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ARE THE GREAT LAKES RETAINING THEIR ANCIENT LEVEL?

By Staff Commander J. G. BOULTON, R.N.

(Read before the Association of Dominion Land Surveyors at Ottawa, 16th February, 1892, and now published for the first time.)

This question is not easy to answer definitely, from past experience, because, as far as I am aware, there are no continuous records of the movements of lake waters farther back than thirty years. During this period careful records have been kept, and the question would have been better put in this form: Are the great lakes likely to maintain the mean level of the last thirty years? Or it might be put thus: Have we any reason to fear that the lakes are being slowly but surely drained? I was led to make a few remarks on this subject because of the unprecedently low stage of water at the present time on all the lakes excepting Lake Superior. I have no theory to propound as to the future movement of the lake waters. My object has been simply to collect and give the Association what information I can upon the present and past condition of the inland seas, and invite opinions on the likelihood of their future movements.

Many of the members here present have read of the anxieties of shipowners and vessel captains about the low stage of water last year, and there is little wonder at their alarm when official records kept by the United States Government show that before the close of navigation in 1891 the water in Lake Huron was 3½ feet lower than the level in June, 1886.

What no doubt increases the alarm is that this is not a sudden dip, but a steady fall of half a foot a year since 1886. The members of this Association know sufficient of marine matters to understand how seriously this action of the water may have affected the earnings of the splendid 3000-ton steamers belonging to the States, trading from Lake Erie to Lake Superior, built in 1886, when the water had stood at a high and apparently permanent level for four years. Vessels which when loaded were drawing all the water the canals and artificial channels could give them in the high stage of 1882 to 1886, found on their last trips in the fall of last year 3½ feet less water; that is, if they made the trips at all; which they could only do with half a cargo. To these men, to Canadian shipowners, and to lake commerce generally, the question of the maintenance of the lake level is a very important matter.

From records of the rain and snowfall kindly furnished me by Charles Carpmael, Esq., it appears that the diminished quantity of precipitation since 1886 is nearly equivalent to the amount the water has fallen below the mean level since that date.

In Lake Superior the rainfall has been normal, and the level has not lowered like that of the other lakes. Those well versed in the subject of forestry will be able to say whether the clearing of the woods by fire and axe is likely to cause a permanent diminution of rain and snow.

Evaporation plays an important part in the lowering of the level of the lakes, no doubt, not merely from the sun's rays (which in the course of the survey my officers and myself had reason to feel hot enough at times), but by the dry westerly winds accompanying a bright sky, and blowing with great force and evaporating effect when forming the dry rear semicircle of the revolving storms which pass over the lakes. An alteration in the meteorological conditions to cause for a period a preponderance of these winds in duration and force would, no doubt, have a marked effect on the water of the lakes.

The Welland Canal is an additional outlet for Lake Erie, the Sault Canal for Lake Superior, the lower canals for the River St. Lawrence, and the deepening of St. Clair River for Lake Huron. But I leave it to hydraulic engineers to calculate the additional quantity of water carried off in this artificial way.

Another interesting calculation would be the wearing effect of continual running water at the various rapid outlets. It is possible the rocky outlets of these lakes are wearing deeper by this natural means.

It is not necessary to say much about the reported subterranean passage from Lake Huron to the Gulf of St. Lawrence, because, if it exist, it is probably of very ancient origin, and may be considered a constant factor affecting equally both sides of the equation, the future and the past.

Should any member of the Society have made a survey of this passage at any time, a few words from him about it might be interesting. This tradition has some value, however, on account of its being handed down by seamen whose veracity on all matters maritime has *never yet been impugned.*

In 1838 there seems to have been the highest stage of water of which we have any authentic record. This high water has been used by the United States authorities as the plane of reference for the soundings on their charts, and for the records of the oscillations to which I have alluded.

From 1859 to 1887 the mean water-surface of Lake Ontario was 2·1 feet below the high water of 1838. There has been, on the whole, a gradual fall from 1859 to 1872, and a similar rise to 1888. I have not the records from 1888 to date, but have reason to believe the fall has been similar to that in Lakes Huron and Michigan, for which there are records to the end of last year. In Lake Ontario during this period of twenty-eight years the water has fluctuated from 18 inches above to the same distance below the mean level for that period. The relationship between the rainfall and the stage of water in this lake, however, is not very apparent. The range of the yearly rise and fall is greater in this than in any of the other lakes, having been as much as 4 feet in 1867; the highest water taking place in May and the lowest in mid-winter.

In Lake Erie the mean level from 1859 to 1887 was 2 feet below the high water of 1838. Although the records are not printed to date there is every reason to believe that since 1887 the water in this lake has fallen similarly to that of Lake Huron, of which we have records. There has a been a gradual fall from 1859 to 1872, and a corresponding rise to 1887, but not so marked as in Lake Ontario. The fluctuations on either side of the mean line have not been so great as in Lake Ontario, nor has the yearly range exceeded 1¾ feet, excepting twice.

For Lakes Huron and Michigan the mean level from 1859 to 1887 was 2·8 feet below the high water of 1838. There was a period of low water from 1864 to 1869; again in 1872-73, also in 1879 and 1880. The water then rose steadily to 1886, and has fallen over 3 feet since, or to 1½ feet below the mean level of 1859 to 1889. The average yearly fluctuation is about 15 inches. In those two lakes the periods of high water have been attended by copious rainfalls, and *vice versa*.

For Lake Superior the mean level from 1859 to 1887 is given as 3 feet below the high water of 1838, and this level has been maintained very steadily to the present time. The relationship of the lake level to the rainfall is not very evident here. The yearly fall and rise is about one foot.

In all the lakes, excepting Lake Superior, the period from 1881 to 1886 was attended by high water, its level during the principal summer months having been 1 foot higher than the mean from 1859 to 1887. This period was sufficiently long for men who had not studied the previously recorded movements of the waters to conclude that this stage of water was the normal condition, and it quite accounts for the alarm of the shipowners and masters, who have had unpleasant reminders by the grounding of their vessels that the water has been steadily falling half a foot yearly since 1886.

The water in Lake Ontario attains its maximum in May, in Lake Erie in June, in Lakes Huron and Michigan in July and August, and in Lake Superior in August and September.

This rapid fall of the water since 1886 was very noticeable in the steep shores of the vicinity of Parry Sound last year, the rocks being void of vegetation and stained black from 2 to 2½ feet above the level of the present water.

Admiral Bayfield in 1820 shows two clean granite rocks just level with the water in that year. In 1887 these two rocks were in the same condition.

Gen. Poe, U. S. A., the best authority probably on the hydrography of the inland seas, says in a letter to me: "I cannot believe that the unprecedently low water in Lake Huron will continue, but think the level will come up again as soon as the precipitation becomes normal. For four or five years in succession the precipitation in the basins of the lakes eastward of Lake Superior has been below the mean, a fact which sufficiently explains the low stage we now have. Still I am further of the opinion that the surface of the lakes has been at some time at a considerably lower level than that of which we have any record, and it is possible that the subsidence may continue till that lower level is reached. That is, evidence exists to show that we are now in the highest state of a series of fluctuations which have long periods, probably a century or two."

Mr. Carpmael, the director of the Meteorological Observatory at Toronto, says: "As to whether the recent deficiency in rainfall is likely to be permanent, is a question of great difficulty. It seems not unlikely, to a limited extent, the recent deficiency may be owing to the diminution of the forests."

Geological Notes.

By Sir J. William Dawson, LL.D., F.R.S.

The following notes, made in my recent sojourn in the South, may be of interest to some readers of the Record:

I.—*The Classification of the Oldest Rocks.*

Much controversy has raged over the age and arrangement of the older rocks of the Scottish Highlands; and ever since I had an opportunity to talk over the subject with my old friend and fellow-student, Prof. Nicol, of Aberdeen, I have felt that the matter was not in a position for a detailed comparison of these rocks with the clearly defined series worked out by Logan in Canada. Quite recently, however, I have read in the new American "Journal of Geology," an article by the distinguished head of the Geological Survey of Great Britain, in which he gives, avowedly for the benefit of those "engaged in the study of the oldest rocks of North America," a summary of the latest conclusions on the subject. From this I deduce the following general statements:

1. The older group of the Highlands is not the whole of the Lewisan group of Murchison, the Laurentian of Logan, but only the lower part of it—the Ottawa group of the Canadian Survey, and this holding probably a larger proportion of intrusive igneous matter than is usual in Canada. He mentions, however, certain rocks of Loch Maree in Ross-shire which, so far as mineral characters go, may represent a portion of the Upper Member of the Laurentian. No doubt when he has time to examine the Western Islands he will find there the Upper or Grenville series as well; so at least specimens from these islands would seem to indicate. I may mention here that recent examinations by Dr. F. D. Adams seem to have confirmed the conclusion that the Upper Laurentian of Logan is mainly composed of igneous material erupted in the latter part of the Lanrentian period, so that in the typical Ottawa region only two bedded members exist, the Ottawa group and the Grenville

series. Whether any of the series of crystalline bedded rocks associated with the typical Lower Laurentian west of Lake Superior and in New Brunswick represent in time these eruptive masses of Anothosite remains as yet uncertain though it seems plain that some of them belong to the seemingly long interval between the Laurentian and the Huronian. For the present, however, the Middle Laurentian or Grenville series may in the Ottawa district be regarded as the Upper Laurentian.

2. The Torridonian sandstones and associated beds in Scotland seem to occupy a position corresponding to that of the Huronian in Canada, and resemble them in mineral character and in the few fossils which they contain.

3. The so-called Dalradian series in Scotland is apparently of uncertain age; but in Ireland it would seem that a similar series holds conglomerates with pebbles of the older gneiss, precisely as the Canadian slate conglomerate does. This also may represent the Huronian or the series approaching to it in age or constituting the upper part which Hunt has named Taconian.

4. The Uriconian and Longmyndian of England and Wales may also, as Geikie suggests, be in part Huronian, or equivalents of the Scottish Dalradian. Specimens of these rocks which I have studied leave the impression that lithologically they may admit of this reference.

5. There remains, however, much probability that equivalents of the remarkable Kewenian series of North America may be included in the latter formations; in which case as in Canada, they may admit of distinct separation as an Upper Huronian or possibly as a downward extension of the Basal Cambrian.

6. It is evident that in Great Britain, as in Canada, the Laurentian rocks had been elevated into land before the Huronian period; and that the latter with the Kewenian constitute littoral formations of coarse clastic material and volcanic ejections following the lines of the old Laurentian coast and constituting the oldest members of those great sedimentary formations which reach upward continuously

through the Palæozoic Period. In Canada they extend in patches along the coast line of the old Laurentian continent and stretch inward into its bays and inlets. The account given of them by Logan and Murray in the Geology of Canada under the names Lower and Upper copper-bearing series is in many respects the best up to the present time, as I can testify from personal examination of portions of the ground.

It may be remarked here that in Canada, though the Laurentian beds are much folded and contorted, they are comparatively little affected by faults or over-thrusts ; and the succession is often extremely clear, while the outcrops of individual beds can be traced over great distances. This applies especially to the Upper or Grenville series, holding the great limestones and beds of graphite and magnetite, and the serpentinous limestone containing Eozoon.

The simple arrangement of the infra Cambrian rocks as Kewenian, Huronian and Laurentian is further vindicated by Walcott's section in the Colorado Canyon, which shows only these superimposed but unconformable. The lowest member is a granitic rock probably equivalent to the Fundamental Gneiss. Walcott has found in the upper part of the infra Cambrian an obscure Discina-like or Stenotheca-like shell and a fragment resembling the cheek of a small Trilobite. Still lower are the stromatoporoid masses of supposed *Cryptozoum*. Some specimens of this recently sliced show distinct traces of structure similar to that of Hall's typical species of Cryptozoum.

In the second number of the "Journal of Geology," Van Hise sums up what is known of the older rocks of Lake Superior and divides them into what he calls "Basement Complex," equivalent to the Lower Laurentian of Logan, Lower Huronian and Kewenian. In this he agrees perfectly with the original classification of Logan and Murray in the Geology of Canada, 1863, except that possibly some Upper Laurentian rocks are included in the "Lower Huronian." The true Upper Laurentian or Grenville series seems, however, to be absent in the Lake Superior region, so far as yet known. Possibly it may have been removed by denudation before or during the Huronian age, or it may have assumed different mineral characters which may have caused it to be referred to the so-called Kewatin or Lower Huronian group.

2.—*The Most Ancient Fishes.*

Walcott has now found, and showed me when in Washington, large portions of the armour of a Placoganoid from the Siluro-Cambrian of Colorado. These fragments seem completely to remove any doubts as to the nature of the detached plates previously found. They have not as yet been described; but would seem to indicate a type not very remote from some Upper Silurian and Devonian genera.

3.—*Comparison of Existing and Pleistocene Glaciers.*

An interesting and thoughtful paper, by Warren Upham, has just appeared,* in which he institutes a comparison between "Pleistocene and Present Ice-sheets." The present ice-sheets are stated to be four. (1.) The Antarctic or that which fringes the Antarctic continent and is probably better entitled to the name than any other; but which differs from the supposed ice-sheets of the Pleistocene in fronting on the sea and discharging all its produce as floating ice. In this, however, it certainly, resembles many of the great local glaciers of the Pleistocene. (2.) The great nevé of Greenland, which however discharges by local glaciers and these open on the sea. (3.) The Malaspina glacier of Alaska, evidently a local glacier of no great magnitude, though presenting some exceptional features. (4.) The Muir glacier of Alaska, also a local glacier, but perhaps, like the Malaspina, showing some features illustrative of local Pleistocene glaciers.

In the "conferences and comparisons," however, the facts detailed in the earlier part of the paper are placed in comparison with postulates respecting the Pleistocene which are incapable of proof. (1.) It is taken for granted that

* Bulletin Geol. Society of America, March 24, 1893.

the upper limits of glaciation in the mountain ranges of America indicate the thickness of a continental ice-sheet. They probably indicate only the upper limit of the abrasion of local glaciers. (2.) Hence it is computed that the thickness of a continental glacier flowing radially outward in all directions from the Laurentian highlands of Canada, amounted to two miles; and in connection with this it is stated that the maximum thickness of a continental glacier of the great Cordilleran glacier of the west has been estimated to be about 7,000 feet, an entirely different thing and referring to the maximum depth of a local glacier traversing deep valleys. (3.) It is admitted that the assumed continental glacier could not move without an elevation of the Laurentian highlands to the height of several thousand feet, of which we have no evidence, for the cutting of the deep fiords referred to in this connection must have taken place in the time of Pliocene elevation of the continents before the glacial period. (4.) The Upper and Lower Boulder drift, so different in their characters, are accounted for on the supposition that the former comes from material suspended in the ice at some height above its base, the other from that in the bottom of the ice. In like manner the widely distributed interglacial beds holding remains of land plants of North temperate character, are attributed to such small local occurrences of trees on or under moraines as appear in the Alaska glaciers. (5.) The rapid disappearance of the ice is connected with a supposed subsidence of the land under its weight, though from other considerations we know that if this was dependent on such a cause, it must have been going on from the first gathering of the ice, so that the required high land could not have existed. All the evidence, however, points to subsidence and elevation owing to other and purely terrestrial causes, and producing not produced by the glaciers of the Pleistocene.

The paper is short and clearly written, and I think will convince any intelligent reader that the writer could not have arrived at the conclusions he indicates except by assuming the continental glacier as a foregone conclusion.

It may be added that Upham accepts the recency of the glacial period, and its causation by changes of ocean currents, which of course would imply that its date coincided in Europe and America, though not necessarily or probably in the Southern Hemisphere. In the concluding paragraphs he attaches too much importance to the alleged occurrence of implements in the later portion of the glacial detritus. These finds belong in most cases, if not always, to the Post-glacial.

4.—*Erosion by Glaciers.*

Prof. Bonney, F.R.S., in a paper read before the Royal Geographical Society,[1] discusses this question in detail and arrives at the same conclusion which I stated in 1866, after visiting the Savoy Alps; viz , that glaciers are "agents of abrasion rather than erosion," and that in the latter their power is much inferior to that of fluviatile action. Nor are glaciers agents in the excavation of lake basins, which are to be accounted for in other ways; and the great gorges and fiords which have been ascribed to them are due to aqueous erosion when the continents were at a high level, before the glacial age.

5.—"*Palæolithic*" *Man in America.*

Every reader of the scientific journals of the United States must be aware of the numerous finds of "palæolithic" implements in "glacial" gravels. I have endeavored to show in a work published several years ago,[2] how much doubt attaches to the reports of these discoveries; and how much such of the "palæoliths" as appear to be the work of man resemble the rougher tools and rejectamenta of the modern Indians. But since the publication of that work, so great a number of "finds" have been recorded, that despite their individual improbability, one was almost overwhelmed by the coincidence of so many witnesses. Now, however, the bubble seems to have been effectually pricked

[1] Nature, March 30, 1893.
[2] "Fossil Men," Hodder & Stoughton, London, 1880.

by Mr. W. H. Holmes of the American Geological Survey, who has published his observations in the American Journal of Anthropology and elsewhere.

One of the most widely known examples was that of Trenton on the Delaware, where there was a bed of gravel alleged to be Pleistocene, and which seemed to contain enough of "palæolithic," implements to stock all the museums in the world. The evidence of age was not, however, satisfactory in a geological point of view, and Holmes, with the aid of a deep excavation made for a city sewer, has shown that the supposed implements do not belong to the undisturbed gravel but merely to a talus of loose debris lying against it and to which modern Indians resorted to find material for implements, and left behind them rejected or unfinished pieces. This alleged discovery has therefore no geological or anthropological significance. The same acute and industrious observer has inquired into a number of similar cases in different parts of the United States, and finds all liable to objections on the above grounds, except in a few cases when the alleged implements are probably not artificial. These observations not only dispose, for the present at least, of palæolithic man in America, but they suggest the propriety of a revision of the whole doctrine of "palæolithic" and "neolithic" implements as held in Great Britain and elsewhere. Such distinctions are often founded on forms which may quite as well represent merely local or temporary exigencies, or the debris of old workshops, as any difference of time or culture. All this I reasoned out many years ago on the basis of American analogies, but the Lyellian doctrine of modern causes as explaining ancient facts seems as yet to have little place in the science of Anthropology. It may be added that Wright, in recent papers, attempts to defend some of the "palæolithic" finds against Holmes's criticisms; but his case seems weak.

6.—*Palanthropic and Neanthropic Man in Switzerland.*

Excavations, made by Dr. Nuesch and reported by M. Boule, in the deposits under a rock shelter at Schweizersbild, near Schaffhausen,[1] show an overlying deposit with "neolithic" implements and bones of recent animals, a bed of rubble and loam, destitute of human remains, and below this a bed containing bone implements, worked flints, and traces of cookery of the Palanthropic period. The whole rests on a bed of rolled pebbles supposed to be the upper part of the glacial deposits. This shows the interval between the Palanthropic and Neanthropic periods, and also the Post-glacial date of man in Switzerland.

THE DETERMINATION OF LONGITUDE.[2]

By Professor C. H. McLEOD.

If we suppose the earth to be cut by 24 planes passing through the polar axis and being equally spaced, tne surface traces will be along lines called meridians, and any point on one of these meridians will be 15 degrees or one hour in longitude distant from any point on the next adjoining meridian. They will be 15 degrees apart because the whole 360 degrees has been divided by 24. Since the earth revolves on its axis once, or through 360 degrees, in 24 hours it will turn through 15 degrees in one hour. So that the longitude distance between the meridians may be spoken of indifferently as 15 degrees or one hour. We shall perhaps avoid difficulty if we speak of longitude differences in hours, or time, only.

If, as a matter of convenience, we make one of our meridians pass through a given point such as Greenwich, then the longitude of a point on another meridian may be described as one, two or three, etc., hours east or west of Greenwich, as the case may be. Thus we say approximetely, Montreal is in longitude five hours west of Greenwich, or more precisely, the longitude of the transit instrument in the Observatory is 4h. 54m. 18s., decimal something

[1] Nouvelles archives des Missions, &c., Vol. III., noticed in "Natural Science," 1893.

[2] Somerville Lecture—delivered April 13th, 1893.

(the precise fraction is at present not quite assured but we have hitherto called it ·54) west of Greenwich.

Now imagine one of our meridians—such as that of Greenwich—to be fixed, then the next adjoining meridian to the west will, as the earth revolves, come up to it in one hour, the second in two and so on. Suppose a star or the sun to be on the meridian of Greenwich (i. e., in the plane of the meridian) then the next meridian will contain the star one hour afterwards. That is, in the case of the sun it is apparently 12 o'clock at Greenwich, when, at the westerly station, it is 11 o'clock.

We see, therefore, that if we can determine the local time at any given instant at any two stations and compare these times we have the difference in longitude of the stations. If we know the time at Greenwich now to be one hour and thirty minutes past midnight, when here it is eight hours and thirty minutes past noon, our longitude is the difference in these times, or five hours. The determination of longitude then consists in obtaining the local time at the two stations, and as in all English-speaking countries longitudes are referred to Greenwich, we must, directly or indirectly, know the time at Greenwich. Comparatively few, however, of the longitude determinations made are by direct connection with Greenwich, the usual practice being to determine with the greatest possible accuracy the longitude of a conveniently situated observatory, or station in the given country and from this observatory to establish the various points required by differences of longitude with it.

There are various methods of determining longitude, but none so accurate as what is called the telegraphic method. This method admits of several modifications, but the plan which I shall first describe is now almost exclusively adopted. An observer is required for each station and usually two stations only are concerned. A programme of work having been agreed upon, the stations are occupied simultaneously by the observers. The instrumental outfit at each station should be a transit instrument, a clock and a chronograph. The stations must of course be connected by a telegraph line. The transit is the astronomical instrument used because by it time can be determined most accurately. This instrument should not be too large to be portable, as there are advantages in an observer constantly using the same instrument and each observer should therefore carry his instrument with him. The chronograph records the beats of the clock, the observations made by the observer at the transit instrument, and also affords the means of accurately comparing the clock at the distant station with his own clock.

The usual programme of work is as follows:—Telegrams are exchanged as to the probability of clear weather at the stations. If the weather be fair the observers will make a determination of their clock errors by the observation of from 10 to 20 stars. This will occupy perhaps two hours, after which an exchange of time signals between the stations takes place. If we call the stations A and B. Then A. sends signals which are recorded on its own chronograph and on the chronograph at B. On land line work it is sufficient to send for one or two minutes, or from 30 to 60 signals and these may be direct clock signals, i. e., the beats of the clock at A sent along the line to B, or may be arbitrary hand signals coming in at irregular intervals on the chronograph record. B then sends an equal number of signals to A, which are also recorded on the chronograph at B. For security against accident it is usual to send a second or check set from A to B and again from B to A. The object of sending signals in both directions is to eliminate what is called "wave time" or "transmission time" If, for example, we are exchanging between Montreal and Toronto, the Montreal clock being ahead of the Toronto clock on local time, the Montreal signals arriving at Toronto will be slightly retarded and the comparison of clocks on the Toronto Chronograph will give a quantity which will be two or three hundredths of a second too small. On the other hand the comparison on the Montreal chronograph will give a quantity two or three hundredths too large, the

Montreal clock having gained that much on the Toronto signals during their transmission. On the assumption that the time of transmission in the two directions is equal, which for land work, at least, we may safely make, the mean of the comparisons gives the precise difference in the clocks. As a matter of fact, clocks at distant stations which are connected by a well insulated land telegraph line can be compared and their difference ascertained with the same accuracy as when beside one another. When in the exchange, clock signals only are sent over the telegraph line, the two systems of signals may be passing simultaneously, the clocks at A and B recording on both chronographs.

The comparison of clocks having been made a second set of star transits is observed. Thus the clock error being known just before and again just after the clock comparison may easily be computed for the instant of the comparison.

The following taken from the Cambridge (U. S.,)—Montreal determination will serve as an example of what has been described :—

Date.	Montreal Clock	Correction	Montreal Time	Cambridge Clock	Correction	Cambridge Time	Difference
	RECORD ON MONTREAL CHRONOGRAPH.						
1883 June 2	h. m. s. 15 36 31.07	s. +2.01	h. m. s. 15 36 33.08	h. m. s. 15 46 34.65	s. —14.33	h. m. s. 15 46 20.32	m. s. 9 47.24
	RECORD ON CAMBRIDGE, CHRONOGRAPH.						
	15 21 27.60	+2.01	15 21 29.61	15 31 31.26	—14.33	15 31 16.93	9 47.32
	Mean difference of time of the stations						9 47.28

Now if the clock corrections here used were quite correct this result, 9m. 47·28s., would be our true and final value of the difference of longitude. Unfortunately, however, it is not an easy matter to obtain a clock error which is true to the nearest hundredth of a second or even to the nearest tenth. It would probably be nearer the truth to say that an uncorrected result of a set of observations by a good observer is likely to be somewhere within a quarter of a second of the true error. If, however, he is a well trained observer he should always be in error (within a range of one tenth of a second) to the same amount and in the same direction. Thus, a given observer may on the average be 0.25^s. (one quarter of a second) in error, say slow, but he should never be more than three-tenths nor less than two-tenths slow. This is what is called the "personal equation" of the observer. In this case when compared with an absolute standard it is the absolute personal equation. The absolute personal equation is however, a very difficult matter to arrive at, and in longitude operations its attainment is not attempted. What is important is the relative personal equation of the observers and this must, either directly or indirectly, be obtained. If at the commencement of the work or at the end of it, or better both before and after the work, the observers observing the same stars and using their own transits, separately determine the error of the same clock, the personal equation is determined and may be used as a correction to a longitude result obtained when the observers do not occupy both stations. In the example already given, the Montreal observer observed earlier than the Cambridge observer by $0^s.22$ and this quantity therefore should be added to the difference of time, giving a value for the difference of longitude of $9^m. 47.28+0^s.22= 9^m. 47^s.50$.

Although this method is sometimes employed it is much better to eliminate the effect of personal equation by an interchange of observers. On the completion of the observations with the observers at the stations A and B as already explained, including at least three nights on which full sets of observations have been made at both stations, the observers exchange stations, and make a second series of observations similar in extent and character to the first. Thus, referring again to the Montreal-Cambridge determination three full nights' observations were obtained on June 2nd. 4th. and 5th., the arithmetical mean of the differences of local time uncorrected for personal equation was $9^m. 47^s.292$. The observers then exchanged stations, and on June 20th. 21st. and 23rd., the second series was obtained giving a mean of $9^m. 47^s.741$. This shows a personal equation of $0^s.224$

(equal to half the difference of the results) and gives a mean value for the difference of longitude of $9^m.\ 47^s.516$. In the final reduction of such work, a process known as "weighting" is employed. That is, some portions of the work are given a greater value than others, depending upon the accuracy and the number of the observations obtained. This does not, however, and should not in good work materially affect the result. Thus, in the work referred to, the mean difference after weighting is $9^m.\ 47^s.514$ or practically the same as the arithmetical mean.

Another method of conducting a longitude determination telegraphically, is to select certain stars which are to be observed at both stations and recorded on both chronographs. Thus the observer at the easterly station observes a star and records its passage over the wires of his instrument on the chronograph at the western station as well as on his own chronograph. After the lapse of the necessary time (the difference in longitude) the star comes to the meridian of the western station when the observer there, also records it on both chronographs. This method has the practical disadvantage that it requires the use of a telegraph line between the stations during the whole evening instead of during a few minutes as in the method usually employed. It has the advantage, however, of being free from errors due to star places (the time given in the catalogue for the star's passage of the meridian). This small source of error can also be eliminated in the other and usual method if the precaution be taken to observe the same stars at both stations. In the longitude work referred to, five stars were observed on June 23rd., at both Montreal and Cambridge, and recorded on the Montreal chronograph giving a mean difference after correction of $9^m.\ 47^s.406$; three stars were observed at Montreal and Cambridge which were recorded on the Cambridge chronograph, giving a mean of $9^m.\ 47^s.523$. The mean value for the difference of longitude from both sets is therefore $9^m.\ 47^s.465$, a result very slightly less than that obtained by the main determination. This result was given some weight in computing the final longitude difference, Montreal west of Cambridge, $9^m.\ 47^s.510 \pm {}^s019$., the $0^s.19$ indicating the probable error of the result, is equivalent to a distance east or west of about 20 feet.

In longitude determinations carried on through land lines the signals obtained are sharp and the transmission time small, so that there is little or no difficulty in comparing the clocks at the distant stations. When, however, an ocean intervenes between the stations, and the signals have to be sent through 3,000 miles of cable the difficulties in the way of the clock comparisons are greatly increased. In fact until quite recently it was not practicable to get any automatic record such as we obtain by our chronographs on land lines. In the longitude determinations between Europe and America, carried out in 1866, '70 and '72 by the U. S. C. & G., Survey, the receipt of the signal through the cable was observed by the deflection of a beam of light from the galvanometer mirrors, at that time exclusively employed in ocean telegraphy. This was a matter of considerable uncertainty and the cause of much anxiety and trouble to the observers engaged in the work.

In our recent longitude work between Montreal and Greenwich the siphon recorder was found, after some little difficulty in its adaptation had been surmounted, to answer all the requirements for an accurate comparison of the clocks at the cable ends. This is believed to be the first occasion on which time signals in longitude work have been received and automatically recorded through an ocean cable. While the wave time was of course large, (amounting on the average to $0^s.26$) the variation from night to night was only a few hundredths of a second.

There is here, however, a possible source of error. The wave time may not be the same for a signal passing eastward as for one passing westward. This we are not able at present to determine, but we have good ground for assuming that the difference cannot in any case amount to any more than a very few hundredths of a second, if it exists at all. The difficulty in the comparison of the clocks is not the only one peculiar to this work. There is another and more serious difficulty, arising from the large value of the longitude. If the time observations at the two stations are made simultaneously they must be on stars differing in right ascension (the *sidereal* time at which the star passes the meridian)—in the case of Montreal and Greenwich—by five hours. Now as the accuracy of the star places depends upon the going of the standard clock in the Observatory in which the positions were determined, there is a possible systematic error in the relative places of the two groups of stars which would, by just so much, affect the resulting longitude. If on the other hand, the same groups of stars be employed at both stations, i. e., the observations be made at the same time of day, there will be the possibility of error from change of rate of the clocks employed in the longitude work.so that in either case the uniformity of clock rate is concerned. The latter method has the advantage of greater convenience of working hours, and this, as it materially concerns the constancy of the observer's personal equation must have very great weight in the decision as to the method to be adopted.

In the Montreal-Greenwich work there were, in addition to the terminal stations, the two intermediate stations at the ends of the cable—the offices of the Commercial Cable Company at Hazel Hill, Nova Scotia and Waterville Ireland. The observers being designated by the letters A. B. C. D., the programme of work was as follows :—

Date	Montreal	Hazel Hill	Waterville	Greenwich
April, 6 to 12	A & B observations for personal equation..C & D			
April, 19 to 30	A	B	C	D
May, 4 to 20	B	A	D	C

The observer B then went to Greenwich and observed with D and C for personal equation, and afterwards the English observer C came to Montreal.

Aug., 16 to 31	C	A	D	B
Sept., 4 to 17	A	C	B	D

The method of work adopted was that observations at all stations should be made at the same time. The time exchanges were carried out in such a way as to practically give two clocks at each station. Using Greenwich time an exchange was made between Greenwich and Waterville at 8 p.m., and again at 12 midnight. The cable exchange was made at 11.45 p.m. Between Hazel Hill and Montreal, exchanges were made at 11 30 p.m., and 2.30 a.m. The cable exchanges, therefore, came in between the land line exchanges, and near to ne of them. The clocks in the fixed observatories at the terminal stations were available as a check on the rates of the cable station clocks. Unfortunately the reductions of this work are not at the present time sufficiently far advanced to justify any public statement as to results.

In the previous trans-atlantic longitude determinations to which reference has been made, there was no interchange of observers and the telegraphic facilities were comparatively imperfect. Owing to the liberality of the British and Canadian Governments we were in this work able to meet the expense involved in the exchange of observers, and through the generosity of the Commercial Cable Company and the Canadian Pacific Telegraphic Company, an unrivalled telegraphic connection was obtained between the stations. Any reference to our indebtedness in connection with this work is not complete without a record of the great assistance given by Mr. Hosmer and his staff of assistants here, by Mr. Dickenson, the able superintendent of the Cable Company at Hazel Hill, and his chief assistant, Mr. Upham. And beyond the Atlantic, our thanks are due to Mr. Wilmot, the superintendent at Waterville, and to Mr. Bambrige in London, the European representative of the Company.

Of methods other than the telegraphic, the chief one is that depending upon the transportation of chronometers. This is the method almost exclusively employed in navigation. The error of the ship's chronometer with respect to Greenwich time and its rate, being known when the ship leaves port, Greenwich time may be obtained and a comparison made with the local time as determined by astronomical observation at any point on the voyage. The instrument used in the observations is of course the Sextant. Before the successful laying of the cable in 1866, our longitudes in America depended upon results obtained by this method, the chronometers being carried between Harvard College Observatory and Greenwich. The chronometer errors were of course determined at both observatories by the transit method.

Amongst other methods, the chief are lunar distances and moon culminating stars, in both of which the moon stands for the hands of the clock, the vault of the heavens for the dial and the fixed stars amongst which the moon moves, for the marks on the dial. The nautical almanacs furnish the data by which, from an observation of the position of the moon with reference to certain fixed stars, Greenwich time may be computed at any instant. Owing, however, to the slow movement of the moon, the irregularity of its motion, and the unavoidable errors of observation, these methods have not hitherto furnished results of any great accuracy. The lunar distance method is suited to navigation and chiefly employed in long voyages where the chronometer rates are not sufficiently reliable to establish Greenwich time.

In fact, the honor of having improved the methods of determining longitude at sea is about equally divided between the astronomers and the chronometer makers. This was recognized by the British when a long standing offer of a reward of £10,000 to any one who would find a successful method of determining longitude at sea, was divided between an astronomer who greatly improved the tables of the moon's motion and a watchmaker who improved the marine chronometer.

It was owing chiefly to the difficulty experienced in the determination of longitude at sea and the importance of the problem to navigation and commerce that the Royal Observatory at Greenwich was founded. The duty of the

Astronomer Royal was, on the establishment of the office in 1675, declared to be "to apply himself with the most exact care and diligence to the rectifying the tables of the motions of the heavens, and the places of the fixed stars, in order to find out the so much desired longitude at sea for the perfecting of the art of navigation."

NOTES ON A GREAT SILVER CAMP.

By W. A. CARLYLE, Ma.E., of McGill University.

High up on the Mosquito Range in Colorado, 10.000 feet above sea level, two parties of intrepid prospectors simultaneously discovered, in 1860, in California Gulch in the Arkansas Valley, paying gold-alluvions, and, with characteristic rapidity, a large town, "Oro City," sprang up as in a night close by what was to become the site of Leadville. These alluvial deposits, very rich in gold but limited in area, were soon exhausted in three or four years, when the inhabitants of this "city" vanished as quickly as they had come, for newer and richer diggings, leaving behind a few to carry on a little desultory mining in the gravels and also along some quartz-veins that had been discovered near by, no thought or search being given for any other metal but gold, nor any heed taken of the hoary, iron-stained rock that stuck in the sluices, until in 1875, when some miners, suspecting what others had not, and sending some of this rock to Denver for assay, learned its great value in argentiferous lead carbonates, and by the spring of 1877 active prospecting had begun everywhere in this region, and "from this time on the development of rich and productive mines advanced with astonishing rapidity." (Phillips' "Ore-Deposits.")

These carbonates were soon traced to their source, which proved to be a dark-colored bluish limestone, which thus has ever since been known as the "Blue" limestone, forming the lowest member of the Carboniferous series, that is quite extensively developed through this part of the West. The ore was found to consist of silver-bearing galena, with gold in some of the chutes, together with the products of alteration, cerussite ($Pb\ Co_3$), horn silver ($Ag\ Cl$), and, as accessory minerals, augusite ($Pb\ So_4$), pyromorphite ($3\,Pb_3\,P_2\,O_8 + Pb\,Cl_2$), minium ($Pb_3\,O_4$), blende $\left((zn\ Fe)\ s\right)$, colamine ($zn\ S\ O_4$), and also native silver. The discovery of this new ore-bearing horizon, so unusual and hitherto entirely unsuspected, began a new era of vast importance to the West and even to the world, as a new territory of large extent was found to the prospector and miner, great ore beds extremely suitable for smelting all classes of ores of the precious metals, owing to the presence of much lead that gathers within itself all the gold and silver in the molten rock of the furnace and then separates from the slag completely, made feasible the present enormous smelting plants; and the production of silver increased with such prodigious strides as to raise the world's supply, thus lowering the ratio value of silver to gold, in as much that the price of silver has depreciated from $1.30 to 83 cents per ounce.

The most ancient rocks at Leadville are Archæan granites and gneisses, the veritable backbone of the Rockies, upon whose flanks lie successively, but little uptilted, Cambrian quartzites or Potsdam, Silurian dolomitic white limestones, Carboniferous limestones (including the "Blue"), grits and shales, and finally rocks and beds of much later epochs. Overlying the Lower Carboniferous limestones, *i. e.*, the "Blue," particularly so at Leadville, or forced in along bedding planes, or cutting obliquely the stratification in dyke-form, is the all important igneous rock of different varieties of fine-grained quartz diorite or "porphyry," as it is locally called; all-important in that this intrusive rock has undoubtedly played a most important *role* in perhaps being the source of the ore or else a very potent agency in its deposition in these sedimentary formations. Faults occur, some of considerable throw, along which ore is seldom found, except fragmental stuff dragged along the fault planes from the regular ore bodies, although in some workings down below this horizon, or in the quartzites, ore is being now mined along faults where it was first deposited.

As to the vital questions where and how does the mineral occur, in the early days of this district the ore was mined in the "Blue" limestone just below and in contact with the overlying "white porphyry," and these ores for several years comprised mostly carbonates and oxides formed by the decomposition, by circulating surface waters carrying carbonic acid and other solvents, of the original sulphides, which in due course, since greater depths have been reached and mining been carried on below the natural drainage-level, or below the influence of these waters, are found as first formed and are the chief source of supply at the present; for a positively authentic case of the original deposition of lead, silver or zinc as oxides or carbonates, and not as sulphides, is yet to be recorded. Emmons, in the early days of this camp, when but comparatively little work underground had been done, made a careful and successful examination here for the United States Geological Survey, and from the abstracts of his very valuable reports, published in 1882,[1] we glean some of his convictions as to the genesis of these ore bodies. He concludes that the ore was deposited when these formations lay at a depth of 10,000 feet from the surface, and he believes "in the occurrence, on an enormous scale, of intrusive bodies of eruptive rock of Secondary or Mesozoic age, which are so regularly interstratified as to form an integral part of the sedimentary series; and yet which never reach the surface, but were spread out and consolidated before the great dynamic movement or mountain-building period at the close of the Cretaceous.

"The original ore deposition took place after the intrusion of the eruptive rocks, and before the folding and faulting occasioned by the great dynamic movement.

"That the minerals contained in the principal ore deposits

[1] Annual Report of the Secretary of the Interior, vol. iii, 1882, p. 203.

of the region were derived from circulating waters, which in their passage through the various bodies of eruptive rocks took up certain metals in solution; and, concentrating along bedding-planes by a metamorphic or pseudomorphic action of replacement, deposited these metals as sulphides along the contact or upper surface, and to greater or less depths below that surface, of beds generally of limestone or dolomite but sometimes also of silicious rocks."

Leadville is still producing vast quantities of ore, and will continue to do so for many decades, judging by the large bodies now exposed; but much of it, however, is of very low grade in silver, but very valuable as a fluxing ore by reason of the presence not only of lead but a large percentage of iron. It has been proved that throughout the whole thickness of the "Blue" limestone ore bodies may be found, and that, besides running in chutes through the main body, as large and persistent ore bodies are being found at the bottom of this limestone along the "grey porphyry," an intrusion of igneous rock of later date than the "white" first met with above, that not only underlies this limestone but sends tongues up through even into the older porphyry, or intercalates sheets along the stratification planes, significant of the tremendous internal forces that can wedge apart with molten rock the strongly bedded limestones weighted down with thousands of feet of superimposed strata.

Very soon prospectors, now aware of the ore bearing possibilities of the "Blue" limestone, guided in some degree by Hayden's Geological Maps, quickly scattered along the ranges, along whose sides the basalt edges of those deeply formed formations are now exposed, having been forced up by some of the great mountain-forming movements that have pushed up granite core masses through the great overlying thickness of sedimentary rock, crumpling, contorting and faulting them, or else re-elevated the veteran primal mountains, around which as islands flowed the Carboniferous seas. For geological evidence there seems to be that these main ranges of Archæan age that form the continental divide have never been entirely resubmerged, but since their first upheaval on the contracting of the cooling earth crust their summits have ever borne the brunt of attack from the waves and storms of all the succeeding ages. Over many miles in Colorado and Utah these ore-bearing limestones have been traced, and found sometimes lying nearly flat, as at Leadville, or else dipping steeply, almost vertically, as at Mount Snow, Mass., the outcrop presenting in places bold, precipitous escarpments towards the main range. Thousands of mining claims have been and still are being located, but not everywhere does it appear that the mineral depositing conditions have prevailed, although each year develops new areas along this horizon, and established mining districts extend farther along as new mines are discovered, some of wonderful extent and richness.

In 1879 these prospectors crossed over through Independence Pass to the west side of the Sawatch range, the mountains of Archæan rock, and followed the Roaring Fork river in a north-westerly direction down a valley with granite exposures rising high on either side, to where the river cuts across nearly at right angles the steeply inclinal Palæozoic strata, which in the direction of their strike, northeast and southwest, resting upon the granites, rise rapidly on each side of the valley to form Smuggler Mount on the northeast and Aspen Mount on the southwest. On the former mountain there is a thickness of 600 feet of detrital matter or wash, with only the granite and quartzite exposed, with few or no indications of ore-bearing rocks, excepting a mass of sinter-like dolomite at the base that assayed well in silver, and was located as the "Smuggler" claim. But up Aspen Mount runs Spar Gulch, having on the south-east quartzite, and on the northwest a steep lofty wall comprising the upturned edges of the Silurian dolomite and the Lower Carboniferous limestones, the trail in the bottom of the gulch following along the junction of the quartzite and dolomite. Ore was found on this mountain, and at its base now lies the town of Aspen, the prettiest and most prosperous mining town in the West, whence during the last year ore to the value of $10,000,000 was shipped to the smelters at Leadville, Pueblo or Denver; and for several years the writer was engaged in engineering work that took him into nearly all the great mines, where was learned some insight into the intricacies of the geology and the character of the ore deposits.

A vertical section through Aspen Mount transverse to the strike would reveal:

(1) Archæan granites; (2) Cambrian quartzites; (3) Silurian dolomitic limestone; (4) Lower Carboniferous limestones, *i. e.*, the "Blue" and the "Brown"; (5) Middle Carboniferous shales and shaley limestones; (6) intrusive diorite; (7) Middle Carboniferous limestone (grey); (7) Jura-Triassic sandstones. In this district many differing conditions are noted when compared with Leadville. Here it is seen that a great part of the originally calcareous "Blue" limestone has been altered to dolomite by magnesian waters permeating the stratum, and that the whole of the lower part, together with narrow bands in the upper part or the "Blue," has been thus dolomitized,[1] and is known in the miner's phraseology as the "Brown" limestone, from the brownish color due to the oxidation of iron along faces. These terms "Blue" and "Brown" limestones became both common and important, as the belief was almost general for some years that the Aspen silver horizon was along the bedding plane or "contact" between the limestones, as the ore for a long time certainly seemed on first examination to be thus located, and hence long and expensive lawsuits arose. By the United States mining laws, a claim 1,500 feet, with parallel end lines 50 600 feet long, according to local laws, must be located along the outcrops or apex of a vein or lode, so that the owners may have the right to follow and mine the ore down along the vein as far as possible, even if the vein on its dip passes without the side-lines and

[1] Papers on Aspen in "Engineering and Mining Journal," June, 1888, by D. W. Brunton, M.E., and "Transactions of American Institute of Mining Engineers," vol. xvii, p. 156, by Carl Henrich, M.E.

within the lines of contiguous property, the only boundaries limiting being those formed by the planes passing vertically along these parallel end-lines produced. These rights of the apex were in the main considered proper and just, as up to the time of the discovery of this great ore-zone in those sedimentary rocks veins had been found to have generally a very steep inclination or verticality, and few questioned the justice of the law, although some very curious and complex cases have become famous in the courts. For example, the same vein changing considerably and abruptly in the direction of its strike, two claims are located on this vein, but each along a different direction; then their end-lines produced will overlap, and each will claim that part of the vein thus doubly overlapped; or claims may be located on two veins that intersect or even merge into one another. At Aspen the owners of locations along this outcropping contact between the two limestones have maintained that the ore was placed along the "contact," and constitutes a vein or lode as meant in the law of the apex, and consequently have instituted suits against owners of those locations down from the outcrop in which extremely rich ore-bodies have been found. The camp of miners has been divided into two factions, "Apexers" and "Side-liners," the latter of whom contend that the ore is found in irregular, disconnected bodies, and not as continuous veins or lodes, and therefore, they aver, apex rights cannot here be upheld, and the courts have never as yet exactly decided this point.

Looking at the section taken at Aspen another difference will be noticed in that a great thickness of shales intervenes between the "porphyry" and the "Blue" limestone below. Little or no ore has been found here along the igneous rock, even where in a few places it traverses the limestones as dykes, at which contact the limestone has been marble ized. Ore has been found and mined in these shales, consisting of lead and silver sulphides, but no bodies of high grade and value.

In 1888, Mr. D. W. Brunton, one of the most eminent mining engineers in the west, after a very thorough study of Aspen Mt. made while preparing for these apex-side-line law suits, published (loc cit.) a resumé of his views as to the location of the ore and the character of these deposits, in which paper he claimed that the bedding contact between the "brown" and "blue" limestones had *not* been the channel for mineral-bearing solutions, nor the place of deposition of these ores, but that with a strike nearly coincident with that of the strata and a dip of 45° to nearly verticality, was a series of faults, some causing a displacement of a few feet, others of much more, that thus allowed the "brown" and "blue" limestones to be adjacent to each other for hundreds of feet on the dip, but the contact at such places would be along a "fault contact" or place of faulting. That, also, ore-bearing solutions passing along these fault-planes, did not deposit the minerals from solution *in* these fault planes, but that finding in places conditions physically and chemically favorable, these solutions impregnated to a greater or less distance the rock on one side or the other, or even both, of the fault plane, and some of the mineral contents being precipitated as sulphides, part or all of the rock was locally replaced by ore, by metasomatic or chemical replacement,[1] and that ore *might* be found along a "bedding contact" but only a limited distance from the faults. These views, at first, were derided by all but a few of the mining men, but within two years a mining location was hardly thought valuable unless a fault was known to traverse it, and faults were diligently being sought out and prospected everywhere, as it became evident, beyond doubt, that the "contact" between the two limestones near which such wonderful ore bodies were being found, was a "fault contact." Some of the faults, probably of later fracture have been barren, also faults running obliquely to the first series, although some of these cross faults have had a very important influence upon its ore-bodies.

In the famous "Aspen" mine at Aspen, from whose small area of seven acres, millions of dollars have been gained, in sinking the shaft an enormous body of very rich silver ore was struck at a depth of 180 feet and in six weeks alone $1,000,000 were won from part of this deposit. Thousands of tons of ore were afterwards mined out of the "blue" limestone, one superintendent thinking that he had exhausted this body, but his successor (changes are often in these mines) making further trials and assays in the apparently valueless solid rock, would find great wealth still remaining until, in places, ore had been sloped out for 30 or 40 feet away from the "contact," on the other side of which the "brown" limestone, nearly perfectly free even of traces of silver, presented a smooth, in parts "slickensided" wall, with parallel, nearly vertical groves or striae, showing so clearly that this was a fault wall. This great body of ore proved to be nearly buticular in shape and rich in lead as well as silver, but on driving levels further along this fault wall for some distance without ore, one of the cross faults was cut along which its strata had been moved 30 feet horizontally, so that the levels now ran through the "brown" limestone, which henceforth proved to be ore-bearing while the "blue" was comparatively worthless. Levels were driven in this as well as in many other mines, along the real bedding contact but almost invariably fruitless.

On Smuggler Mt., in some of the mines, the ore is found in bodies of wonderful richness and extent under somewhat different circumstances. There is one fault coincident in strike, and only a little more vertical in the dip, with the strata, and with such a vertical displacement that the shafts have been brought opposite the "brown" limestone. In this dolomite is a band of very hard chert of irregular thickness and distance from the fault plane, and the ore is found sometimes in its shale, along its contact of shale and dolomite or even sixty feet in the dolomite, but never (unless recently developed) beyond this chert band which in places is separated from the shale only by ore. Another very important fault was met with, dipping only 30° from the horizontal but at right angles to the other fault, and subsequent in age, along which fault plane the corresponding portions of the strata above and below it were horizontally separated by 210 feet, and of course, the ore bodies similarly situated.

It will be easily understood that in mining in this district the miner constantly meets with many puzzling complications, and a level may be run, all unknown, within a foot or more of ore, but the more extended use of the electric diamond core drill is proving a great ally in easily and cheaply prospecting its formation for 300 or 400 feet in any direction.

The ores of Leadville, as already said, are very favorable for smelting, but at Aspen, most of the ore is "dry" or with less than 5% of lead, and what was for a long time very detrimental, with more or less of "heavy spor" or barite which made the ores refractory. The presence of "copper stain" of the blue or green of copper carbonates in the ore is considered as generally a sure index that it is valuable enough to mine, and sometimes in the mines when a fresh face of ore had been just disclosed on blasting, the ore looked very beautiful with the white glittering spor richly colored with these stains and interspersed with the shining faces of galena crystals in a setting of dull black of silver minerals.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY.

Annual Meeting.

MONTREAL, May 29th, 1893.

The annual meeting of the Society was held this evening, the Very Rev. Dean Carmichael, President, in the chair.

The minutes of the last annual meeting and of the regular meeting of April 24th were read and approved.

Minutes of Council meeting of 17th April were read.

Hon. Justice Wurtele read the report presented by him on behalf of the Society at the annual meeting of the Royal Society at Ottawa.

A letter was read from Mr. D. McNichol stating that the C.P.R. had completed all arrangements for the excursion to Ste. Agathe on the third of June; Mr. Shearer also reported to the same effect. The President gave a short verbal address, regretting that owing to ill health it had been impossible for him to attend the regular meetings of the Society as he had desired to do. Mr. John S. Shearer then read the report of the Council.

Mr. James Gardner, treasurer, read the Treasurer's Report, showing $2011.17 as the receipts, and $1953.79 expenditure, leaving a balance of $57.47.

Mr. A. F. Winn read the Report of the Curator, in which he stated that many of the specimens in the Museum had been cleaned and re-arranged, and that 1420 persons had visited the Museum during the year.

Mr. E. J. Chambers read the Report of the Library Committee.

The Rev. Dr. Campbell reported on behalf of the Editing and Exchange Committee, showing that the four numbers of the *Record of Science* had been issued during the year.

Moved by Dr. Frank D. Adams, seconded by Dr. J. Wesley Mills, that a committee be appointed to enquire into the condition of the Natural History Society, and make recommendations as to the way in which its condition could be improved, the committee to be selected by the Council of the Society. Carried.

Moved by Judge Wurtele, seconded by J. S. Shearer, that Sir J. William Dawson be elected Honorary President; the rules having been suspended. Carried.

Moved by R. W. McLachlan, seconded by J. S. Brown, that the rules be suspended and Mr. J. S. Shearer be elected 1st Vice-President. Carried.

The following were elected Vice-Presidents by ballot:—Hon. Edward Murphy, Sir Donald A. Smith, J. H. R. Molson, J. Stevenson Brown, B. J. Harrington, Ph.D.,F.R.S.C., Rev. R. Campbell, D.D., Geo. Sumner, Very Rev. Dean Carmichael, M.A.,D.C.L., J. H. Joseph.

Moved by J. S. Brown, seconded by Hon. Edward Murphy, that R. W. McLachlan be elected Hon. Recording Secretary. Carried.

Moved by J. S. Shearer, seconded by J. S. Brown, that Dr. J. W. Sterling be elected Honorary Corresponding Secretary. Carried.

Moved by the Rev. Dr. Campbell, seconded by J. S. Brown, that A. F. Winn be elected Hon. Curator. Carried.

Moved by J. S. Brown, seconded by Edgar Judge, that James Gardner be elected Treasurer. Carried.

Moved by Geo. Sumner, seconded by S. Finley, that E. T. Chambers be elected Hon. Librarian. Carried.

The following gentlemen were elected members of the council by ballot: Hon. Judge Wurtele, Prof. John Cox, A. Holden, Dr. F. D. Adams, S. Finley, Edgar Judge, C. S. J. Phillips, J. Fortier, L. A. H. Latour.

Moved by J. S. Shearer, seconded by S. Finley, that the following constitute the Editing Committee: Dr. F. D. Adams, Chairman; Rev. Dr. Campbell, Dr. J. Wesley Mills, Dr. Harrington, Prof. John Cox, Rev. Dr. Smyth, J. F. Whiteaves, G. F. Matthews. Carried.

C. G. Arthur, M.A., was proposed as an ordinary member; the rules were suspended and he was elected by acclamation.

On motion by J. S. Brown, seconded by A. Holden, thanks of the Society were given to the retiring officers.

Report of Council.

The Council of the Society beg to submit herewith for the information of the members, and also for the citizens, their report for the Session of 1892-93, to be followed by the reports of the Treasurer, Curator, Librarian, Editing Committee, and their delegate to the meeting of the Royal Society at Ottawa. Eight meetings of Council have been held, and seven monthly meetings of the Society during the year. Seven new members have been added during the session, and three have been removed by death, namely, Dr. G. Ross, Thomas Mussen, and W. F. Ray. The Society's building is in fairly good condition, but a few repairs will require the attention of the House Committee during next year. The large Hall has again been rented to the same parties who have occupied it for many years past.

Although considerable work has been done this Session by the Society, the same interest has not been evinced as in former years; difficulties had to be overcome, (a very unusual thing) in getting papers for the monthly meetings, and the attendance has not been as large as usual. We hope the officers for the ensuing year will throw themselves thoroughly into the work of the Society, and create by their example, a greater interest in every department. Undoubtedly, the citizens of Montreal do not come forward as they ought, to the support of the "Natural History Society," and contribute liberally to the Museum, the Library, and for lectures during the winter season; we have to depend upon the citizens to furnish the means necessary for this work. The Provincial Government has not given us the annual grant this year. A correspondence has been going on between the Hon. J. S. Hall, and the Chairman of the Council for the past six months, but without any positive result, though there are indications that we may ultimately receive it. This grant, as you are aware, is given to assist in the publication of the RECORD OF SCIENCE. The free course of Somerville lectures, six in number, were delivered to good audiences, during the winter, and were much appreciated. The Museum was open for an hour before each lecture. The lectures were as follows:

Thursday, March 2nd, "THE STORAGE OF ELECTRICAL ENERGY," Prof. Chas. H. Carus-Wilson.

Thursday, March 9th, "THE WEALTH OF MINES," Prof. W. A. Carlyle, Ma.E.

Thursday, March 16th, "LIGHTNING AND LIGHTNING RODS," Prof. John Cox, M.A.

Thursday, March 23rd, "DISTRIBUTION OF POWER BY COMPRESSED AIR AND THE ECONOMIES OF SMALL INDUSTRIES," Prof. J. T. Nicolson, B.Sc.

Thursday, March 30th, and Friday, 31st, "THE COMPARATIVE STRENGTH OF MATERIALS UNDER DIFFERENT CONDITIONS, WITH PRACTICAL ILLUSTRATIONS," Prof. H. T. Bovey, M.A., C.E.

Thursday, April 13th, "DETERMINATION OF LONGITUDE," Prof. C. H. McLeod, M.E.

The thanks of the Society are due to the gentlemen who gave their valuable time in preparing and delivering these lectures. The Society's field day at the River Rouge, on the 4th of June last year, was a success in every respect. A full synopsis of the day's outing will be found in the RECORD OF SCIENCE, Volume V, No. 3. We beg to extend the thanks of the Society to the Hon. J. K. Ward, for his kind invitation and hospitality. Our thanks are also due to the officers of the C.P.R. for their kind, and courteous attention; everything possible was done by them to promote the comfort and enjoyment of the excursionists. The thanks of the Society are hereby tendered to the editing Committee, for the RECORD OF SCIENCE, issued regularly, full of interesting and instructive matter; and we desire especially to thank Dr. Campbell for his work on this Committee. It gives us pleasure to welcome back from the South our Hon.-President, Sir J. W. Dawson, in renewed health, after his long and severe illness, and we hope that he will again, as much as possible, give his valuable assistance to the work of the Society. The health of our esteemed President, the Very Rev. Dean Carmichael, during the past winter, prevented him from being with us as frequently as we could have wished, but we are glad that he is very much better, and able to preside at this meeting to-night.

The membership Committee have not met during the past year; we would urge them for next year, to meet monthly, and endeavour, as far as possible, to prevent members from resigning, and give their attention to getting new members.

The field day of the Society for this year, will be on Saturday, the 3rd of June. The place selected is the village of St. Agathe, formerly called Beresford, on the Canadian

Pacific Railway. We hope the members and their friends will avail themselves of this opportunity of enjoying a pleasant day in a lovely section of the country, amongst the Laurentides.

The whole respectfully submitted.

JOHN S. SHEARER,
Chairman.

REPORT OF THE EDITING COMMITTEE OF THE RECORD OF SCIENCE.

Owing to the absence of Dr. Adams from the country during the early part of the year, and the multiplicity of his engagements since his return by reason of the illness of Sir William Dawson, the duty of overseeing the four issues of the RECORD OF SCIENCE for the past year fell upon me. These numbers averaged fifty-nine pages each, and embraced considerable variety of matter, much of it of a high standard. To the contributors of papers the committee express their thanks, only regretting that the amount of money at their disposal did not enable them to provide such illustrations as were sometimes required to set forth fully the value of the articles. But even with its defects the RECORD OF SCIENCE seems to be appreciated by scientific students in all parts of the world, as is seen by the large and increasing list of exchanges obtained for it.

The question has now to be met whether the RECORD OF SCIENCE is to be continued, in view of the threatened withdrawal of the small grant made to the Society, for the purposes of the publication, by the Provincial Government, for some years past. It would be a serious loss to the science of the Dominion, should it be necessary for lack of funds to cease the publication. Besides it would be injurious to the Society itself in more ways than one. At once most of the additions to the library, and those the most valuable, which come to us as books to be reviewed or as exchanges would be cut off, and the Natural History Society would lose much of the prestige abroad which it has won through this channel. The committee bring this matter before the Society in the hope that vigorous action will be taken to avert such a calamity as the suspending of the publication would surely prove.

ROBT. CAMPBELL,
Acting Editor

TREASURER'S REPORT.

Natural History Society of Montreal in account with James Gardner, Hon. Treasurer.

RECEIPTS:

To Balance from last year	$ 240 98
Rents	1114 00
Members' annual subscriptions	610 00
Entrance fees, Museum	35 00
Interest	11 19
	$ 2011 17

DISBURSEMENTS:

By Superintendent's salary and commissions	$ 517 20
Sundry expenses	210 21
Light	205 25
Fuel	146 62
Taxes	28 00
Lectures	17 63
Insurance	69 88
Museum	84 67
Library	97 49
Field-day deficit	26 60
Record of Science	300 15
Endowment Fund, 5 life memberships paid in from 1st May, 1885, to date	250 00
Balance on hand	57 47
	$ 2011 17

1893.

May 29, To Balance on hand $57 47

Examined and found correct { Sam'l. Finley, Chas. F. J. Phillips, J. W. Stirling.

Montreal, 29 May, 1893.

The Treasurer stated that the usual Government grant towards the publication of the Record of Science not having been received has necessitated deferring payment of balance of account due the publishers, but it is hoped the grant will be forthcoming shortly, and that there may be no difficulty in this regard in the future, the funds of the Society, as the statement shows, not permitting the continuance of the publication without this assistance.

MEMO.—*Accounts due by the Society:*

Gazette Printing Co., Record account	$ 263 00	
Special Assessment, widening Lagauchetaire Street	17 30	
		$ 280 30

Accounts due to the Society:

Numismatic & Antiquarian Society, balance of rent to 1st May, 1893	$ 30 00	
Plymouth Brethren	2 00	
		32 00

Annual Report of the Hon. Curator, 1892-3.

The following donations have been made to our Museum during the past year:

Ruby throated Humming-bird.
Morning Warbler.
Horn-fly.
Collection of Swiss Butterflies.
Collection of Montreal Plants.
Several specimens of Canadian Insects.
Sea Dove.
Rattle Snake.
Flying Fish.
Maori Feather Rug.

Also a Large Flag for flagstaff of building, presented by Mr. James Morgan.

The mammals have all been taken out of their cases twice during the winter and given a much needed cleaning with benzine, and some will require another going over in the near future. Similar work has been begun on the birds, but only part of the collection has been completely done, as the amount of work is very great and will probably take 3 or 4 months constant labor to put everything in first-class shape. The careful and thorough manner in which this work is being done is very creditable to our valued Superintendent, Mr. Griffin, and the Society is fortunate in having such a willing worker for the position.

The collection of birds' eggs will be arranged by Mr. Wintle, who has kindly undertaken to look after this department, as soon as we can get the cabinet ready.

Botanical specimens have been promised by several members as soon as a case for their reception is provided, and I hope my incoming successor will be instructed by the incoming Council to procure the necessary cabinets at once as we cannot afford to refuse such generous offers as that of Rev. Dr. Campbell, simply because we have no space for them.

The arrangement of the foreign insects has been commenced by Mr. Hausen and myself, but there is an enormous amount of work to be done before any of the specimens can be put in place, almost every specimen requiring to be re-set, and most of them are unnamed at present. The collection will however be a great additional attraction to the Museum when arranged, and will no doubt be largely increased shortly.

Respectfully submitted,

ALBERT F. WINN.

Hon. Curator.

REPORT OF LIBRARY COMMITEEE.

The Library Committee have to report the following donations to the library during the past year:—

From M. de Beaujeu, "Le Heros de la Monongahela," "Documents inedits sur la Col. de Longueuil."

From Dr. G. M. Dawson, two papers read by him at the meeting of the Royal Society of Canada.

From Mr. E. D. Wintle, "Histoire des Decouvertes et Voyage dans le Nord." 2 vols.

From Mr. H. Vennor, a copy of Vennor's "Birds of Prey," and from Mrs. Caulfield, "Mudie's Feathered Tribes." 2 vols.

Your Committee have also to report the receipt of 112 different publications from State departments, public institutions and Societies in exchange for the Record of Science.

A complete list of these exchanges is herewith presented, and those requiring it have been duly acknowledged.

A set of all the papers relating to the visit of the British Association in 1884 has been entrusted to the care of the society.

The standard books on science purchased at the end of last session have given general satisfaction to members, and appear to have drawn attention to some other valuable works in the library, the books being much more freely used than in former years.

As the money promised last year for binding the volumes of exchanges was not provided, there has now accumulated above 180 volumes ready for the binder. These would be a valuable addition to your library. Your Committee trust that you will enable them to get this work done that these volumes may be available for the use of members before the valuable papers contained in them lose their interest.

The absence of those volumes from their proper position on the shelves, prevents the completion of a catalogue which otherwise is nearly finished.

Respectfully presented on behalf of the Library Committee.

E. T. CHAMBERS, *Hon. Librarian.*

EXCHANGES RECEIVED SINCE JUNE 1ST, 1892.

CANADIAN :—

Montreal Medical Journal.
Canadian Institute, Toronto, Transactions.
Canadian Institute, Archæological Report.
Canadian Institute, Appeal on the Rectification of Parliament.
Canadian Institute, Ornithological Section Report.
Canadian Entomologist.
Ottawa Naturalist.
Geological Survey of Canada, Contributions to Micropalæontology.
Geological Survey of Canada, Catalogue of Canadian Plants, VI
Geological Survey of Canada, Maps to Report of 1888-89.
Royal Society of Canada, vol. IX.
Meteorological Report of Dominion.
Statutes of Canada 1892.
Experimental Farm Bulletin, Ottawa.
Hamilton Association Journal.
Journal of the Natural History Society, New Brunswick.
Patent Review, Ottawa.
Bulletin of Inland Revenue Department, Ottawa.
Journal of Hygiene.
Fruit Growers Association of Ontario, Report.

UNITED STATES :—

American Philosophical Society, Proceedings.
Kansas University, Quarterly Transactions.
American Monthly Microscopical Journal.
Cincinnati Society of Natural History Journal.
American Museum Annual Report.

Catalogue of Maine Plants.
Birds found near Bridport, Conn.
Journal of Comparative Neurology.
Southern Historical Magazine.
Report of Newberry Library.
Wisconsin Historical Collections.
Denison University Bulletin.
New York Microscopical Society Journal.
Torrey Botanical Club Bulletin.
Boston Society of Natural History, Memoirs.
Boston Society of Natural History, Proceedings.
The Journal of Geology, Chicago.
Proceedings of Rochester Academy of Science.
National Museum, Washington, D.C., Bulletins and Reports.
Elisha Mitchell Society Journal.
Philosophical Society of Washington Bulletin.
U. S. Fish Commission Bulletin.
Geological Survey of United States.
Mineral Resources of United States.
Smithsonian Institute Bulletin.
Life Histories of North American Birds.
Michigan Flora.
Maine Pomological Society Transactions.
Wisconsin Academy Transactions.
Natural History Survey of Minnesota.
American Historical Association Reports.
American Academy of Arts and Sciences Proceedings.
New York Academy of Science Transactions.
New York Academy of Science Annals.
American Antiquarian.
The Auk.
Franklin Institute Journal.
Journal of Comparative Medicine.
Johns Hopkins University, Baltimore, Circulars.
Minnesota Natural History Survey Report.
State Historical Society of Wisconsin, Proceedings.
Meriden Scientific Association Transactions.
University of New York Bulletin.
Geological Survey of America Proceedings.
United States Department of Agriculture and Food Products, parts 1 & 2.

British:—

Royal Society Proceedings.
Linnean Society Proceedings.

Linnean Society Journal.
Manchester Literary and Philosophical Society Proceedings.
Northumberland and Durham Natural History Society Transactions.
Royal Society, Edinburgh, Proceedings.
Royal Physical Society Proceedings 1891-92.
Botanical Society, Edinburgh, Proceedings.
Royal Irish Academy, Anatomy of Cerebral Hemisphere.
Royal Dublin Society Scientific Transactions and Proceedings.
Royal Irish Academy Transactions and Proceedings.

FRANCE:—

Société de Geographie Comptes Rendus.
Société de Geographie Bulletins.
L'Académie de Dijon Memoires.
Feuille des Jeunes Naturalistes.

MALTA:—

Mediterranean Naturalist.

ITALY:—

Publications Del Instituto di Studi Superiori Florence.
Bolletino de la Societa Adriatica de Scienza Naturali in Trieste.

GERMANY:—

Zeitschrift der Deutschen Geologischen Gesellschaft, Berichte.
Transactions Natural History Society of Hamburg.

HOLLAND:—

Mulhouse Société Industrielle Bulletins.
Nederland Meteorolog Jahrbuch.
Dutch Society of Science, Haarlem, Archives.
Verhandlungen der Kaiser, Konig Geologischen Reichsanstalt.
Jahrbuch der Kaiser, Konig Geologischen Reichsanstalt.
Almanach of Hungarian Academy.
Memoirs presented to section of National Sciences Termesetherdomanque.
Memoirs presented to section of Mathematics.
Bulletins of National and Mathematical Sciences, *Ertesito.*
Memoirs of Commission of National and Mathematical Sciences, *Kozelmenyth.*
Mathematische und Naturwissenschiften, Berichte.
Report of Hungarian Society of Sciences.
Adriatic Society of Natural Science.

RUSSIA—

Memoires du Comite des Geologique.
Geological Committee of St. Petersburgh Bulletin.
Imperial Mineralogical Society Report.
Imperial Society of Naturalists, Moscow, Bulletin.

Society of Naturalists of New Russia, Odessa.

JAPAN :—

Imperial University of Japan, Tokio, Calendar.
Geographical Society Journal, Tokio.

MEXICO :—

Sociedad Cientifica Memoires.

SOUTH AMERICA :—

Museum of de la Plata Report.
Société Scientifique du Chili, Actes.
Universidad Central del Equador, Annales.
Academy of Sciences, Cordova.

AUSTRALIA :—

Linnean Society of New South Wales Proceedings.
Royal Society of South Australia.
Australian Museum Records.
Royal Society of New South Wales Journal and Proceedings
Geological Survey Department of Mines, Victoria.
Linnean Society of South Australia Transa' 'ons.
Queensland Geological Survey Reports.

ANNUAL FIELD DAY.

On Saturday morning, June 3rd, a large number of members of the Natural History Society with their friends gathered at the Windsor Station ready to leave for Ste. Agathe, the point which had been selected by the Council for the Annual Field Day of the Society.

The weather had been very threatening, rain having fallen in the morning and it was doubtful at first whether the excursion would start. A telegraph from Mr. Carpmael, of the Dominion Meteorological Service, however, stating that the weather would be fine, decided the question and the excursion left about 9 a.m.

The party was much larger than usual, about 180 persons being present. A special train was provided by the C.P.R., and all arrangements were excellent.

On leaving St. Jerome, the newly constructed portion of the road was reached and the Laurentian mountains were entered.

As the engine labored up the steep grades and followed the many windings of the North river, beautiful views were obtained of the mountains rising on all sides.

The district has been hitherto difficult of access and was thus a terra incognita to most of the party.

At Ste. Agathe the whole population were drawn up in their Sunday attire to welcome the Society. The Mayor presented an address from the Town Council, in which he spoke of the honor conferred on Ste. Agathe by its visit, and hoped that nature would yield them many treasures, that the rocks would be found stored with valuable minerals and that the flora would afford them rare and unknown specimens.

Mr. Shearer, Vice-President, called upon ex-Ald. Rolland to reply. After thanking the Mayor and Council of Ste. Agathe on behalf of the Natural History Society for the address, he claimed that this advent would be a great advantage to the place by calling the attention of the outside world to its advantages as a summer resort. The beauty of the lake and the surrounding mountains only needed to become known to attract people seeking relief from the weariness of the town. It remained for the inhabitants to make preparation for their coming by building cottages suitable for them to live in. The harvest would come if they were only ready to gather it in. After a few words by Mr. Sumner announcing that prizes would be offered for the best botanical, geological and entomological collections, the party divided up, some under the leaders of the several sections devoting themselves to the Natural History of the vicinity, while others more attracted by the beauties of the landscape drove or walked to various points in the neighborhood.

Rev. Dr. Campbell and Miss Derick, B.A., were the enthusiastic leaders of the botanical section. Collections were made by a large number of members of the Society, and there was consequently a sharp competition for the prizes in this section. Miss Jessie Brown took that for named specimens, having twenty-one correctly named, and

Miss Smaile obtained the prize for the largest collection of unnamed plants, having fifty-five species.

Mr. H. H. Lyman acted as leader in entomology, and very large collections were obtained by several gentlemen. Mr. Winn secured the first prize for his collection of 104 species, while the second prize was awarded to Mr. Hausen.

Dr. Adams, the leader of the geological section, at the outset explained the general geological structure of the whole district passed over since leaving Montreal, illustrating his remarks by diagrams in coloured chalks sketched on a large slab which was found by the road side. He stated that although the district about Ste. Agathe was most interesting as showing geological structure, the underlying rock was very uniform in character and did not furnish many specimens to the collector. The rock, he stated, was all anorthosite, composed almost exclusively of a lime-soda feldspar, and had been erupted through the true Laurentian rocks forming a great area of 990 square miles in extent. Ste. Agathe was situated about the centre of this area.

The effects of the great pressure to which these rocks had been subjected and which had served to crush them in a peculiar manner, were pointed out, also the effect of the ice, which had ground them down in the last glacial age, as well as the numerous boulders of rocks not found in the vicinity which had been carried to the locality by the ice during this glacial period.

At 5 p.m., there was another gathering of the villagers at the station to say good-bye. The thanks of the Society were expressed in two or three short speeches, and the train started homeward amid the cheers of both the villagers and their visitors. After a fast run home, which was enjoyed as much as the trip out, the Windsor station was reached without further incident. There a vote of thanks, with three hearty cheers, was given to Mr. McNichol and officers of the C.P.R. for the kindly manner in which the Society had been treated.

The trip was one of the most enjoyable and successful which the Society has made for many years and will be remembered with pleasure by all who took part in it.

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

LIFE MEMBERS.

Burland, J. H.
Claxton, T. J.
Claxton, F. J.
Dawson, Sir J. W.
Drake, Walter
Drummond, Hon. G. A.
Ferrier, James
Finley, S.
Hingston, W. H., M.D
Hobbs, W.
Hodgson, Jonothan
Joseph, J. H.
Latour, Major L. A. H.
Lyman, H.
Mitchell, J.
Molson, John
Molson, J. H. R.
Molson, J. T.
Molson, J. W.
McCulloch, F.
McFarlane, T.
McGibbon, A.
Nivin, W.
Redpath, Peter
Sumner, G.
Sutherland, L.
Watt, D. A. P.
Winn, J. H.

HONORARY MEMBERS.

Baldwin, Bishop Rt. Rev....... London, Ont.
Beaubien, Hon. Louis........... Montreal, P. Q.
Hall, Prof. J.................... Albany, N. Y.
Lefroy, General J. H............ London, Eng.
Montgomery, T................ Toronto, Ont.
Rae, D......................... London, Eng.
Rogers, C....... .... London, Eng.
Selwyn, D. A., R.C.............. Ottawa, Ont.
Whiteaves, J. F.... .... Ottawa, Ont.

CORRESPONDING MEMBERS.

Brown, John.................... Hamilton, P. O.
Bailey, L. W.................. Fredericton, N. B

Baylis, Rev. J. G................Longueuil, P. Q.
Campbell, Dr. A...............
Hubbard, O. P....................Hanover, N. S.
Jowett, A. A.....................Sheffield, Eng.
Laberge, C ....St. Johns, P. Q.
Langevin, J......................Rimouski, P. Q.
Latour, Dr. C. H.................Boucherville, P. Q.
Lavallée, Rev. M. C..............St. Vincent de Paul.
Leacroft, J. W...................Quebec.
Lemoine, J. M....................Quebec.
Lee, Dr. J. C....................London, Ont.
Macoun, Prof. J..................Ottawa, Ont.
Marsh, Prof. J. W................Forest Grove, Oregon, U. S.
Matthew, G. F....................St. John, N. B.
Mackay, A. H.....................Pictou, N. S.
McDougall, P. L..................Toronto, Ont.
McCantee, Dr. T. B...............Boston, Mass.
Macfarlane, T....................Ottawa, Ont.
Nelson, Dr. Wolfred.............
Newcombe, Dr. W..................Troy, N. Y.
Niles, B. F......................Washington, D. C.
Osler, Dr. C. B..................Philadelphia, Pa.
Pilote, Rev. F...................St. Anne de la Pocatière, P. Q.
Packard, A. S....................Providence, R. I.
Robinson, Rev. P.................Abbotsford, P. Q.
Rose, H..........................Granby, P. Q.
Sailsbury, D. J. W...............New York.
Saunders, W......................London, Ont.
Sicotte, Judge...................St. Hyacinthe, P. Q.
Spencer, J.......................Pointe Claire, P. Q.
Taché, J. C......................Quebec, P. Q.
Thieleke, H......................Quebec, P. Q.
Turcot, Dr. M....................St. Hyacinthe, P. Q.
Westwood, Prof. J. O.............Oxford, Eng.
Winslow, Dr. W. C................Boston, Mass.
Wurtele, Rev. L..................Acton Vale, Eng.
Woodward, A. Smith...............London, Eng.

ORDINARY MEMBERS.

Alexander, C.
Allan, Andrew
Adams, R. C.
Adams, Dr. F. D.
Kennedy, W.
Kerry, John
King, Warden
Knowlton, G.

Arthur, C. J.
Baker, M. C.
Beattie, John
Bent'ey, D.
Bethune, Strachan
Blackader, Dr. A. D.
Brainerd, T. C.
Brown, J. Stevenson
Bemrose, Jos.
Beaudry, J. A. U.
Baker, J. C.
Bovey, Prof. H. T.
Bond, E. L.
Beaudry, Dr. J. A.
Browne, Dr. A. A.
Botterell, E. H.
Burke, David
Birkett, Dr. H. S.
Baby, Judge
Boulter, G.
Beaujeu, M. de
Branchaud, C.
Campbell, Kenneth
Campbell, Rev. R.
Chambers, E. T.
Cheney, G.
Costigan, W. T.
Craik, Dr. R.
Carsley, S.
Carnegie, J.
Chapman, W. H.
Carmichael, Very Rev. Dean
Cassils, C.
Carter, E. F.
Coristine, J.
Chisholm, C. R.
Cameron, Dr. J. C.
Creak, G.
Cox, Prof. John
Drysdale, W.
Donald, Prof. J. T.
Dyer, W. A.
Deverell, G. J.
Evans, W. N.

Kavanagh, W.
Kinloch, W. G.
Linton, R.
Lockerby, A. L.
Lyman, H. H.
Lovejoy, Dr. G. W.
Lacey, E. D.
Lewis, Mrs. (Assoc.)
Laing Miss "
Lynch, W. H.
Matthewson, J. A.
Mills, J. W.
Mitchell, R.
Morrice, D.
Mills, Prof. T. Wesley
Murphy, Hon. Ed.
Morgan, Jas.
Murphy, John
Martin, Horace T.
Mott, Henry
Morrice, W. J.
Macfarlane, J.
Martin, Mrs. (Assoc.)
Macfarlane, W. J.
Macdonald A. C.
McCallum, Dr.
McDonald, W. C.
McEachran, Dr. D.
McKenzie, H.
McLennan, Hugh
McLachlan, R. W.
McGregor, James
McBean, A. G.
McHenry, G. H.
McLaren, Harry
McDougall, R. W.
Penhallow, Prof. D. P.
Prowse, G. R.
Patton, Thos.
Phillips, C. S. J.
Paton, Hugh
Paton, Jas.
Pennell, A.
Prume, J. J.

Ewing, A. S.
Ewing, S. H.
Euard, W.
Empson, Rev. Canon
Fortier, Jos.
Gardner, James
Garth, C.
Girdwood, Dr. G. P.
Goode, J. B.
Greene, E. K.
Graham, Hugh
Greenshields, E. B.
Grindley, R. R.
Gault, A. F.
Greene, G. A.
Harrington, Dr. B. J.
Henshaw, F. W.
Holden, Albert
Hope, John
Harvie, R.
Henderson, A.
Hill, J. W.
Harper, John
Hodgson, T. E.
Hannaford, E. P.
Hausen, J. F. (Assoc.)
Hague, G.
Huot, L.
Hart, C. T.
Inglis, A.
Ives, H. R.
Johnston, J.
Judge, Edgar
Johnston, Dr. J. W.
Jackson, F. S. (Assoc.)
Ross, P. S.
Roddick, Dr. T.
Ruttan, Dr. R. F.
Robertson, Alex.
Stirling, John
Shearer, James
Shorey, H.
Shearer, John S.
Silverman S.
Smith, Sir D. A.
Smyth, Rev. W. J.
Stevenson, R. R.
Slessor, J.
Smith, J. Murray
Smith, Annie Louise (Assoc.)
Stirling, Dr. J. W.
Small, E. A.
Stewart, Dr. J.
Scott, W. A.
Shepherd, Dr. F. J.
Shaw, J. Gibb
Thomas, F. W.
Thomas, H. W.
Van Horne, W. C.
Vasey, T. E.
Williamson, J.
White, R.
Williamson, Rev. J.
Wanless, Dr. J.
Winn, A. F.
Wurtele, Judge
Wilson, Prof. C. Carus
Ward, Hon. J. K.
Wintle, E. D.

Proceedings of the Microscopical Society.

Montreal, 10th April, 1893.

The regular monthly meeting of the Montreal Microscopical Society was held this evening in the library of the Natural History Society, 32 University Street, at 8 o'clock.

Present, Dr. Girdwood, President, in the chair, Senator Murphy, Dr. Sterling, and Messrs. Stevenson, Geo. Sumner, Richards, Learmont, Chambers, Beaudry, Johnston, Gardner, Lovejoy, Shaw. The minutes of last meeting were read and confirmed.

At the request of the President, Dr. Wyatt Johnston then read an exceedingly interesting paper, his subject being the "Microscope in Medicine." He began by saying that it was about 30 years since the microscope began to be used in the investigation of different diseases to which humanity was subject, and by its aid an immense amount of light had been thrown upon what was now termed the germ theory. In such diseases as tuberculosis, heart disease, la grippe and others, the bacilli in the sputum could be recognized by the aid of the microscope, and the practitioner was greatly assisted in diagnosing his case. Through the same instrumentality it had been proved that dysentery was caused by an intestinal parasite, and the discovery of the common bacillus of cholera was also due to its power. In the examination of blood it was shown to be invaluable; it not only revealed its condition, but often assisted the physician to locate disease when other methods failed.

Great interest was manifested in the experiments which followed, as Dr. Johnston gave practical illustrations of the methods employed in the examination of blood.

At the close of the lecture the members present joined in a general discussion of the subject, and before adjourning a very hearty vote of thanks was tendered to Dr. Johnston for his interesting lecture.

The President then announced that the last lecture of the season would be delivered by J. B. McConnell, Esq., M.D., C.M., subject, "Normal Histology of the Brain and Spinal Cord."

The meeting then adjourned.

SWEDISH CAMBRIAN-SIBERIAN HYOLITHIDÆ AND CONULARIIDÆ.[1]

This memoir marks an era in the study of these conical shells of the older Palœozoic rocks. The author, Dr. Gerard Holm has had unusual facilities for the examination of these fossils, having had before him the large collections of the Swedish Geological Survey, amounting to over 1100 examples, and 45 operculæ, as well as numerous specimens from the museums of Stockholm, Upsala, Christiania, Copenhagen, &c.

Dr. Holm discusses the zoological position of Hyolithes at considerable length, of which the following is a summary :

This type of shell was at first taken to be a Pteropod, and has been so described in all the earlier, and best known works on Palæontology, but of late years serious objections have been made to this view.

Among the objectors are Neumayr and Pelseneer; the former of these writers (1879-89) considers that the Hyolithidæ belong to an entirely independent extinct group of animals, which never had a place near the Pteropods, but were nearly related to the Gasteropods; he thinks there can be scarcely any doubt that they are molluscs.

Neumayr undoubtedly makes a mistake when he, following the old custom, unites the genera Hyolithus and Conularia in the one family or division. Between these genera there are surely great differences—as the following:

In *Hyolithes* the shell is solid, rigid, thick, and consists of at least three layers; it is composed of calcium-carbonate. In *Conularia* it is thin, flexible, and formed of calcium-phosphate, united with a horny substance.

In *Hyolithes* the shell is bilaterally symmetrical with dorsal and ventral sides plainly marked. In *Conularia* it is quadrately or rhombically prismatic, without any distinct dorsal and ventral side, etc.

The mouth of the shell in *Hyolithes* is not drawn together, but is always furnished with an operculum. In *Conularia*, on the contrary, the mouth has its four sides bent inward, and never has an operculum.

Hyolithes appeared earlier than *Conularia*, and there is no indication that the latter spring from any form of the former, or from any common ancestor.

Lindström has examined the zoological standing of Conulariidæ and concludes that they ought to be referred permanently to the

[1] Sveriges Kambrisk—Siluriska Hyolithidæ och Conulariidæ, Series C., No. 112 af Gerhard Holm, Stockholm, 1893.

Pteropoda until some better ground can be shown for removing them to another group in the animal kingdom – better than have been shown by Hackel, Neumayr and Jhering.

Pelseneer has lately fully and profoundly discussed the Palæozoic groups which have been referred to Pteropoda, as to their relationship to living Pteropods, and showed that nearly all the chief characters of Hyolithes and Conularia are entirely wanting in the Pteropods now existing. Pelseneer refers the Pteropods to Ophistobranchia among the Gasteropods, considering that they have sprung from the Bullidæ and Actæonidæ. The remains of Pteropod are wanting in nearly the whole of Mesozoic time, which is hard to understand if they had already appeared in numerous forms in the Palæozoic. Pelseneer shows with reason that it appears to be a fixed law of nature that a group of animals once extinct can never reappear.[1]

The result of Pelseneer's investigations agree fully with Neumayr's statement that Hyolithes and Conularia cannot belong to any living group, and thus can stand in no generic relation to the Pteropoda. In opposition to Neumayr he shows that they probably belong to widely distinct groups, but does not attempt to define their place in the scale of being.[2]

Likewise Walcott has been uncertain of the place of Hyolithes and Conularia, &c., though he places them under the category of Pteropoda as being in a measure representative of recent Pteropoda, they differ in other respects so much that it appears as though a division of the Gasteropoda equivalent to the Pteropoda might consistently be made to receive them.[3]

The fossil which Linnarsson described as *Hyolithes lævigatus* is by G. Holm removed from that genus, and the new genus Torellella instituted for it. The shell as in Conularia consists of *calcium phosphate*, the form is round, firm, weakly arched, of nearly equal breadth; a compressed tube with elliptical section, of which the edge of the orifice must have been straight. He refers this shell as well as Salterella and Tentaculites to the Annelida.

Of the Family Hyolithidæ, Holm says that it contains only the genus Hyolithus, and that other genera have certainly been referred here erroneously. Some show themselves to be less well

[1] Pelseneer, P., Report on Pteropoda collected by H. M. S. Challenger during 873-76—Zoology Vol. 23. London, 1888.

[2] The connection with modern Pteropoda may be through Styliola and Creseis, &c., which collectively range through the Lower and Upper Silurian and Devonian. Some of these minute forms may yet be detected in the Mesozoic rocks. G.F.M.

[3] Second contribution to the study of the Cambrian faunas of North America, Bullet. No. 30, U.S. Geol. Surv., p. 131. See also Trans. Roy. Soc. Can., Vol. iii, pt. iv, p. 47, 1885.

grounded and belong under Hyolithus, (*Camerotheca, Diplotheca,* Matt. *Pharetrella* Hall); others probably have no relation to Hyolithus (*Coleoprion,* Sandb. *Coleolus,* Hall and *Clathrocœlia* Hall); still others are grounded on objects whose structure has been misapprehended (as *Hemiceras,*[1] Eichw, and *Hyolithellus* Bill.)[2]

HYOLITHIDÆ

Holmes describes the genus *Hyolithus*[3] very fully, as follows:

Shell bilaterally, symmetrical, pyramidal, or conical, more or less elongated, straight or slightly bent in a symmetrical plane, rarely towards one of the sides. Cross section usually sub-triangular, but also circular, elliptical or lenticular. Dorsal and ventral sides usually distinguishable.[4] Dorsal side slightly arched, flat or gutter-shaped. Ventral side strongly arched, generally more or less angulated along the middle. Mouth angulated or straight; in the first case with dorsal side semicircularly arched; in the latter, on the other hand, cut off straight or oblique against the dorsal or ventral side. The sculpture consists of growth lines parallel to the orifice, occasionally besides of longitudinal elevated lines or mouldings, whereby more or less complicated sculptured surfaces can arise. Diaphragms are often observed in the apex of the shell; they are entire, not perforated by any siphon. The operculum completely closed the mouth, no matter whether the same was angulated or straight; sometimes it was slightly conical, with the nucleus nearest the ventral side, and with concentric growth lines.

[1] "*Hemiceras* is evidently grounded on the interior of siphons of Endoceras, as plainly appears from Eichwald's figures of all three species."

[2] Speaking of the family *Hyolithellidæ* of Walcott, Holm says "The name is quite inapplicable * * * since the genus *Hyolithellus* Bill. is grounded chiefly on a Brachi pod previously described by Hall under the generic name *Discinella* which Billings and Walcott wrongly declared to be the operculum of a form nearly related to *Hyolithus*. This was, by the last named authors, placed together with some shining tubular form, whose nature is hard to determine."

[3] He adopts this spelling as the correct form of the name, though the originator of it, Eichwald, wrote Hyolithes.

[4] "Opinions have changed as to which side should be regarded as the dorsal, and which the ventral. In the simplest forms both sides are quite obscurely differentiated, but with the more highly developed genus (subgenus *Hyolithus* sens. strict), the separation on the other hand is plain. With the latter two opposite sides can always be distinguished, they are shown by a more or less sharp edge. One of these sides is longer and has the edge of the orifice strongly arched forwards, and this is considered the dorsal side; the other whose mouth-edge is transverse, as the ventral. Same conception has been entertained by Salter, Matthew, and from 1886 by Walcott. But Hall, Billings and Walcott, before 1886, have held the contrary view Barrande avoided distinctly determining this point by applying the terms "La grande face," (dorsal side) and "Les petitis faces (ventral side). Novak named them "Die Hinderflache," and "Die Vorderflache. By following the development from the higher stages backward to the lower, one can decide even in the earliest form which side is dorsal and which ventral in the sub-genus Hyolithus sens. str."

Shell formed of calcium-carbonate, of the same nature and appearance as in Gasteropods.

Dr. Holm says that species of Hyolithus have been described under the following generic names:—*Hyolithes*, Eich. *Orthoceras*, Munst., *Theca*, J. Sow, *Pugiunculus*, Barr., *Vaginella* (pars.) d'Orb· *Cleodora* (pars.) Ludw· *Cleidotheca* (pars.) *Centrotheca* (pars) Salt. *Cryptocaris* (pars) Barr. *Camerotheca* (pars.) *Diplotheca* (pars.) Matt. *Orthotheca* (pars.) Novak, *Pharetrella* (pars.) Hall, *Ceratotheca* (pars.) *Bactrotheca* (pars.) Novak.

Although Dr. Holm rejects *Orthotheca* Novak as a genus he accepts the term as of sub-generic value, and divides Hyolithes into two subgenera as follows:

Subgenus 1, Orthotheca, Novak, 1887.

Mouth quite transverse, forming one plane, Operculum thereby also flat or slight convex, seldom with the nucleus concave, but always having the edge of the operculum in one and the same plain. The dorsal part of the operculum is never distinctly semiconical.

Subgenus Hyolithus, sensu. str., Eichwald, 1840.

Edge of the orifice on the dorsal side semi-circular projecting, on the ventral side the edge is transverse, therefore the mouth of the shell forms two planes coming together at an obtuse angle. Operculum having the same form as the mouth, and similarly angled, and consisting of a small lunate ventral part and a semi-conical dorsal part.

Dr. Holm has been at great pains to arrange systematically the forty species of Hyolithes which have passed under his observation, and as he has in almost all cases been able to show the exact geological horizon from which these species have come, the arrangement is of great value to the biologist. In his sub-genus *Orthotheca* we find the following sections:

1. *Teretes.* The transverse section circular or almost circular—Cambrian (Kjerulfi to Forchammeri Zone).

2. *Complanati.* The transverse section perfectly rounded, but with the dorsal side distinctly, though slightly flattened. Lower Cambrian.

3. *Plicati.* The transverse section, reniform, cordiform or triangular, with the dorsal edge of the section concave, the dorsal side strongly grooved. Cambrian (Œlandicus-Forchammeri Zone).

4. *Semielliptici.* The transverse section semi-elliptical or subtrapezoidal. The lateral edges sharp or almost sharp. The dorsal side plain or very slightly grooved. The aperture usually obliquely cut, with the ventral side projecting (—Bactrotheca, p. p., Nov.) Lower Silurian.

5. *Quadrangulares.* The transverse section almost rectangular.

The shell with four quite sharp edges, and four sides flat or slightly concave The aperture obliquely cut, with the ventral side longer. On the surface of the shell fine longitudinal raised lines prevailing. (—Bactrotheca, p.p., Novak). L. Silurian.

6. *Lenticulares*. The transverse section almost symmetrically lentiform. The lateral edges extraordinarily acute. The lines of growth on the dorsal as well as on the ventral side concave. Upper Silurian.

In the sub-genus *Hyolithus*, as restricted by Holm, he finds two main divisions, these are:

I. *Æquidorsati*. The ventral side wanting grooved channels near the lateral edges. If the lines of growth there change direction that is done by degrees with an even curve. The boundary line between the real dorsal and the ventral sides are therefore the same as the lateral edges of the shell, which are almost always sharp.

II. *Magnidorsati*. A little from each of the lateral edges on the ventral side is a stronger or feebler channel, bordered outward by one or several longitudinal raised lines at the side of the channel, the growth suddenly changes in direction. Those channels are the boundary lines between the real dorsal and the ventral sides, which therefore are not identical with the lateral edges of the shell, the dorsal side turning along those edges, and passing into the ventral half of the shell. What seems to be the ventral side, therefore, is divided into three fields, those belonging to the turned over dorsal side, and that in the middle being the real ventral side.

Under the division *Æquidorsati* the following groups are contained.

1. *Transversistriati*. The surface of the dorsal side as well as the ventral side has lines of growth only——This is a large section containing species ranging from the Œlandicus Zone to the Upper Silurian (*c.*) of the Swedish divisions.

2. *Ventrilineati*. The surface of the dorsal side with lines of growth only, that of the ventral side, ornamented with coarser or finer lines, straight longitudinal raised lines covering the whole breadth of surface. The lateral edges acute.—Forchammeri—Lituite Zone, mostly Lower Silurian.

3. *Dorsilineati*. The dorsal side with longitudinal raised lines over the whole surface, or at least at the lateral edges.—Lower Cambrian to Trinucleus Zone.

4. *Crispati*. The surface of the shell on the dorsal side as well as on the ventral side with very elevated lamelliform longitudinal raised lines, most often with the edge more or less undulating.—Lower Silurian.

Under the division of Magnidorsati are the following divisions:

1. *Aequali.* The ventral side rounded without a sharp keel in the middle.—Vaginatus to Lituite limestone.

2. *Carinati.* The ventral side sharply keeled, with the lip and lines of growth of the middle field, forming either a single strongly projecting obtuse angle, or two side arches, separated by an inward curvature The channel bordered outward by a single strongly developed longitudinal raised line.—Olenus Zone to Vaginatus limestone.

These are the main divisions of Dr. Holm's classification, but each is sub-divided into one or more sections and sub-sections, and the Swedish type species of each section mentioned, so that the scheme forms a complete key to the classification of the Swedish species, and a most valuable reference for the Hyolithoid form of all countries.

This classification, based as it is on so large an amount of material, will be of great service in the future study of this group of fossils. As it is largely based on external ornamentation it is more readily available than if it turned entirely on internal structure. It has accomplished for Hyolithes what de Verneuil's classical work did for Orthis nearly fifty years ago,[1] but in a much more complete and systematic way. By treating the genus in its relations to time and space it brings out the genetic relations of the different sections of Hyolithes, and shows the simpler forms to have been the earlier.

The tendency of opinion in modern times, however, is to the breaking up of large and unwieldy groups such as Hyolithes and Orthis, and so we think that future writers will, by using lines of descent, endeavour to perform this service for Hyolithes, as it has been done recently for Orthis by Messrs. Hall and Clarke. Whatever may be attempted in this way in future years it is certain that Holm's classification of Hyolithus will be found exceedingly useful.

There are other features in this work well worthy of study. Following the example of Barrande in his work on the Pteropoda of Bohemia.[2] Dr. Holm devotes considerable space to the geographical distribution and vertical range of the different species of Hyolithes. Systematic and complete tables are given of the occurrence of species in Sweden, Norway, Denmark, Russia, Great Britain, Bohemia, Canada, United States and other countries. Also a

[1] Russia and the Ural Mtns, 1845.

[2] Système Silurien de la Bohême, Vol. III.

[3] Genera of Palæozoic Brachiopoda, Part I, 1892.

list of all described Cambrian and Silurian (Upper and Lower) species, with synonyms. The total number of species of Hyolithus, including those of the Devonian, Cambrian nnd Permian, are stated by Holm at 178. He gives a list of species-names suppressed as being synonyms or wrongly applied ; also an historical outline of the literature of the genus in Sweden, also an "Attempt at a Natural Grouping."

This scheme or table for a natural grouping, intended to show the derivation and supposed genetic relations of the several sections of Hyolithes will interest biologists. Dr. Holm finds that the only species outside of Scandinavia which can be used for a purpose of this kind are those of Bohemia and North America, others are few in number, or imperfectly described or based on defective material. The oldest forms known at the base of the Cambrian show already two "stem forms," viz., the two sub-genera of Hyolithes, which Dr. Holm recognises represented by several species; hence he infers that the Lower Cambrian Hyolithes of necessity must have sprung from some older, and to us unknown fauna.

About sixty-three pages of the work are devoted to descriptions of the numerous Swedish species, most of which are herein for the first time described.

CONULARIIDÆ.

The Conularias form a less important feature of this work than the Hyolithidæ, the species of the former genus being somewhat scarce in Sweden, and the work not treating of any later species than those of Silurian age. But the description of the group has been carried out with the same completeness and assiduous attention to detail which marks the part relating to the Hyolithidæ. Bohemia still stands forth as "par excellence," the region of the Conularias, with twenty-four species, unearthed and described chiefly by the illustrious Barrande. Sweden presents sixteen species described chiefly by Holm and Lindström, while the United States has eighteen species, nearly half of which have been described by Jas. Hall. The only species known, older than the Lower Silurian, is one described by Walcott from the Upper Cambrian.

As with Hyolithes so in this genus Dr. Holm gives a tentative natural grouping of the species. He divides them as follows:

1. *Læves.* Shell smooth, only having growth lines, which appear as wrinkles. Segmental line indented.

2. *Longitudinales.* A preponderating sculpture of longitudinal elevated lines. Segmental line elevated.

3. *Moniliferæ.* Sculpture obliterated by cross threads beset with

tubercles, without any fine threads connecting the former, or of tubercles only, arranged in transverse rows.

4. *Cancellatæ.* Sculpture a lattice work of transverse coarse main ribs, always plainly and sharply bent at obtuse angles; also finer and lower small ribs connecting the former.

The forms are further classified under these general heads by more minute variations of sculpture, as in the case of the Hyolithidæ, so that the whole scheme forms an excellent key to the identification of species.

About sixteen pages of the work are devoted to the description of the Swedish species of Silurian (Upper and Lower) Conulariidæ.

TORELLELLIDÆ.

Gen. *Torellella* Holm.

Under this heading is described two small slender organisms which Dr. Holm separates from Hyolithes, chiefly because the shell is composed of calcium phosphate (66 per cent.) He regards them as probably allied to the worms. One is from the Lower Cambrian the other from the Lower Silurian, and as regards the former he expresses surprise that no related species has been found in the Lower Cambrian of North America. It has been collected from the Lower Cambrian of Norway, Sweden, Finland and Denmark. He suggests that *Hyolithes elongatus* Barr. and *Coleoprion bohemicum* Barr. and *C. Sandbergeri* Barr. may belong to this genus.

Dr. Holm's work is illustrated by six excellent plates showing in detail the characters of all the species treated of in his memoir; which is one of the series of works published by the Geological Survey of Sweden, and one of the most meritorious, in that it introduces order into the chaos of species heretofore passing under the name Hyolithes, Theca, &c.

G. F. MATTHEW.

ABSTRACT FOR THE MONTH OF MAY, 1893.

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

DAY.	THERMOMETER. Mean.	Max.	Min.	Range.	* BAROMETER. Mean.	§ Max.	§ Min.	Range.	† Mean pressure of vapour.	‡ Mean relative humidity.	Dew point.	WIND. General direction.	Mean velocity in miles perhour	SKY CLOUDED IN TENTHS. Mean.	Max	Min	Per cent. of Possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	43.47	48.9	41.0	7.9	30.1173	30.210	29.970	.240	.2277	80.0	37.7	E.	16.7	10.0	10	10	00	0.15	....	0.15	1
2	42.30	45 6	39.7	5 9	29.9585	30.036	29.881	.145	.2587	96.0	41.0	N.E.	13 9	10.0	10	10	00	0.47	....	0.47	2
3	43.40	49.4	38.4	11.0	29.9697	30.021	29 924	.097	.2613	92.7	41.3	N.E.	9.3	10.0	10	10	00	0.03	....	0 03	3
4	40.52	45.3	37.2	8.1	29.5512	29.895	29.368	527	.2480	91.7	40.0	N.E.	29 9	10.0	10	10	00	0 94	....	0 94	4
5	42.18	47.7	34.9	12.8	29.5665	29.689	29.418	.271	.2313	86 8	38.0	W.	12.3	10.0	10	10	00	0.23	....	0.23	5
6	43.53	48.7	38.2	10.5	29.8593	29.999	29 730	.269	.2177	76.8	36 5	N.	9.0	8.8	10	3	04	0.09	....	0.09	6
SUNDAY...... 7	....	59.0	42.3	16.7	....	......	......	....	.....		....	N.W.	13 8	....	....	.	76	....	....	..	7 .... SUNDAY
8	53.33	62.8	45.6	17.2	30.2175	30.261	30.178	.083	.1872	45.5	32.8	N.	10 1	4.3	10	0	80	....	....	....	8
9	56.78	68.0	47.5	20.5	30.1830	30.252	30.121	.131	.2063	42.3	35 3	S.W.	19 3	7.5	10	2	67	....	....	....	9
10	62.78	75.6	49.6	26.0	30.1200	30.146	30.094	.052	.2540	45.0	40 5	S.W.	29 4	2.5	10	0	96	....	....	...	10
11	68 40	78.8	56.5	22.3	30.0813	30.161	29.976	.185	.3137	45.3	45.8	S W.	22.0	0 0	00	0	91	....	....	....	11
12	71.02	84.4	56.3	28.1	29 8553	29.994	29.741	.253	.3207	43.3	46.3	S.E.	13.5	3.2	10	0	86	....	....	....	12
13	60.45	73.3	50 2	23.1	29.7365	29.836	29.609	227	3168	62 0	46.3	N.E.	22.4	7.8	10	0	24	0.01	....	0.01	13
SUNDAY...... 14	.....	54 1	47.7	6.4	....	......	......	....	.....	....	...	N.E.	12.5	....	....	..	04	0.05	....	0.05	14 ...... SUNDAY
15	52.00	61.5	44.9	16.6	29.8018	29 830	29.765	.065	.3462	89.2	48.8	N.	8.1	7.0	10	0	19	0.16	....	0.16	15
16	51.70	59.6	44.3	15.3	29.7072	29.839	29.551	.288	3612	92.8	49.8	N.E.	13.7	10.0	10	10	00	0.05	....	0.05	16
17	55.65	63.5	51.5	12.0	29.3293	29.472	29.245	.227	.4013	89.7	52.8	N.E.	15.9	10.0	10	10	00	0.18	....	0.18	17
18	50.33	58.0	44.5	13.5	29.3632	29.531	29.287	.244	.3190	86.7	46.3	S.E.	9.9	10 0	10	10	00	0.23	....	0.23	18
19	48.65	56.7	42.5	14.2	29.7753	29.943	29.570	.373	.2508	71.8	41.3	W.	16.8	7.8	10	0	22	0.04	....	0.04	19
20	5? 45	70.8	45 4	25 4	29.8933	30.029	29.727	.302	.2780	56.3	42.8	W.	18.0	5 0	10	0	95	0.01	....	0.01	20
SUNDAY........ 21	.....	71.5	55 6	15.9	....	......	......	....	.. ..	...	....	S.W.	29 5	....	....	..	00	....	...	....	21 ...... SUNDAY
22	58.57	71 0	50.2	2?.8	29.7602	29.841	29.696	.145	.2845	58 2	43.5	S.W.	15.2	5 5	10	0	97	....	....	...	22
23	65.37	84.8	54.6	30.2	29.4700	29 578	29.349	.129	.4068	65 5	52.8	S.E.	18.9	7.7	10	0	00	0.14	....	0.14	23
24	50.40	57.5	44.2	13.3	29.9047	28.988	29.700	.288	.2120	58.2	36.2	W.	28.8	9.0	10	5	72	....	....	....	24
25	52.67	67.5	44.0	23.5	29.8538	30.005	29.665	.340	.2883	69.5	42.7	W.	21.0	3 2	10	0	58	0 31	....	0 31	25
26	50.65	60.2	39.8	20.4	30.0245	30 071	30.001	.070	.2152	58.5	36.3	W.	13.8	7 2	10	0	72	.	....	....	26
27	52.20	63.5	41.3	22.2	29.8655	30.072	29.637	.435	.2647	69 0	41 3	S.E.	10 3	6.7	10	0	45	0 07	...	0 07	27
SUNDAY........ 28	. ...	60.1	47.5	12.6	....	....	......		. ...	....	....	W.	21.3	....	....	....	53	0.11	....	0 11	28 .... SUNDAY
29	58.03	71.5	47.0	24.5	29.7688	29 831	29.731	.100	.2930	61.7	44.3	S.W.	13.4	1.7	6	0	97	....	....	....	29
30	56.40	70.8	47.3	23.5	29.7915	29.866	29.756	.110	.3313	74.2	47.3	S.E.	11.7	6.3	10	0	46	0.09	....	0 09	30
31	62.23	72.5	52.5	20.0	30.0582	30.114	29.974	.140	.4168	74.2	54.0	W.	12.8	3.5	9	0	87	....	....	....	31
....Means	53.87	63.3	45.9	17.4	29.8364	....	......	.212	.2856	69.7	....	S. 65° W.	16.6	6.8	..	..	¶41 6	3.36	....	3.36	Sums ....
19 Years means for and including this month	54 34	63.57	45.37	18.20	29.9327	....	.....	.167	.2823	65.41	....	......	....	6 3	..	..	50 2	2.89	....	2.89	19 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles	672	2337	720	1347	445	3102	2755	943	
Duration in hrs..	63	129	55	92	40	147	157	59	2
Mean velocity...	10 7	18.1	13.1	14.6	11.1	21.1	17.6	16.0	

Greatest mileage in one hour was 48 on the 23rd.

Greatest velocity in gusts 60 miles per hour, on the 23rd.

Resultant mileage 2522.

Resultant direction, S. 65° W.

Total mileage, 12,321.

Average velocity, 16. 6m. per hour.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 12 years only.

The greatest heat was 84.8 on the 23rd and; the greatest cold was 34.9 on the 5th, giving a range of temperature of 49.9 degrees. Warmest day was the 12th. Coldest day was the 4th Highest barometer reading was 30.261 on the 8th; lowest barometer was 29.245 on the 17th, giving a range of 1.016 inches. Maximum relative humidity was 97 on the 2nd and 16th. Minimum relative humidity was 23 on the 12th.

Rain fell on 19 days.

Auroras were observed on 2 nights.

Solar halo on the 9th

Thunderstorm on 4 days.

ABSTRACT FOR THE MONTH OF JUNE, 1893.

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

DAY.	THERMOMETER. Mean.	Max.	Min.	Range.	* BAROMETER. Mean.	§ Max.	§ Min.	Range.	† Mean pressure of vapour.	‡ Mean relative humidity.	Dew point.	WIND. General direction.	Mean velocity in miles perhour	SKY CLOUDED IN TENTHS. Mean.	Max.	Min.	Per cent. of Possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	65.45	75.3	54.0	21.3	30.1438	30.187	30.109	.078	.4022	64.5	52.8	S.E.	9.1	6.7	10	0	49	....	....	....	1
2	65.70	75.5	59.3	16.2	30.1232	30 165	30.082	.083	.4613	73.5	56.2	S.E.	16.2	10.0	10	10	07	0.06	....	0.06	2
3	67.05	77.6	61.4	16.2	30.0687	30.118	29.998	.120	.5975	90 3	63.8	S.E.	13.2	8.8	10	5	14	0.68	....	0.68	3
SUNDAY.......4	.....	74.8	65.5	9.3	....	......	......	....	.....	....	....	S.E.	10.3	....	..	..	07	1.35	....	1.35	4
5	74.85	84.5	64.0	20.5	29.8105	29.854	29.761	.093	.6473	75.0	66.2	S.W.	15.1	2.5	7	0	93	....	....	....	5 ....SUNDAY
6	47.68	74.0	63.5	10.5	29.7633	29.817	29.702	.115	.6200	91.2	65.2	S.W.	15.4	9.5	10	7	00	0.46	....	0.46	6
7	60.68	70.3	54.2	16.1	30.0282	30.152	29.905	.247	.3687	70.2	50.5	S.W.	20.6	6.2	10	0	71	....	....	..	7
8	68.33	79.5	54.4	25.1	30.1325	30.198	30.067	.131	.4220	61.3	54.0	S.W.	15.9	2.2	8	0	93	....	....	....	8
9	71.77	82.8	60.2	22.6	29.9757	30.091	29.876	.215	.5077	66.7	59.3	S.W.	14.4	2.8	8	0	84	....	....	....	9
10	71.63	80.8	62.8	18.0	29.8725	29.979	29.828	.151	.5278	67.8	60.3	S.W.	17.1	7.3	10	4	83	....	....	..	10
SUNDAY.......11	.....	63.0	54.4	8.6	....	......	......	....	.....	....	....	N.	20.1	....	....	..	00	0.43	....	0 43	11 ....SUNDAY
12	61.10	67.8	53.2	14.6	30.1037	30.139	30.043	.096	.4563	84.3	56.5	N.	13.2	6.8	10	0	14	0.07	....	0.07	12
13	68.83	79.0	57.7	21.3	30.1345	30.184	30.083	.101	.5602	80.0	62.0	S.E.	5.8	3.2	10	0	77	....	....	....	13
14	74.23	84 0	62.0	22.0	30.0128	30.107	29.915	.192	.6008	73.-	64.0	W.	13.8	0.5	2	0	88	....	....	....	14
15	74.65	82.6	62.1	20.5	29.9105	29.966	29.881	.085	.5207	60 3	59.8	N.	15.2	2.2	5	0	91	....	....	....	15
16	65.68	73.5	57.8	15.7	29.9825	30.013	29.910	.103	.4508	66.5	55.8	S.E.	15.0	8 2	10	0	17	Inap	....	Inap	16
17	64.83	75.7	53.9	21.8	29.9667	30.030	29.913	.117	.4470	73.2	55.7	S.E.	8.4	7.7	10	6	35	0.32	....	0.32	17
SUNDAY.......18	.....	84.1	60.0	24.1	....	......	......	....	.....	....	....	N.	3.0	5.2	10	0	85	0.08	....	0.08	18 ....SUNDAY
19	71.53	81.8	58.5	23.3	29.9725	30.111	29.854	.257	.5743	71.2	62.0	N.	7.8	5.2	10	0	69	0.06	....	0.06	19
20	76.30	86.5	67.0	19.5	29.9022	29.982	29.829	.153	.6383	70.2	65.7	W.	12.3	3.3	7	0	85	....	....	....	20
21	71.37	80.6	61.5	19.1	29.7275	29.838	29.641	.197	.5230	67.0	60.0	N.	11.7	3.2	9	0	88	....	....	....	21
22	65.58	75.6	59.0	16.6	29.6395	29.675	29.612	.063	.4523	72.2	56.2	S.E.	13.2	9.3	10	6	00	0.07	....	0.07	22
23	59.20	65.3	57.1	8.2	29.8198	29.947	29.685	.262	.4540	90.5	56.5	S.E.	4 2	9 7	10	4	00	0.52	....	0.52	23
24	61.63	71.5	54.3	17.2	29.9562	29.981	29.929	.052	.4820	88.0	58.0	N.	4.3	7.5	10	0	15	0.49	....	0.49	24
SUNDAY.......25	.....	73.2	54.2	19.0	....	......	......	....	.....	...	....	N.	3.6	....	....	..	56	....	....	....	25 ....SUNDAY
26	64.08	74.5	59.5	15.0	29.7400	29.808	29.703	.105	.5055	85.0	59 2	S.E.	5.1	8.3	10	1	00	0.40	....	0 40	26
27	64.77	75.6	56.3	19.3	29.9363	30.032	29.857	.175	4712	78.2	57 5	S.	8.0	9 7	10	8	32	....	....	....	27
28	66.87	75.5	61.0	14.5	30.0963	30.117	30.068	.049	.4785	73.2	57.7	S.W.	5.0	1.3	6	0	89	....	....	....	28
29	71.20	80.4	60.2	20.2	30.0812	30.124	30.035	.089	.5628	74.2	62.3	S.W.	11.0	4.3	8	0	72	....	....	....	29
30	73.15	84.0	62.6	21.4	30.0515	30.095	30.008	.087	.5517	69 0	61.8	S.W.	7.8	0.8	6	0	96	....	....	....	30
31																					31
....Means	68.01	77.0	59.1	17.9	29.9597	.....	......	.131	.5109	74.5	59.2	S. 40° W.	11.2	5.90	..	..	50	4.99	....	4.99	Sums ....
19 Years means for and including this month......	64.75	73.51	56.16	17.35	29.9022	.....	......	.153	.4289	69.1	....	......	....	5.7	..	..	¶54 1	3.44	....	3.44	19 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles...........	1748	236	70	1910	302	2633	1079	86	
Duration in hrs..	156	36	19	163	42	197	89	13	5
Mean velocity...	11.21	6.55	3.68	11.72	7.19	13.36	12.12	6.60	

Greatest mileage in one hour was 33 on the 11th.

Greatest velocity in gusts 36 miles per hour, on the 11th.

Resultant mileage 2034.

Resultant direction, S. 40° W.

Total mileage, 8,064.

Average velocity, 11. 2m. per hour.

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

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 12 years only.

The greatest heat was 86.5 on the 20th and; the greatest cold was 53.2 on the 12th, giving a range of temperature of 33.3 degrees. Warmest day was the 5th. Coldest day was the 23rd. Highest barometer reading was 30.187 on the 1st; lowest barometer was 29.612 on the 22nd, giving a range of 0.575 inches. Maximum relative humidity was 99 on the 23, 24 and 27th. Minimum relative humidity was 40 on the 15th.

Rain fell on 14 days.

Auroras were observed on 2 nights.

Fog on 2 days.

Thunderstorms on 6 days.