scarcely able to crawl. One could trample them under his feet, and finally they died in hundreds, so that they could be gathered in heaps, and their putrefying carcases might be found in some places in such numbers as to taint the air. The reason assigned for this by the common people, was that they had eaten all the grain or other suitable food, and that they had nothing to subsist on but raw potatoes, which proved unwholesome.

But Dr. McDonald says that, after haying, millions of fleas (?) could be seen upon them, and that, to rid themselves of these tormentors, they rushed to the nearest river or pond and were drowned in great numbers. None of my informants in the county of Pictou speak of anything of this kind, but it is commonly reported that at Cape George they took to the salt water and died, their bodies forming a ridge like seaweed along the edge of the sea, and codfish being caught off the coast with carcases in their maws.

At the northwestern part of the district, another cause was assigned as a means of their destruction. Mr. Samuel Waugh, of Tatamagouche, mentioned to me that winter set in early, with one of the most remarkable sleet-storms ever known here. The ground was covered with a sheet of ice perhaps an inch thick. It came so early that the wild geese had not left the north shore. At that time they were in the habit of stopping there for some time. They then passed over to the shores of the Bay of Fundy, where they lingered a few days, and then passed to the southern shore, where they again stopped before taking their final flight to the South. But, on this occasion, they were caught in the sleet-storm when crossing the Cobequid mountains. Their wings became so encrusted with ice that they were unable to fly. Their cries were heard, and settlers, attracted to the place, killed numbers of them. This, or the difficulty of obtaining food in consequence, was regarded by my informant as the cause of the disappearance of the mice. The next year, it was supposed from the same cause, the wild animals were found to be very scarce. However, I have not found any person in the eastern or southern portion of the district who recollects this storm, and perhaps it did not extend that far.

At all events, over nearly the whole district, which one season was ravaged by these creatures, in the next, as Mr. Graham says, scarce a mouse was to be seen. The only exception to this of which I have heard was at the East River of St. Mary's. Here Mr. Roderick McKay informs me that, for several years, they were numerous enough to be troublesome. But it may be observed that there were not more than five families there, who only arrived in the year of the mice, and made the first breach in the magnificent hardwood forests of that region.

6. *Causes.*—I do not intend fully to discuss the causes of these phenomena. All I design is to supply such information as I have obtained which may throw some light on the subject. The Rev. Thomas Trotter, late of Antigonish, arrived in the province in 1818. He had heard the contents of Mr. Graham's letter before leaving Scotland, and was interested in the question. When he arrived, the whole matter was fresh in the minds of the people, and by enquiring into the facts he thought he had arrived at an explanation of the case. He gave me his views, but it is

so long ago that I can only recollect their general purport. According to his report, one season before, I think that of 1813, and perhaps also the one previous, had been extremely favourable for the production of mast. Wild fruit and nuts were in unusual abundance. Then winter set in with a fall of snow which covered the ground before it was frozen, and it remained so covered the whole season. In the woods, therefore, in such circumstances and with such abundance of food, the mice would multiply rapidly. During the summer of 1814, as Mr. Graham says, they began to show themselves, but still they had sufficient food in the forest. That summer, however, did not prove so favourable, so that, with their increased numbers and decreased supply of food, by the spring of 1815 the woods no longer afforded them the means of subsistence, and they were driven to seek it in the clearings. The same cause, namely, "a failure of their ordinary food in the woods," is assigned by Sir W. Dawson, in the paper referred to above. I cannot but think, however, that if, on the one hand, there were such circumstances favourable to their multiplication, on the other, the destruction which had been going on among the fur-bearing animals for some time, must have been removing one of the natural barriers to their increase, and thus helped to produce the result.

At all events, when we consider the fecundity of these creatures, that they produce from five to eight young at a birth, and this at intervals of from one to two months, so that it has been calculated that a single pair might in one year produce 20,000, we need not be surprised that under circumstances favourable for their increase, and with the removal, in any measure, of the checks which Nature has set up against it, they should on occasions appear in such overwhelming numbers.

Other bearings of the subject I must leave to skilled naturalists to consider.

The Rearing of Bears and the Worship of Yoshitsune by the Ainos of Japan.

By D. P. Penhallow, B.Sc., F.R.S.C.
Professor of Botany, McGill University, Montreal.

Griffis,[1] in speaking of the Aino worship says:—"They worship the spirit of Yoshitsune, a Japanese hero, who is supposed to have lived among them in the twelfth century, and who taught them some of the arts of Japanese civilization." This is a statement which one frequently meets with in the modern literature of Japan; and it is also so often met with by those who are resident in northern Japan, that there appears to be some reason for its general currency, more substantial than that of mere fable. Yoshitsune, the son of Yoshituno, was born in 1159, and while yet a babe in his mother's arms, was saved by her from the vengeance of his father's assassins. He lived to become the ideal of chivalrous and knightly valor, to all future generations of those who aspired to military fame. Becoming the leading general in the army of his elder brother Yoritomo, his success in gaining a victory over the Tiara so aroused the jealousy of the latter, that his execution was ordered upon very slender grounds. According to some accounts, after escaping toward the north of Honshiu, Yoshitsune found further escape impossible, and committed hara-kiri. Another account relates that he escaped to the Island of Yeso, where he ruled undisturbed for a time. While yet another version, derived from the Chinese, identifies him with Genghis Khan. It is in connection with the second version that the account of his reign over the Ainos, and the worship of his spirit by them is associated. That there is, therefore, considerable uncertainty as to the actual manner and time of his death is evident, and to those who have studied the Ainos, his worship by them has also always been surrounded by very grave doubts. It is, therefore, a pleasure to produce testimony obtained by Mr. John Batchelor, which seems to throw a great deal of light upon the true nature of the relations existing between this

[1] Mikados Empire, 34.

renowned warrior and the savages of the north. His account, which he has sent to us, is as follows:—

THE WORSHIP OF YOSHITSUNE BY THE AINU.

"It appears to be a generally received opinion among those persons, whether Japanese or foreign, who have written or made any special inquiries respecting the subject, that the Ainu people are in the habit of worshiping the image or spirit of Kurōhonguwan Minamoto no Yoshitsune, who, it will be remembered, was driven to Yezo by his elder brother in the twelfth century of our era. And, indeed, when we call to mind that there is a little shrine upon a cliff at the village of Piratori, containing an idol representing that great personage; that some Ainu residing at and immediately round Piratori itself actually tell inquirers that some few of their number do at times, though not often, worship at the said shrine; and when we note the fact that most, if not all, of the Ainu men recognize the name Yoshitsune, then we see that this generally received and constantly asserted opinion has, apparently, a good degree of foundation in fact. The writer of these lines formerly shared, in common with many others, the generally received views on this subject, but after long residence with the people themselves, having spent many months in the village of Piratori (at, so to speak, the very doors of the shrine in question), he has been obliged to change his opinion, or at least very considerably to modify it, in regard to this as well as many other subjects connected with the Ainu. The following remarks contain a few facts bearing upon this question, and the writer's reasons for believing that the Ainu do not, in the commonly received meaning of the term, actually *worship* either the spirit or image of Kurōhonguwan Minamoto no Yoshitsune.

"In the first place, it must be clearly understood that when persons say the *Ainu* worship Yoshitsune, they mean that people not as a nation, but merely a few individuals resident in the Saru district. Again, the facts are still more narrowed when we make strict inquiries; for it is not even pretended that all the Saru Ainu worship him, but only those of Piratori. Now, there are two Piratoris, viz.: Piratori the upper and Piratori the lower. These two villages were once united, but are now situated from about a quarter to half a mile apart. The shrine of Yoshitsune (and there is but one shrine in Yezo) is at the upper Piratori, and the inhabitants of the lower village will tell an inquirer that it is the people of the upper Piratori who worship the person in question. Now, the upper village contains only about thirty-two huts, and we find that not even ten persons out of these families really worship Yoshitsune. It is clear then that the Ainu, considered as a race or nation, do not at the present day deify that hero.

"Then again, it should be noted that the present shrine is decidedly of Japanese make and pattern: in all respects it is like the general wayside shrines one may see anywhere in Japan. It was built about ten years ago by a Japanese carpenter resident at a place called Sarabuto (Ainu, *San-o-butu*). Previous to this there was also a Japanese-made shrine on the same spot, but a much smaller one. The idol in the shrine is both small and ugly; it is a representation not so much of a god as of a warrior, for it is dressed in armour and is furnished with a pair of fierce-looking, staring eyes and a horribly broad grin; it is just such an idol as one might expect in this case, seeing that Yoshitsune was a warrior. Besides this, the Ainu have treated the image to an *inao* or two. There is nothing more, and the shrine is too small for a person to enter.

"Now, it is a fact not generally known, I believe, that, according to Ainu ideas and usages, it is absolutely necessary to turn to the east in worshipping God (the goddess of fire excepted). Hence, the custom of building all huts with the principal end facing the east. The chief window is placed in the east end of the hut, so that the head of a family may look towards the east when at prayer. It is considered the height of impoliteness and disrespect to look into a hut through the east window. But the shrine of Yoshitsune is placed in such a position that the worshippers would have to sit or stand with their backs to the east. In every other matter (and why not in this also), assuming such a position in prayer would be a great disrespect to the object worshipped.

"The image of Yoshitsune is looked upon from the east, hence, speaking from analogy, it would appear that it is not the Ainu worshipping Yoshitsune, but either Yoshitsune worshipping the Ainu, or the Ainu insulting Yoshitsune; such a conclusion may appear to be somewhat far fetched, but is, when compared with other things, at any rate a logical one. The writer does not intend to say that the Ainu, in the present case (for with them religion is a serious thing), place such a construction upon the form of the shrine, though they dearly like to play upon a person sometimes. All he wishes to remark is, that the position of the shrine of Yoshitsune does not come up to the acknowledged requirements of the Ainu ideas of Deity worship.

"Again, it is said by the people that they would not worship an idol, because it would be directly against the expressed command of *Aioina Kamui*, their reputed ancestor. The Ainu are, in many things, a very conservative people, and in the matter of religion, particularly so. Note the following incident. In the days of the Tokugawa *regime*—so runs the tale—the Ainu were ordered by the Government, or rather by the authorities of Matsumai, to cut their hair Japanese fashion. The result was a great meeting of the Yezo chiefs, which ended in sending off a deputation to beg that the order be countermanded, or at least suffered to lapse. For, say the Ainu, we could not go contrary to the customs of our ancestors without it bringing down upon us the wrath of the gods. And, though a few Ainu, particularly those at Mori, did cut their hair as ordered, the people as a whole were let off. If then a mere change in the fashion of cutting the hair should be such a weighty matter, what would the institution of idol-worship involve?

"But notwithstanding all this, there is still not only the fact of the shrine being at Piratori to be accounted for, but also the fact that some Ainu do tell us tnat Yoshitsune is worshipped by a few of their number, though very seldom. What is the explanation?

"An Ainu himself shall answer the first question. "You know," says he, "we have for a long time been subject to the Japanese Tono Sama and Yakunin; and it has been to our interest that we should try to please them as much as possible so as not to bring down trouble upon ourselves. As we know that Yoshitsune did come among our ancestors, it was thought that nothing would please the officials more than for them to think that we really worship Yoshitsune, who was himself a Japanese. And so it came to pass that the shrine was asked for and obtained." This statement was made to the writer quite spontaneously and confidentially, along with many other matters. Taken by itself, this statement might not be worth much, but viewed with other things of the sort, it speaks volumes. The spirit here unwittingly shown is happily fast dying out, for the Ainu begin to see that there is now but one law for both peoples, and that there is justice obtainable even by them. Nevertheless, the spirit above exemplified has been a real factor in the life and actions of the Ainu people.

"The whole secret of the second question turns upon the meaning of the word worship. The word used by the Ainu is *ongami*, and the meaning is "to bow to," "to salute." The Ainu are delightfully sharp in some things, and this is one of them. An Ainu told me one day, with a most benign grin, reaching almost from ear to ear, that he did *ongami* (salute) Yoshitsune's shrine or idol; but as for (*otta inonno-itak*) praying to that person, neither he nor any one that he knew, did so; and, as regards (*nomi*) the ceremony of offering *inao* or libations of wine to him, both he and many others were always ready to do so providing someone else would find the *saké!* Here, then, is the point; the Ainu do not worship Yoshitsune in the sense of paying him divine honour any more than the people of England worship Lord Beaconsfield; but some Ainu *do* worship him in the sense of honouring him, in the same sense as Lord Beaconsfield is honoured by the members of the Primrose League, only not in anything like the same degree. Some London cabman would be just as pleased to worship Mr. Gladstone by drinking his health, and in the same sense, too, as an Ainu would be to hold libations in honour of Yoshitsune; for after all, the said libations are neither more nor less than a drinking of *saké*. The real god worshipped is the person's own stomach.

"Such then are my reasons for dissenting from the generally received opinion on this subject. On the contrary, I believe that Yoshitsune is merely honoured by the people. And this opinion rests, not upon the argument of question and answer, but upon that together with actual observation and spontaneously given information. It is, indeed, a wonder that the Ainu do not worship him as a god, and perhaps a few of the rising generation may yet do so; but I hope not."

A second point of interest, is that relative to the bringing up of young bears by the Ainos. The bear, which in Yezo closely resembles the cinnamon bear of the Western States, if, indeed, he is not the same species, is an object of worship among these people. Whenever the young can be captured, they are kept in close cages until of a certain age, when they are sacrificed with great ceremony. Every Aino village and hamlet has at least one such cage, and a traveller usually finds them occupied. The belief is common among the Japanese—and it has also been freely accepted by foreigners—that when these bears are captured very young they are nursed by the Aino women as they would their own babes. That such could be the case, has always appeared to the writer as highly improbable, but in view of the difficulty of gaining trustworthy testimony, it has heretofore been impossible to satisfactorily deny the truth of the common assertion. Mr. Batchelor has now brought forward the result of evidence obtained during his residence among these people, and his statements are sufficiently conclusive to justify us in asserting our original opinion. His communication to me is as follows:—

The Rearing of Bears by the Ainu.

"It appears to be thought by many people, both English and American, that the Ainu women are in the habit of bringing up bear cubs at the breast as they do their own children. This opinion has received so much credence because many persons who have written anything about the Ainu race have, for some reason or other, either passed the subject over without even venturing a word of denial or explanation, thereby appearing, at all events, to give assent thereto, or else they have stated it to be fact. But no one —that I am aware of—has ever told us that he has actually seen an Ainu woman nursing a bear's cub, and I for one, shall be very much surprised if ever I hear it has been seen by any foreigner. It is not intended to deny absolutely that bear's cubs have, in a sense, been brought up at the breast, or that they may again be so brought up. But allow me to remark, in behalf of the Ainu, that during five year's sojourn amongst, and almost daily intercourse with them—living with them in their own huts—I have never once witnessed anything of the sort, nor can I find a single Ainu man or woman who has seen the cubs of bears reared by women in the same way as a mother rears her child. The facts appear to have been somewhat over-stated, and it is hoped the following remarks may be received in extenuation of the charge.

"My experience of the rearing of young bears is as follows :—Bears' cubs are very seldom taken so young that they cannot lap water, and when a dish of millet and fish, boiled into a soft pap, is placed before a cub it soon learns to feed itself. They never care to starve for more than a day or two. With those, therefore, that can lap (which is by far the greater proportion), no difficulty is experienced. The only inconvenience with them arises from the great noise they make in crying for their mother. This nuisance is soon cured, for the owner of the cub takes it to his bosom and allows it to sleep with him for a few nights, thus dispelling its fears and loneliness.

"When a cub is taken so young that it cannot even lap its food, it is fed from the hand and mouth, not from the human breast. Sometimes small portions of fish or a little millet (often both mixed) are chewed by a person and thrust little by little into the animal's mouth, and it is thus made to swallow. At other times millet is made into a kind of batter or very thin paste, a mouthful of which is taken by a man or woman and the cub allowed to suck it from the lips, which it will readily do. In fact, it is at first fed in much the same way as boys at home feed young birds. The next step is to teach the animal to lap from the hand, which is also soon accomplished; then it learns to take its food from a wooden tray. This is the general way of rearing bear cubs, and any one who knows how fond bears are of licking things, will readily understand how easy it would be to teach a cub to lap. A very young cub could almost subsist by licking only.

"However, a woman may occasionally be found who is strong-minded enough to take a very young cub—a cub whose eyes are not yet open—to her breast, once a day, for a day or two, but at the same time she feeds it from the hand and mouth in the manner above stated. Such women are very scarce indeed, as is also the occasion for them, for cubs are seldom taken young enough to admit of being so nursed. I have seen the cubs of bears brought up by hand, but have never seen one nursed as a woman nurses a child.

"No doubt the Ainu are low enough in the scale of humanity and have some barbarous manners and customs, but their barbarity has been exaggerated, as their stupidity has been taken too much for granted. Thus, in the case under discussion, it seems to me that the bringing up of bears' cubs at the human breast, should not be called an Ainu custom merely because a few strong-minded women can be found, after a great deal of search, who will take and nurse a cub for a day or two. They are exceptions to the rule."

The results of the communications as above, are of considerable interest as showing that the Ainos are, at least in some respects, of a much higher order than might be inferred from the writings of many, and we cannot but feel that these facts are of considerable ethnological interest, concerning as they do, a most interesting remnant of a people of whom we are just beginning to gain a correct knowledge.

On the Physiology of the Heart of the Snake.

By T. Wesley Mills, M.A., M.D.

Professor of Physiology, McGill University, Montreal.

This paper will furnish an account of a study of the heart of the Snake, as a continuation of a series of papers already published on the cardiac physiology of the cold-blooded animals, including thus far also the Water Tortoise, the Sea Turtle, the Fish, the Alligator, and Menobranchus.

The snakes used belonged to the genus *Tropidonatus,* and the experiments were made during the midwinter of 1886 and 1887. The animals had been without food since their capture in the autumn, but were not apparently in any degree hibernating, the temperature of the apartment in which they were kept being not far from 17° C. They were left in a tank, with fresh water running constantly from a tap, but they were free either to remain in the water or to betake themselves to the dry shelves of the tank, on which they were, in fact, mostly seen coiled up together. The method of study has been that pursued throughout, viz., direct observation, and as a stimulus, the interrupted current supplied by a Du Bois' inductorium, fed by one good-sized Daniell's cell.

The Vagus Nerve.

Comparison of the vagi througout these experiments has established the following conclusions for this animal:—

1. In no case was either vagus without effect on the rhythm of the heart. In every case actual slowing, and with a sufficiently strong current, arrest followed stimulation.

2. In the majority of instances the *right* vagus was more efficient than the left.

3. In a very few cases, both nerves seemed to be almost, if not quite equally, influential over the heart's rate.

In this comparison, then, it appears that the vagi of the snake resemble functionally those of the other cold-blooded animals examined by me.

After Effects of Vagus Stimulations.—These were of the following kinds:—

1. Increased rate of beat, more marked the slower the heart at the time of stimulation,

2. In all cases increased force (working power) of the heart. This was, sometimes, the only effect noticeable.

3. When irregularity of rhythm of either the whole or some part of the heart existed prior to stimulation, this was abolished for a longer or shorter period.

In these respects the heart of the Snake follows those of the other animals referred to above; but none of the effects have been so marked as in the case of the Chelonians, though more certain than in the Fish, so far as my own observations on that animal go.

Mode of arrest and of re-commencement of the cardiac beat.—When the current is too feeble to arrest the whole heart; or when the whole heart is not amenable to its action, as is the case when its nutrition is much impaired, the *auricles* are the first or only parts to stop pulsating. The *sinus venosus* is always the first part to commence to pulsate after vagus arrest, and for several beats the auricles proper may be quiescent, the wave of contraction passing over what I have called the "Sinus extension,"[1] to the ventricle which may respond for some seconds prior to the auricles.

I am inclined to believe that the auricles are not a little dependent for the maintenance of their rhythm on the intracardiac blood pressure, and that this may enter as one factor into the explanation of this phenomenon. At all events, the same takes place in all the poikilothermers I have examined. McWilliam[2] pointed it out for the Eel, and as I indicated in my paper on the Sea Turtle,[3] Gaskell[4] is in error when he states that in the Tortoise an excitation wave cannot travel from the sinus to the ventricle and cause a

[1] "The Rhythm and Innervation of the heart of the Sea Turtle," *Journal of Anat. and Phys.*, vol. xxi.

[2] *Journal of Physiology*, Vol. vi., Nos. 4 and 5.

[3] Op. cit. p. 7.

[4] *Journal of Physiology*, Vol. iii., Nos. 5 and 6.

ventricular contraction independently of a wave of contraction over both parts of the auricle.

Inexcitability of the Sinus and Auricles under vagus stimulation.—One of most interesting results of the recent cardiac studies has been the unexpected demonstration that certain parts of the heart in some animals (the particular region being variable) are, to a greater or less degree, *inexcitable* to direct stimulation when the heart is arrested by vagus influence.

[1]McWilliam has stated that the excitability of the auricle is temporarily abolished in the Eel's heart under vagus stimulation. But this investigator is entirely in error when he affirms that such is not observed in the heart of the Snake, though he is correct as regards the other animals he instances. I have established, by experiments, that *during vagus stimulation, the sinus and auricles of the heart of the Snake do not respond to direct stimulation.* If the heart be at its best, and the stimulating current sufficiently strong, the excitability may be wholly abolished; but with a weaker current, or a less vigorous heart, the effect may be only partial. I have shown that in [2]*Menobranchus* the ventricle is the part of the heart most readily and most profoundly affected by stimulation of the vagus, and that during such stimulation the ventricle is inexcitable. According to [3]McWilliam, in the *Newt*, the sinus, auricles and ventricle, are all inexcitable to direct stimulation during strong inhibition.

These peculiarities and differences show how dangerous it is to *assume* the applicability of the same physiological generalization to animals, even closely related morphologically. This conviction on my part had much to do with my beginning these studies and continuing them on animals of related groups; for I felt satisfied that a systematic comparison would establish differences unsuspected by those accustomed to extend conclusions derived from experiments

[1] Op. cit., p. 226.

[2] *Journal of Physiology*, Vol. vii.

[3] Proceedings of the British Physiological Society, *Journal of Physiology*, Vol. vi.

on one species or even genus of animals to others. A survey of my own series of investigations alone, will amply demonstrate the desirability of such a course as I have pursued, and still more so if taken in connection with the work of other investigators, like McWilliam, who have followed the comparative method to any degree. A great deal of laborious work, without brilliant results, must be done, but I wish to state most emphatically my conviction that it is the only way by which a broad, solid and safe physiology can be produced.

Cardiac Riflexes.

I have noticed in the Snake, as often in the Chelonians, that while the medulla oblongata is intact, the heart may be very irregular, but that upon the destruction of that part, the rhythm at once changes, becoming always regular and often more frequent. The explanation is probably to be sought in the various influences reaching the medulla and passing down the vagi in an animal in an abnormal condition from the circumstances of the experiment. But when stimuli are applied to various parts, as the skin, the viscera, etc., the results are found to be very variable. Apparently there are great individual differences, and not a little depends on the vigour of the animal at the moment of experiment. Much of what has been established for the Chelonians[1] might be repeated for the Snake.

It only remains to note a few peculiar results of special interest in this connection. It sometimes happens in the Frog, and rarely in the Chelonians that the first effect of vagus stimulation is not slowing but acceleration of the beat of the heart. This I have not witnessed in the Snake; but, on one occasion, when reflex inhibition was unusually marked, on placing the electrodes over the lung, the rate was accelerated for 3-4 beats. In my paper on the Fish,[2] it has been pointed out that a certain strength of current

[1] *Journal of Phys.*, Vol. VI.; *Journal of Anat. and Phys.*, Vol. XXI.

[2] Op. Cit. p. 89.

may give rise only to acceleration, or acceleration followed by slowing, when a stronger current caused only decided and prompt inhibition. In such cases the result has followed stimulation of various parts of the body. Similar observations have been made in the Sea-Turtle[1] on stimulation of the surface of the liver. In these cases the nerve mechanism requisite for reflex inhibition was intact, and the brain beyond the medulla destroyed. As the above has been an almost constant result of excitation by the interrupted current of the anus, and above all of the tail in the Fish, it is not possible to explain it in this animal by escape of current on either the main stems or terminal branches of the vagi. Nor do I think this explanation holds for either the Sea-Turtle, or the Snake. The subject has been discussed in my paper on the Alligator.[2] Our knowledge does not seem to be sufficient at present to clear up these cases fully; in the meantime, I add the results in the Snake to those already recorded for other cold-blooded animals.

In the explanation of Marshall Hall's remarkable result on crushing the stomach of the Eel, when cardiac inhibition followed, notwithstanding that the brain and spinal cord had been wholly destroyed, McWilliam[3] holds that Hall's explanation of exhibitory action through the sympathetic system is not valid, and that the result is to be explained by vibratory stimulation of the vagi, owing to the concussion of the blow of the hammer used in crushing the stomach.

With a view of testing the above hypothesis as regards the Snake, in a case in which reflex inhibition was specially well marked, I destroyed the whole brain and then attempted to get cardiac arrest by blows upon the animal with a large forceps, and heavy blows on the table on which the subject of the experiment rested, but with entirely *negative* results. That in the sensitive heart of the fish McWilliam's explanation might, in certain cases, be valid, it is possible to understand; but that they explain either Marshall Hall's experi-

[1] Op. Cit. p. 7.

[2] *Journal of Anat. and Phys.*, Vol. xx., p. 555 *et seq.*

[3] Op. cit., p. 238.

ment or my own results as detailed in my paper on the Alligator and the Fish, I am unable to believe.

When Hall stated his belief that the sympathetic was a channel for influences that may lessen the heart's action, he reached, I believe, a new truth. In my paper on the Terrapin,[1] I called attention, for the first time, to certain peculiar and hitherto unobserved phenomena, that I then felt must lead out to something of importance. If Gaskell's[2] conclusions turn out correct as to the physiological character of certain different kinds of nerve fibres, then my previous statement that "the vagus is a sympathetic with inhibitory fibres; the sympathetic a vagus without these fibres, if indeed it be wholly without them (a point I have suggested previously as not yet to be considered settled),"[3] may be considered the first announcement in distinct form, in a published paper, of a doctrine likely to be soon established on a firm anatomical and physiological basis. But yet it must be admitted that the genius of Marshall Hall was the first to penetrate the darkness. At the time of writing the above, I was unaware of his suggestion as to the influence of the sympathetic over the heart. If it be true that certain fibres running in the sympathetic system have the effect of first increasing metabolic action, thus leading to exalted functional activity followed by exhaustion, then certain results of stimulation pointed out by me in my papers on the Terrapin and the Fish, become clearer, though not, perhaps, fully explained, *e.g.* acceleration followed by slowing on stimulation of various parts of the body, even with the whole brain destroyed.

Faradization of the Heart.—The results of this method of stimulation may be stated somewhat briefly, as, in the main, they correspond with what I have found in the other animals experimented upon. The results vary much with the strength of the current used, but especially with the functional condition of the heart at the time. When

[1] *Journal of Physiology*, vol. vi., p. 271, 283, etc.
[2] *Journal of Physiology*, vol. vii., No. 1.
[3] Op. Cit., p. 383.

at its best, the heart may be arrested on placing the electrodes over either auricle or sinus. When somewhat exhausted, the auricles alone, or but one of them, may be arrested on placing the electrodes over one auricle. Arrest of the sinus is, of course, always followed by stoppage of the rest of the heart.

The behaviour of the ventricle, when thus directly stimulated, differs from that pointed out in the heart of the Sea Turtle.[1] In the Snake, stimulation of the ventricle is never followed by that "intervermiform" action so common in the Sea Turtle, and less frequently seen in the Terrapin. One of the first effects, if the current be not too strong, may be accelerated action; and I believe the ventricle is only arrested by the escape of current on the rest of the heart, so that the ventricular pause is really due to the arrest of the sinus. As after arrest from vagus stimulation, the sinus and ventricle often beat for some time before the auricles begin. The usual paralysis and light colored points, to which allusion has been made in my other papers, are evident in the Snake, though not so marked as in the Chelonians. I see no reason to change the opinion expressed in former papers as to the meaning of these phenomena, nor to doubt that arrest of the heart on direct faridisation is owing to stimulation of the fine terminals of the vagi nerves within the heart's substance.

Independent Cardiac Rhythm.—As in former instances, *ligatures* have been used to separate one part of the heart from another. They are unquestionably much more reliable than clamps or other apparatus. When the ventricle is ligatured off from the rest of the heart, in no case does an independant rhythm arise in it. Notwithstanding the increase in pressure, the parts above continue to beat well, even more vigorously than before. A ligature between the sinus and auricles drawn tightly enough to prevent any wave of contraction passing down over it completely arrests all parts below; and I have in no case seen an independant rhythm arise in these regions of the heart. In short, my experiments have given negative re-

[1] Op. cit.

sults as to a really independant rhythm, and confirm views already expressed in the other papers in which my work has been recorded.

SUMMARY.

1. The investigations recorded in this paper were made in midwinter, on fasting but not hibernating animals.

2. Comparison of the vagi showed that in every instance both nerves were efficient; but usually the right was the most so; in some cases the difference, if actual, was minimal.

3. Stimulation of the vagi, leads to after increased force and frequency of beat, or of the former only, and according to the law[1] of inverse proportion previously announced by the writer.

4 The mode of arrest of the heart is identical with that noted in the Chelonians, Fish, &c.; the same applies to the mode of re-commencement.

5. During vagus arrest the *sinus* and *auricles* are inexcitable.

6. There are certain peculiar cardiac effects not explicable by reference to the vagi nerves alone, but which put the sympathetic system of nerves in a new light.

7. Direct stimulation of the heart confirms results previously noted by the writer for other cold-blooded animals. Arrest is, in all the animals of this class yet examined, owing to stimulation of the terminals of the vagi within the heart's substance.

8. As regards independent cardiac rhythm, the results have been negative.

9. The heart of the Snake, upon the whole, seems to lie physiologically between that of the Frog and that of the Chelonians.

PHYSIOLOGICAL LABORATORY,
McGILL UUIVERSITY,

Montreal, June, 1887.

[1] *Journal of Phys.*, Vol vi., p. 281 *et seq.*

The Freshwater Sponges of Newfoundland.

By A. H. MacKay, B.A., B.Sc.

Principal, Pictou Academy, Nova Scotia, Canada.

In August of 1885, I spent a few weeks in Newfoundland, investigating its natural history and paying particular attention to the fauna and flora of its freshwater lakes. My work was confined nearly entirely to the Avalon peninsula and adjacent portions of the island. I dipped into the ponds and lakes more easily accessible from the line of railway extending from St. John's towards the interior, such, for instance, as Virginia, Quidi Vidi, lakes near Harbor Grace Junction, Lady, Bannerman, Rocky, Carbonear and other lakes and lakelets upon the rocky highlands and near the sea level as far west as Heart's Content, on Trinity Bay. This region is generally considered as of Huronian age, and sponge collections were often limited to those growing in the shallow margins of the lakes on the under sides of splinters of hard, slaty quartzites, or more massive more or less water-worn rock fragments. The dredge, although successful in the collection of other material in some of the lakes, brought no satisfactory specimens of sponges from any considerable depth.

Of the sponges, *Spongilla fragilis*, Leidy, was the most abundant and universal. Then came *S. lacustris* var. *Dawsoni* and *Meyenia fluviatilis*, Carter. Next, the newly discovered Nova Scotian sponges, *Spongilla Mackayi*, Carter, and *Heteromeyenia Pictovensis*, Potts. And lastly, *Tubella Pennsylvanica*, Potts, and the following species:

Encrusting stones in lakelets near Heart's Content, on August 14th, this sponge was found. On a superficial examination, from the presence of small birotules in the flesh, nearly identical with those of *Meyenia Everetti*, Potts, it was thought to be the latter species. But the character of the statoblast or reproductive gemmule, showed it to be quite distinct from any other sponge described. The specimens were referred simultaneously to H. J. Carter, Esq., F.R.S., of England, and E. Potts, Esq., of Philadelphia, who substantially agreed on every point. On account of its birotulate dermal spicules which caused it to approach *M. Everetti*, and a tendency of the spinous processes in some of the statoblast spicules to group themselves towards each end of the shaft and assume a partial birotulate aspect, as shown in the accompanying illustration given by Mr. Potts, he was disposed to classify it as a Meyenia. The non-birotulate character of the great majority of these spicules, and the tangential position of their shafts with respect to the spherical chitinous envelope of the statoblast, seemed, however, more technically to bring it under *Spongilla* as defined by Carter.

But, in *Meyenia acuminata*, Potts, we have an example of birotulate spicules placed tangentially. We have in *Spongilla Terræ Novæ*, at all events, a form closely connecting *Spongilla* and *Meyenia*. It is to be regretted that owing to the distance and generally inaccessible nature of the rocky-ridged, lake-cradling highlands around Trinity Bay, that I have found it impossible to obtain more mature specimens of this species as yet, such as would be collected in October, for instance. Mr. Potts has published a description, which is substantially that given below, in the Proc. Acad. Nat. Sci., Phila., 1886, pages 227-230.

Spongilla Terræ Novæ, *Potts and Carter.*

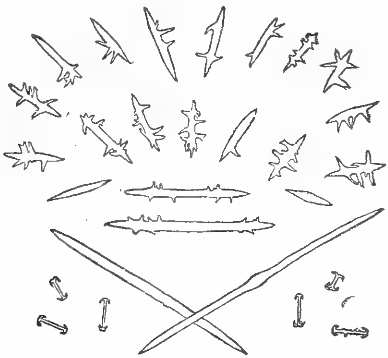
"Sponge encrusting; sarcode of the young growth a dense mass of minute spherical cells, embedding slender, thread-like, curving lines of fasciculated skeletal spicules, developing later into a very loose, open tissue, with few connecting spicules, charged with statoblasts.

"Statoblasts, spherical, rather large, averaging about 0.036 inches in diameter; chitinous coat thin, "crust" apparently wanting; aperture, single, circular, about .0015 inches in diameter.

"Skeletal spicules relatively few, generally smooth, slender and gradually pointed, forming, by overlapping each other linearly, threadlike fascicles; dimensions about 0.0067 by 0.0002.

"Dermal or flesh spicules very abundant, minute birotulates of unequal size, averaging about 0.0007 inches in length; shafts slender. cylindrical, occasionally spined; outer surface of rotules dome shaped; rays prolonged, terminations acute; irregularities frequent. Mixed with occasional linear, spined spicules.

"Spicules upon statoblast fundamentally smooth, robust fusiform, pointed, averaging 0.0015 inches in length, generally having as many as from one to twelve spines unsymmetrically scattered along the shaft, which is placed tangential to the chitinous coat of the statoblast."



SPICULATION OF SPONGILLA TERRÆ NOVÆ, *Potts.*

NOTES ON FOSSIL WOODS FROM THE WESTERN TERRITORIES OF CANADA.

BY SIR WILLIAM DAWSON, F.R.S., &c.

(*Abstract of a Paper read before the Royal Society of Canada.*)

Silicified wood occurs in the country west of Manitoba, in the true Cretaceous beds, in the Laramie and in the Miocene of the Cypress Hills. Consequently the numerous specimens in our collections, picked up loose on the plains, are of little palæontological value, as their sources are uncertain. The author had, however, obtained some specimens found in situ on the Boundary Commission Survey, which were described in the Report of Dr. G. M. Dawson,

1875. More recently, Schroeter had described specimens from the Laramie of the Mackenzie River. A considerable number of specimens from ascertained horizons had now been collected by the parties of the Geological Survey, especially by Dr. G. M. Dawson, Mr. J. B. Tyrrell, and Mr. T. C. Weston; and slices, prepared by the latter, had been submitted to the writer.

The present note on these might be considered as supplementary to previous papers on the fossil plants of the Western Cretaceous. The paper then proceeds to notice the specimens in detail, and to refer them to their probable genera, but as they may have belonged to species already named and described by their leaves and fruits, he thought it unnecessary to give specific names to the new forms, but merely referred to the modern types represented by the several specimens. In this way it appeared that a number of genera of conifers, more especially *Sequoia*, *Taxus*, *Salisburya* and *Thuja*, were present, as well as woods allied to Birch, Poplar, Hickory, Elm, and other familiar forms. Appended to the paper were notices of additional species of plants recently collected in the Belly River and Laramie formations, and concluding remarks on the general bearing of the subject, of which the following is a summary:

While studying the specimens described in this paper, I received the volume of the Palæontographical Society for 1885, containing the conclusion of Mr. Starkie Gardner's description of the Eocene Coniferæ of England. The work which he has been able to do in disentangling the nomenclature of these plants and fixing their geological age, is of the greatest value, and shows how liable the palæobotanist is to fall into error in determining species from imperfect specimens. Our American species no doubt require some revision in this respect.

I have also, while writing out the above notes for publication, received the paper of the same author on the Eocene beds of Ardtun in Mull, and am fully confirmed thereby in the opinion derived from the papers of the Duke of Argyll and the late Prof. E. Forbes,[1] that the Mull beds very

[1] Journal Geol. Socy. of London, Vol. VII.

closely correspond in age with our Laramie. The *Filicites hebridica* of Forbes is our *Onoclea sensibilis.* The species of *Ginkgo, Taxus, Sequoia* and *Glyptostrobus* correspond, and we have now probably found a *Podocarpus* as noted above. The *Platanites Hebridicus* is very near to our great *Platanus nobilis. Corylus Macquarrii* is common to both formations; as well as *Populus arctica* and *P. Richardsoni,* while many of the other exogens are generically the same and very closely allied. These Ardtun beds are regarded by Mr. Gardner as Lower Eocene or a little older than the Gelinden series of Saporta and nearly of the same age with the so-called Miocene of Atane-kerdluk in Greenland. I have ever since 1875, maintained the Lower Eocene age of our Laramie and of the Fort Union Group of the Northwestern United States, and the identity of their flora with that of McKenzie River and Greenland; and it is very satisfactory to find that Mr. Gardner has arrived at similar conclusions with respect to the Eocene of Great Britain.

An important consequence arising from this is, that the period of warm climate which enabled a temperate flora to exist in Greenland was that of the later Cretaceous and early Eocene, rather than, as usually stated, the Miocene. It is also a question admitting of discussion, whether the Eocene flora of latitudes so different as those of Greenland, Mackenzie River, N. W. Canada and the Western States, were strictly contemporaneous, or successive within a long geological period in which climatal changes were gradually proceeding. The latter statement must apply at least to the beginning and close of the period; but the plants themselves have something to say in favour of contemporaneity. The flora of the Laramie is not a tropical but a temperate flora, showing no doubt that a much more equable climate prevailed in the more northern parts of America than at present. But this equability of climate implies the possibility of a great geographical range on the part of plants. Thus it is quite possible, and indeed highly probable, that in the Laramie age, a somewhat uniform flora extended from the Arctic seas through the great central plateau of America far to the south, and in like manner along the western coast of Europe. It is also to be observed that, as Gardner points out, there are some differences indicating a diversity of climate between Greenland and England, and even between Scotland and Ireland and the south of England, and we have similar differences, though not strongly marked, between the Laramie of Northern Canada and that of the United States. When all our beds of this age from the Arctic sea to the 49th parallel have been ransacked for plants, and when the palæobotanists of the United States shall have succeeded in unravelling the confusion which now exists between their Laramie and the Middle Tertiary, the geologist of the future will be able to restore with much certainty the distribution of the vast forests which in the early Eocene covered the now bare plains of interior America. Further, since the break which in Western Europe separates the Flora of the Cretaceous from that of the Eocene does not exist in America, it will then be possible to trace the succession of plants all the way from the Mesozoic Flora of the Queen Charlotte Islands and the Kootanie series described in previous papers in these transactions, up to the close of the Eocene, and to determine for America at least, the manner and conditions under which the Angiospermous flora of the later Cretaceous, succeeded to the Pines and Cycads which characterized the beginning of the Cretaceous period.

Squirrels: their Habits and Intelligence, with Special Reference to Feigning.

By T. Wesley Mills, M.A., M.D., Professor of Physiology, McGill University. With an Appendix by Robt. Bell, M.D., LL.D.

(Abstract of a Paper read before the Royal Society of Canada.)

The writer believes that the comparative method should be applied to the psychology of animals, and in his paper compares the intelligence of the various species of squirrels with each other and with that of other rodents. He thinks the evidence derived from his own studies and the accounts of others, warrants the conclusion that the intelligence of the Flying Squirrel (*Pteromys volucella*) and the Chipmunk (*Tamias striatus*) are about on a par; that the Red Squirrel or Chickaree (*Sciurus hudsonius*) ranks nearly if not quite first; and that, as compared with other rodents, squirrel intelligence is of a high order. The superiority of the Red Squirrel is to be attributed, in part, to his contact with man; and is evidenced by his wide geographical distribution (as pointed out in Dr. Bell's appendix), showing capacity to cope with many and varied conditions. The influence of hibernation on the psychic life of any animal is an interesting enquiry; but, as regards the squirrels, much more information of an accurate kind, in regard to the manner in which these creatures pass the winter, is greatly needed. All species seem to lay up more or less of food for a time of scarcity. It is certainly known that the Chipmunk does hibernate for a portion of the winter, at least; but the real state of the case, as regards the other species of squirrels, has not yet been fully learned. Among the peculiar habits of the squirrels, of special physiological interest, is that of sneezing into the fore-paws when going through the operation of dressing their fur (toilet); it seems to be voluntary, and functionally comparable to clearing the throat in human beings.

Concurrent testimony from widely different quarters has established that, among many different genera of rodents, there is musical capacity both of execution ("song") and, as we must infer, of appreciation. This faculty has been most observed in mice. The writer's investigation into the vocal expression of the Chickaree has revealed a wide range of capacity in expressing the emotions and other psychic states, naturally most marked in excitement. A study of two Chipmunks kept in confinement has enabled the writer to correct some partially erroneous statements of other writers, and has convinced him that while the intelligence of this species, relatively to that of the Red Squirrel, is low, it shows the power to adapt to its surroundings in an intelligent manner beyond what has been supposed.

A large part of the paper is devoted to a critical examination of the various theories relating to *feigning death and injury* by animals, especially in the light of the writer's own study of the Red Squirrel. He believes that the expression, "feigning death," is in a large proportion of cases misleading, the behaviour exhibited being explicable by the influence of fear or other powerful emotion; in other cases, cataleptic influences are to be taken into account. Animals, when in danger, naturally remain quiet from instinct, or a vague perception that it is the best way to escape notice. It is erroneous to assume that an animal forms any abstract idea of death in such cases.

The writer relates in minute detail the histories of cases of feigning injury, etc., in the Chickaree, observed by himself, which show that, in addition to the above noted instinctive behaviour, deliberate feigning was practised in a way which led to successful escape from confinement. The circumstances indicated that there was the clear perception of relations new to the animals, and adaptation of means to accomplish ends. The Chipmunk does not seem to be capable of this, though it appears to become cataleptic from fear sometimes. Experiments with traps had also shown the great superiority of the intelligence of the Chickaree over that of the Chipmunk.

Dr. Bell's appendix deals especially with the Chickaree: its geographical distribution; feeding habits, and intelligence connected therewith; its courage and adaptability to its varying surroundings, etc.

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

This, the thirty-sixth meeting, with Professor Langley as President, was held in the buildings of Columbia College, New York, in August. In numbers and in papers presented, the meeting was at least up to the average. While credit is due to the authorities and teachers of Columbia College, to certain local scientific clubs, to the local committee and some others, for their efforts on behalf of the

Association, New York as a city did not meet expectations. The social element was not as strong as at former meetings, and certainly was not in keeping with what the people of New York are capable of, when they are inclined to be hospitable. Canada was, as regards numbers, somewhat feebly represented; in papers presented, rather strong. Below we give abstracts of most of the Vice-Presidents' addresses, and of that of the retiring President. The next meeting is to be held in Cleveland, under the presidency of J. W. Powell, of Washington.

The Prehistoric Chronology of America.

In Section H (Anthropology) the address given by Vice-President Brinton was "A Review of the Data for the Study of the Prehistoric Chronology of America." He said:

The prehistoric period of America dates back from the discovery of the several parts of the continent; and the problem is to reconstruct the history of the various nations who inhabited both Americas in this period. A review of the means at our command to accomplish this divides them into six classes:

1. *Legendary*—This includes the legends or traditions of the native tribes. These often bear a strong resemblance to Semitic or other oriental myths; but the similarity is a coincidence only, and those writers have been led astray who count it for more. The annals of the Mexicans, of the Mayas of Yucatan and the Quichuas of Peru, carry us scarcely five hundred years before the voyage of Columbus, although the contrary is often stated. The more savage tribes practically remembered nothing more remote than a couple of centuries.

2. *Monumental*—The most famous monuments are the stone buildings of Mexico, Yucatan and Peru. By many, these are assigned an antiquity of thousands of years, but a calm weighing of the testimony, places them all well within our era, and most of them within a few centuries of the discovery. The celebrated remains of Tiahuanuco in Peru are no exception. Much more ancient are some of the

artificial shell heaps along the coast. They contain bones and shells of extinct species in intimate connection with stone implements and pottery. They furnish data to prove that the land was inhabited several thousand years ago.

3. *Industrial*—The industrial activity of man in America may be traced by the remains of his weapons, ornaments and tools, made of stone, bone and shell. In most of the deposits examined, specimens of polished stone and pottery testify to a reasonably developed skill, but in the Trenton gravels and a few other localities, genuine palœolithic remains have been found, putting man in America at a date coeval with the close of the glacial epoch, if not earlier. The vast antiquity of the American race is further proved by the extensive dissemination of maize and tobacco, tropical plants of southern Mexico, which were cultivated in remote ages from the latitude of Canada to that of Patagonia.

4. *Linguistic*—It is believed that there are about 200 radically different languages in North and South America. Such a confusion of tongues could only have arisen in hundreds of centuries. The study of these languages, and of the gradual growth of their dialects, supply valuable data for the ancient history of the Continent.

5. *Physical*—The American race is as distinctively a race by itself as is the African or white race. Although varying in many points, it has a marked fixedness of ethnic anatomy and always has had. The oldest American crania collected from the most ancient quaternary deposits are thoroughly American in type.

6. *Geologic*—As the discovery of implements in glacial deposits located man on this continent, at least at the close of the glacial epoch, this carries his residence here to about 35,000 years ago. But there is no likelihood that he came into being on this continent. He could not have developed from any of the known fossil mammalia which dwelt here. More probably some colonies first migrated along the pre-glacial land-bridge which once connected Northern America with Western Europe. Later others came from Asia. At that time the physical geography of the Northern hemis-

phere was widely different from the present. These various data have been as yet but imperfectly studied; when they shall have received the attention they merit, we may confidently calculate on a large increase in our knowledge of the course of events in ancient America.

Vegetable Parasites and Evolution.

Vice President Farlow in Section F (Biology) discussed "Vegetable Parasites and Evolution." The following is an abstract of his address:

Botanists, as a rule, have contented themselves with considering the ancestral relations of the higher plants only. Hardly any attempt to elaborate a scheme of development for the whole vegetable kingdom has as yet been made. This is due in part to the fact that the older plants, unlike the older animals, have left almost no fossil records. It is my purpose here not to attempt a complete botanical tree of life, but to inquire into the origin of a single group of plants, vegetable parasites.

A parasitic plant is one obliged to obtain its organized material from other plants or from animals. Parasites subsisting on dead matter are called saprophytes; those on living substances true parasites. The mould on bread is a saprophyte; the potato-rot fungus a true parasite. Excepting plants like the Indian pine and dodder, most parasites belong to the fungi.

The parasite is usually destructive to the host on which it lives. As the mould grows, the bread disappears; the decay of the potato is due to the ravages of the potato-rot fungus. There are several cases, however, in which, for the host and parasite, mutual advantages are claimed. Notably among these are lichens, in which the green cells and fungous filaments are said to be reciprocally beneficial. To this mutual relation has been given the name symbiosis. The benefit derived by the fungus is real; that for the alga is at best hypothetical, for the green cells seem to grow more luxuriantly when free from the fungus. A second case of so-called symbiosis is the root-fungus, Mycorhiza, and the trees on which it grows. Frank, who discovered the Mycorhiza, supposed that the fungus conducted all the food from the soil into the roots. However this may be, Hartig has shown that the fungus is not necessary to the tree, and Kamienski claims that it is really harmful. Both lichens and Mycorhiza must be considered cases of true parasitism, not symbiosis. The animals and unicellular algæ offer more promising examples of symbiosis, for here the products of assimilation are such as to render a condition of mutual benefit readily conceivable. Botanists seem to have over-estimated the number of cases of symbiosis, and to have included among them cases of true parasitism.

It is highly probable that vegetable parasites originated at an early epoch from non-parasitic forms. There is reason for believing that the earliest forms of undoubted plants were unicellular and not unlike Protococcus. These once having established themselves, there is no reason why they should not have been quickly followed by colorless, unicellular parasites like Chytridium. The transition from Protococcus to Chytridium is easily effected. As soon as a Protococcus has developed the power of attaching itself to other protococci, lost its chlorophyl and developed means of penetrating the wall of its host, it has assumed all the essentials of a Chytridium. Whether the filamentous and higher parasites have been derived from such chytridiaceous forms is not easy to say. It is, however, perfectly possible.

It seems not unreasonable to suppose that true parasites may have originated at a very remote period from non-parasitic plants; but may not saprophytes first have developed from non-parasitic plants, and then parisites from saprophytes? The question is one not to be answered from actual knowledge; the probabilities seem to favor the view of parasites originating directly from forms like Protococcus.

Still another possibility must be noted. Could not both parasitic and non-parasitic plants have originated simultaneously from a protoplasmic ancestor, neither animal nor plant? The Myxomycetes favor this view. But the Myxomycetes may be animals and, if plants, they have remained in a low condition and have no off-shoot representing higher forms. It is safe to say, however, that the more highly developed parasites have not had their origin in the Myxomycetes; and there is very little to lead us to believe that parasitic and non-parasitic plants were simultaneously developed from primitive protoplasmic structures.

When one regards fungi as a single class of plants, and attempts to trace a clear connection between the highest and lowest members, he finds numerous gaps which cannot well be filled. A general parallel, however, exists between chlorphyll-bearing algæ and fungi, and one is forced to ask whether the order of development has not been from the lowest to the highest algæ, and whether the different groups of fungi have not arisen from different groups of algæ at different periods in the process of evolution. This view seems more in accordance with existing facts than any other.

Economy in the Management of the Soil.

The members of Section I (Economic Science and Statistics) listened to an address by Vice-President H. H. Alvord on "Economy in the Management of the Soil." The following is a partial synopsis:—

The American Association was largely modelled after the British. The section of economic science and statistics was organized at its thirty-first annual meeting. The largest and most important meeting of the section was in Philadelphia, in 1884. The work of the section in the past has included the subjects of education, foods, food-fishes, forestry, and others not classified. The tendency has been toward the many economic problems connected with the material wants of man. Tracing the visible wealth of the country to its source, we find that it has all, with insignificant exceptions, been produced from the soil. Generation after generation has recklessly drawn on the stored fertility of the land, with no systematic effort at restitution. The value of all the possessions of our people, land excepted, does not equal the sum total of three years production of our industries.

For food, clothing, shelter and fuel, we depend almost entirely, directly or indirectly, on the soil. The rapidly increasing demands of our own country are met, and more than met, so far as mere quantity is concerned, for a great surplus is annually sent abroad. For twenty years, agricultural products have constituted three-quarters of all the exports from the United States. And it is manifest that this superabundance of soil products will continue despite all possible increase in population, at least well into the next century. But the wisdom and economy of our present systems of production and disposition is a very different matter. A steady draft continues upon the important elements of fertility, with no adequate system of restitution or recuperation for the soil. Every crop removed from the land diminishes its store of plant food, and this reduces its productive power. The three most important elements of plant food are nitrogen, potash and phosphoric acid. The effect upon the soil depends upon the disposition of the products embodying these. Fortunately very large parts remain upon or are returned to the land; on the other hand, there are vast losses from waste, besides the portions sent to foreign lands.

With our rapidly increasing population and a constantly increasing fertility of soil, we have presented to us questions of the gravest importance. By the wasteful processes prevailing, we are expending our very substance aud daily adding to a burden under which generations to come will stagger. These considerations should increase our regard for the business of farming and our interest in it. We should all rejoice at the revival of agricultural studies and the increasing number of able men who are making them their life's work. Let me cordially invite continued contributions to the proceedings of this section—upon foods, fabrics, forestry, industrial education and other topics closely related to our material welfare.

International Congress of Geologists.

Vice-President Gilbert, in Section E (Geology and Geography) dealt with "The Work of the International Congress of Geologists." His address may be condensed as follows:—

Eleven years ago the Association met at Buffalo. It was the year of the Centennial Exhibition, and we were honored by the presence of a number of European geologists. This naturally opened the subject of the international relations of geology; and the proposition to institute a congress of geogolists of the world took form in the appointment by the Association of an International Committee. The project thus initiated found favor elsewhere, and there resulted an international organization which up to the present time has held three meetings. It convened first at Paris in 1878, then at Bologna in 1881, and at Berlin in 1885. Its next meeting will be held in London next year, and an endeavor will be made to secure for the Uuited States the honor of the fifth meeting. The original committee of the association has been continued with some change of membership, and has sent representatives to each session of the congress.

The work of the congress, as originally conceived and as subsequently undertaken, has for its scope geologic nomenclature and classification, and the conventions of geologic maps. The particular classifications attempted are the establishment of the major divisions used in historic and stratigraphic geology and the subdivision of volcanic rocks. In nomenclature three things are undertaken; first, the determination of the names of historic and stratigraphic divisions; secondly, the formulation of rules for nomenclature in palæontology and mineralogy; and thirdly, the establishment and definition of the taxonomic terms of chronology (period, epoch, etc.,) and of stratigraphy (system, series, etc.) The map conventions most discussed are colors, but all signs for the graphic indications of geologic data are considered. The congress has also undertaken the preparation of a large map of Europe, to be printed in forty-nine sheets. The work accomplished is as follows: Agreement has been reached as to the rank and equivalence of the taxonomic terms employed in chronology and stratigraphy; a set of rules for palæontologic nomenclature has been adopted and many sheets of the map of Europe have been prepared for the engraver. A partial classification of stratified rocks has been agreed to and also a partial scheme of map colors; but the reports of proceedings indicate that action in these matters is tentative, uot final.

The terms and the order adopted by the congress are as follows: Of stratigraphic divisions, that with the highest rank is group, then system, series and stage. The corresponding chronological divisions are era, period, epoch and age. There are propositions before the congress to distinguish the names of individual groups, systems, series and stages by means of terminations. Thus it is proposed by one committee that every name of a group shall end in "ary"—Tertiary, Primary, Archeary; that names of systems shall end in "ic"—Cretacic, Carbonic, Siluric; that names of series shall end in "ian"—Eifelian, Laramian, Trentonian; and that names of stages shall terminate in "in." Another committee has suggested that "ic" be used for stages instead of systems. The adoption of such a plan would enable a writer to indicate the taxonomic rank of a terrane without adding a word for that purpose. Palæontological nomenclature was another point considered by the congress. From one point of view, palæontology is a part of geology, but from another, it is a part of biology. In so far as it names genera and species, it is purely biologic, and it would seem proper that the students of fossils unite with the students of living animals and living plants in the adoption of rules of nomenclature.

No action has yet been taken as to the nomenclature of mineralogy, and action has also been deferred on the classification of eruptive rocks. It is to be hoped that it will be deferred *sine die.* The congress is attacking its two most important undertakings, the classification of terranes and unification of map colors through the geological map of Europe which it is preparing. It is the opinion of many that the smallest unit of such classification should be the stratigraphic system. What is this? The congress implies a definition in saying that a system includes more than a series and less than a group, and that the Jurassic is a system, but this gives only a meagre conception and we need a full one. As the problem of classification demands a true conception of a system, and as there is reason to believe that a false conception is abroad, it is proper that in seeking the true one we begin with the elements.

The surface of the land is constantly degraded by erosion, and the material removed is spread on the floor of the ocean forming a deposit. This process has gone on from the dawn of geologic history, but the positions and boundaries of land and ocean have not remained the same. Crust movements have caused the submergence of land and the emergence of ocean bottom, and these movements have been local and irregular, districts here and there going up while other districts have gone down. The emergence of ocean bottoms exposes the deposits previously made and subjects them to erosions. In transportation from its region of erosion to its place of deposition, detritus is assorted, and so it results that deposits that are simultaneous are not everywhere the same. Many of these variations in deposits are correlate with depth of water and distance from shore, and it results that elevation and subsidence in regions of continuous deposition, produce changes in the nature of the local deposit. If now we direct attention to some limited area, and study its geology, we find that under the operation of these general processes it has acquired a stratigraphical constitution of a complex nature. Its successive terranes are varied in texture. Breaks in the continuity of deposition are marked by unconformities. The fossils at different horizons are different, and when they are examined in order from the lowest to the highest, the rate of change is found to vary, being in places nearly imperceptible and elsewhere abrupt.

It is by means of such features as these—that is, by lithologic changes, by unconformities and by life changes—that the stratigraphic column is classified into groups, systems, series and stages. A system is a great terrane separated from terranes above and below by great unconformities or great life-breaks, or both. Smaller unconformities, smaller life changes and lithologic changes are used for the demarcation of series and stages; and, on the other hand, exceptionally great unconformities and life-breaks are used to mark groups. As the same criteria determine groups, systems and series, differing only in degree, the precise definition of the term system is impossible, and in many cases the grading of a terrane as a group, a system or a series, is largely a matter of convenience.

The Chemistry of Nitrogen.

Vice-President Albert B. Prescott discussed "The Chemistry of Nitrogen as disclosed in the Constitution of the Alkaloids," before Section C (Chemistry). He said in substance:

The character of nitrogen is a challenge to chemical skill. Mocking us by its abundance in its free state, the compounds of this element are so sparingly obtained that they set the rate of value in supplies for the nourishment of life. The agent chosen and trusted for projectile force in arts of war and of peace, yet the manufacture of its most simple and stable compound has been a vain attempt, and it is one urged anew by the chemical industries. Moreover, nitrogen holds the structure of the aniline dyes, and governs the constitution of the vegetable alkaloids. In research, the nearest approaches to the molecule, as a chemical centre, have been reached through organic chemistry. Carbon was the first and hydrogen has been the second element to give to organic chemistry a definition. At present, carbon is looked upon as the member for fixed position, and hydrogen as the member for exchange, in organic families. Nitrogen comes next in turn to receive attention. The study of the carbonaceous compound of nitrogen promises to do for organic chemistry what the latter has done for general science.

The speaker then outlined the history and present state of the structural chemistry of the vegetable alkaloids, as follows:

(1) *Nitrogenous bases as derivatives of ammonia.* It was maintained by Berzelius that the vegetable alkaloids were unions of entire ammonia with organic radicals. In the third decade, Liebig held that these bases were compounds of amidogen, the larger part of ammonia. In 1849,

the French chemist, Wurtz, produced the first chemical derivatives of ammonia by substitution. The names of "methylamine" and "ethylamine" then given by our own Dr. Sterry Hunt, are the names that remain. A. W. Hofmann, who still directs the Berlin laboratory, when in England in 1850, devised means of introducing groups of one or two, or all three atoms of hydrogen, held by the one atom of nitrogen in ammonia. This reaction of Hofmann is of constant and still increasing usefulness, both in research and manufacture. Simply as derivatives of ammonia, however, the structure of vegetable alkaloids has not been revealed.

(2) *Nitrogenous bases represented by aniline.* These artificial alkaloids, extensively produced as color-stuffs from coal-tar materials, are of the so-called "aromatic" constitution, first brought to light by Kekule in 1865. The vegetable alkaloids, when broken up, yield "aromatic" products, but they have not been found actually to possess the "aromatic structure" in any form of it known earlier than 1870.

(3) *The pyridine type in the vegetable alkaloids.* The constitution of the pyridine and quinoline series was ascertained by Koerner and by Baeyer in 1870. These bodies can be obtained from bone-oil and from coal-tar. They are of a remarkable ehemical structure. Like aniline, they have the closed chain of six positions, but, unlike aniline, they have one of these positions held by nitrogen. The introduction of the atom of nitrogen into the closed ring so affects the qualities of the molecule that stable addition products are formed. About 1879 it began to appear that the vegetable alkaloids in general are of the pyridine type, of "aromatic" composition.

In this type the structure of ammonia is not violated; and the theories of Liebeg, Wurtz and Hofmann, are not superseded. Within the last three or four years, the veil has been drawn from the structure of the chief alkaloids of plants. Even before that, the alkaloids of black pepper, tobacco and hemlock, of very simple composition, were studied with success. The alkaloids of the belladonna root, the cinchona bark and the cocoa leaf are now subject to an increasing measure of constructive operation in the laboratory. Morphine is convertible into codeine, and the efforts to convert strychnine into brucine and cinchonine into quinine ought to succeed.

The necessary studies of position in the pyridine molecule are being entered upon. Some good medicinal alkaloids are being made by art. It may come that the identical alkaloids of nature will be made by art. Not by chance efforts, however, nor by premature short-cuts, but, if at all, through the well earned progress of the world's chemistry will these results be gained. And it speaks enough for the rate of this progress to say that one of the very first of the forward steps here recounted was taken by a man still living as a contributor. Due honor for what his hands have done, and all gratitude for what his eyes have seen.

A Decade of Evolution.

In the evening there was a general session in the library to listen to the address of Professor Morse, the retiring president of the association. It was undeniably warm, but every seat had been taken, and there were not a few who listened standing. The speaker began by explaining how he had become engaged in the effort to collate the work that had been done by Americans toward the illustration of evolution during the last ten years. He first quoted the testimony among American naturalists to the derivative theory of those who had written about birds, and said that every principle claimed by Darwin had been illustrated by these little things. Dr. Brewer's work upon nesting was touched upon. O. P. Hay was quoted as authority for the fact that red-headed woodpeckers had taken to hoarding—storing up acorns which had worms in them, and fattening, so to speak, their future food.

Then the speaker glanced from birds to insects, and claimed that there was remarkable individuality in them. Some were superior, some inferior. E. G. Peckham established clearly that wasps could distinguish between colors, and had some amount of memory. Another observer was quoted as authority for an instance of remarkable reasoning power on the part of a hornet that had captured a locust under difficult circumstances, but managed by much ingenuity to fly off with its victim in triumph. The general deduction was that insects were not to be considered as automata acting by instinct, but reasoning creatures, having likes and dislikes of their own, and solving problems presented to them by the exercise of intellectual faculties. He continued his defence of Darwinianism by stating that the missing links which the public so hungrily demanded were being found on every hand. He quoted the emphatic words of Professor Cope, uttered in 1874, and said that in his magnificent collection at Philadelphia he had many fossils that were clearly intermediate. Some brachiopods were singularly favorable specimens, and some gasteropods were nearly equally so. Dr. Putnam and Dr. Scudder were brought forward as authorities for the interesting fact that insects in the palæozoic age were intermediate in some features, particularly their eyes.

Since 1876 Professor Marsh and Professor Cope had published remarkable works upon extinct vertebrate life. Professor Marsh demonstrated that the brains of early mammals were remarkably small, in spite of the huge size of their owners. It was not strange that they were succeeded after the next geologic age by smaller animals with larger brains. The *Dinocerta* were typical creatures for their bulk and smallness of brain, and it might well be that they were too sluggish and too stupid to protect their offspring. Professor John Fiske had advanced a similar argument with regard to the disappearance *in toto* of the early races of mankind. Another observer had pointed out the reptilian character of the *Monotremata* of Australia, obviously a class of intermediate creatures that had survived from a prior geologic age, and were anachronisms to-day.

The speaker's next statement was concerning a creature with a rudimentary third eye; and he observed that no sooner had Dr. Thomas Dwight, in his attack upon Darwinism, limited possible vision in vertebrates to two eyes, than this trioptic creature was discovered. His next argument was drawn from the modifications of the legs of crustaceans, particularly decapods. Then he considered the work of a writer who had examined into the ill-effects, physically, which had resulted from man's deserting the posture of his quadrumanous ancestors and assuming an erect attitude. This author advanced a curious series of facts concerning the valves of men's veins, and specially concerning those veins where there are no valves. In an erect posture this absence of valves is detrimental, but in the ancestral attitude of the mammal man, it was a matter of no moment.

Professor Morse's address was so replete with statements of fact, that the above must be considered a very imperfect and fragmentary account of it; indeed he was obliged to omit in the reading much of what he had written.

Reviews and Book Notices.

The Geology of England and Wales; second edition, by Horace B. Woodward, F.G.S.

This is a new edition of a well-known book, which has for many years been in the hands of all working English geologists, and of those abroad interested in making comparisons with the geology of England.

The present edition is considerably enlarged, and gives a fair account of the recent changes in the nomenclature and classification of English rocks, and which are especially important in the older formations. England is not rich in Eozoic or "Archæan" rocks, and from the occurrence of these in limited areas and with indifferent exposures, there is still some controversy about their nature and arrangement. It is perhaps to be regretted that Dr. Hicks, who has endeavoured to establish these older formations, had not at once boldly called his "Dimetian" Laurentian, and his "Pebidian" Huronian. There can be little doubt that they are the equivalents of the rocks so named by Logan, and to have accepted the names already given might have tended to avoid controversy. The author accepts Sedgwick's term Cambrian for the next rocks in succession, calling the Longmynd and Menebian Lower Cambrian, and leaving us to choose whether we shall call the Lingula Flags and Tremadoc Series Middle or Upper Cambrian. So, in like manner, he seems to leave us to choose as to whether the Ordovician Series of Lapworth shall be called Upper Cambrian or Lower Silurian, or neither. This is no doubt intended to conciliate opposing geological factions; but it tends to obscure the grand general fact that the rocks from the Longmynd to the Lower Tremadoc, inclusive, hold what Barrande has called the *Primordial* fauna, while the rocks from the Arisaig to the top of the Caradoc, hold the *Second* Palæozoic fauna. This is the real distinction. Both the Cambrian and the Ordovician vary greatly in mineral character, even within the limits of England, but they differ in their fossil contents just as the latter does from the the proper Silurian above it.

This leads to the remark that the book is almost entirely stratigraphical, and gives little information as to fossils. There are, it is true, lists of names, but nothing more, and in this respect the work forms a remarkable contrast to Murchison's Siluria or to Phillip's geology of Oxford. It is in accordance with this neglect of fossils that a little further on we find the term "New Red Sandstone" retained for the Permian and Trias, and the former associated with the Mesozoic. It is no doubt sometimes difficult locally to separate them, but the natural arrangement is undoubtedly to place the Permian in the Upper Palæozoic, and the Trias in the Lower Mesozoic.

As is natural in the Geology of England, a large proportion of the book is devoted to the Mesozoic and older Tertiary, and a very clear and connected account of these beds is given. The Pleistocene and its glacial period come in for somewhat extended consideration, and the various complexities which they present in England, are freely discussed. He appears to admit the following changes:—

1. A period of elevated land and cold immediately after the Pliocene (earliest boulder clay).

2. A period of submergence (shells—sands of Moel Tryphaen, &c).

3. A second period of elevation with glaciers and variable climatal conditions, followed by partial submergence.

4. Modern conditions with early elevation and subsequent slight depression of land.

With the exception of a probably exaggerated value attached to No. 1 of the above table, it is not very remote from the general sequence which we obtain on the wider area of North America.

The book is accompanied by a good geological map, and is altogether a most valuable book of reference to the working geologist, whether in England or abroad.

A NATURALIST'S RAMBLES ABOUT HOME; second edition, revised, pp. 485, New York, D. Appleton & Co., 1887.

UPLAND AND MEADOW, pp. 389, New York, Harper & Brothers, 1886.

WASTE-LAND WANDERINGS, pp. 312, New York, Harper & Brothers, 1887.

All of the above works are from the pen of Dr. Chas. C. Abbott, of Trenton, N. J., and are so related in style and matter that they may be reviewed together.

They recount Dr. Abbott's experiences in an ordinary tract of country, no bettter provided by nature than thousands of others; and yet, it seems to have furnished to him themes that at once absorbed his own interest, and in the relation of which he charms the reader, who has any love for nature, into a kind of spell. And what is the real secret of the fascination of these works? We think it lies in the fact that the author has taken Nature's children to his own bosom; he has loved them, and they have, therefore, not refused to give up their secrets, and in such case they never will. What Dr. Abbott has learned, others can learn if they will pursue the same methods. It may be that all may not be able to pour out, in such an artless yet charming manner, what they wish to convey.

No better books than these can be put into the hands of young people. The person that cannot see anything to love in natural objects in his own surroundings after perusing such books, is hopeless. They give what ordinary works, on natural history, fail to do: the methods, step by step, by which the author's knowledge was reached, so that the reader feels stimulated to pursue the same plan; and thus the indirect value of such works becomes far greater than the direct.

We would emphasize another matter. Dr. Abbott's *experiments*, though apparently simple, and in reality simple, are just the kind that in our opinion, are most reliable. He arranged to see animals act under conditions perfectly natural. Such constitutes the very essence of trustworthy experiment. Inferences, under such circumstances, are absolutely reliable, which is more than can often be said of methods more complicated.

The moral effect of such reading is of the best. It makes one feel that there is more in the world to admire than man and his works; and that man is himself but a part of a harmonious whole, though it is his fortune to be at the top.

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