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THE

CANADIAN NATURALIST

AND GEOLOGIST:

A Bi-Monthly Journal of Natural Science,

CONDUCTED BY A COMMITTEE OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

NEW SERIES.—Vol. 1.

(WITH TWO MAPS.)

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THE

CANADIAN NATURALIST.

SECOND SERIES.

BOTANICAL SCIENCE—RECORD OF PROGRESS.

By George Lawson, LL.D., Professor of Chemistry, Dalhousie College, Halifax, Nova Scotia.

1. Flora of Canada.—Canadian botanists will be pleased to learn that the series of "Colonial Floras," now being published under authority of the Home Government, is rapidly progressing; and that Sir William Hooker is now desirous of receiving contributions to the projected Flora of Canada and other British American Provinces, of which Dr. Joseph Hooker is to be the author. As to the nature of materials desired, it may be stated generally that information respecting the occurrence in Canada of plants not hitherto recorded as Canadian, when accompanied by authenticated specimens, will be most useful. In a letter from Sir William, he observes: "Our own materials [at Kew] are very ample for the object in question; nevertheless I am far from discouraging any from sending to us well-prepared specimens, among which it is probable we should find some new things, and more still which would be useful as showing the geographical distribution of species. Most of all we desire, as far as Canada is concerned, that specimens be collected largely in the *most southern districts*, as there would probably be found *United States species* not yet recorded as Canadian. The oaks, the pines, and in general the forest-trees and shrubs, particularly of the South, require a careful study. You define clearly the plants we most desire to have, viz.,

such as are not already published as Canadian, or as are of critical interest."

2. Canadian Ginseng.—My friend and former pupil, Dr. John C. Schültz, the active Secretary of the Scientific Institute of Rupert's Land, called attention some time ago to the trade which was then being carried on in exporting ginseng *Aralia quinquefolia* from Minnesota to China. In western Minnesota the root is collected by Indians, and sold to traders in St. Paul's for a dollar a pound, to be carried to New York for export. Dr. Schültz, seeing several barrels of it at St. Paul's, wisely suggested to Canadians the propriety of taking up this lucrative branch of industry. In a letter which I have received from Sir William Hooker, that veteran botanist observes: "I am glad to see the subject of the American ginseng alluded to. Is it the fact that it is still largely exported to China? and what are the statistics? Now would appear to be the time to send it. I can assure you, that, old botanist as I am, and with correspondents all over the world, with two collectors I have had in Manchuria, intimate with all the Russian botanists, I have never been able to procure even a dried specimen of the Chinese ginseng. With great difficulty Dr. Bunge obtained for me a single dried root, for which three guineas was paid in the country. I have no doubt your ginseng is every bit as good as that of Manchuria, and certainly the Chinese once thought so."

3. Canadian Nuts and Gooseberries.—I find that the common hazel-nut of central Canada is *Corylus rostrata;* that of the Northern States and of the plains west from Canada, *C. Americana*, which in Canada is local, occurring abundantly in some places however, as at Belleville, where it was pointed out to me by Mr. J. McCoun. The common smooth gooseberry of Upper Canada is *Ribes rotundifolium*. The more prevalent one in the New England States is, according to Prof. Gray, *R. hirtellum*.

4. Canadian Habitats *of Diplostachyum apodum.*—Mr. Josiah Jones Bell, of Carleton Place, one of my former pupils, has given me specimens of this very interesting lycopod, collected by him at Dickson's Point, Mississippi Lake, C. W., August, 1863. The only Canadian localities previously known were Detroit River, C. W., where it was found by Dr. P. W. Maclagan; and Belleville, C. W., where Mr. McCoun pointed it out to me last summer. I have since found it in a fertile state in the grass by the

margin of Mill-Creek, a few hundred yards below the village of Odessa, which is some thirteen or fourteen miles from Kingston, C. W. This is the *Lycopodium apodum*, Linn., Pursh, etc., *Selaginella apus*, Gray, Eaton, etc. I have it from Schooley's Mountain, (Mr. A. O. Brodie,) but it is rare in the United States. Being a minute moss-like species, it may be sometimes overlooked. It is admirably adapted for cultivation in a Ward's case, as it covers the soil with a very dense carpet of a most beautiful light green hue.

5. GULF-WEED AT CAPE SABLE.—The Nova Scotia newspapers contain accounts of great quantities of the gulf-weed (*Sargassum bacciferum*) having been thrown upon the shore at Cape Sable, by the gales of December, 1863; the Gulf-stream, it is alleged, being much nearer the land than usual.

6. POA LAXA, Hænke.—This rare alpine grass was found on the White Mountains by Principal Dawson, to whom I am indebted for specimens.

7. FLORA OF ANTICOSTI AND THE MINGAN ISLANDS.—Mr. A. E. Verrill has published in the Boston Natural History Society's Proceedings a list of the plants collected at Anticosti and the Mingan Islands, by himself, Mr. A. Hyatt, and Mr. N. S. Shaler, who formed a party from the Museum of Comparative Zoology for the investigation of the geology, etc., of Anticosti, in 1861. The list contains 209 named species of flowering plants. I note some of the more interesting: *Anemone parviflora*, S. W. Point; *Thalictrum alpinum*, *Ranunculus Cymbalaria; Dryas integrifolia*, Vahl., Mingan, and Anticosti, abundant; (*D. Drummondii*, attributed to Anticosti by Pursh was not met with;) *Rubus Chamæmorus*, abundant; *R. arcticus; Saxifraga Grœnlandica*, L., very abundant at Mingan Islands. A very large number of specimens of this species collected at Mingan, proves, according to Prof. Gray, that *S. Grœnlandica*, *S. cæspitosa*, L., and *S. exarata*, Vill., are only forms of one species; *S. aizoides*, large variety, abundant at Anticosti, about limestone cliffs; *S. aizoon*, Niapisca Island; *Ligusticum Scoticum; Erigeron acre*, (*E. alpinum*, Hook.,) narrow-leaved form, abundant on grassy banks near the mouth of Jupiter River; *Rhodora Canadensis*, L.*; Loiseleuria procumbens*, *Primula farinosa*, and *P. Mistassinica; Mertensia maritima*, a fern with glabrous leaves, was occasionally met with; *Taxus Canadensis; Calypso borealis; Hierochloa borealis*,

&c. Nineteen Orchids are enumerated, yet only two Carices, two grasses, and no Cryptogamia, so that there is still room for useful work at Anticosti and Mingan. The *Kalmia latifolia* of Mr. Billings's Anticosti list is no doubt *K. Angustifolia*, as Mr. Verrill suggests.

8. WOODSIA ALPINA (W. HYPERBOREA), A CANADIAN PLANT. —I am happy to be able to state definitely that this very rare fern is a native of Canada. Last winter several specimens of Woodsia were brought to me by my former pupil, Mr. Robt. Bell, B. A., who had gathered them in Gaspé in the previous year. One of these could not be satisfactorily identified; and through Prof. Torrey, I forwarded it to Mr. Daniel C. Eaton, who has made the American ferns a special study. He kindly took the trouble to compare it with authentic specimens in his rich herbarium of ferns, and with published figures and descriptions that were inaccessible at Kingston. He writes to me that he has now no doubt of the identity of the Gaspé fern with *Woodsia hyperborea* (*W. alpina*, S. F. Gr.). He adds: "it is the first American specimen I have seen." Thus Pursh's record of the fern as occurring "in clefts of rocks, Canada," is confirmed. Mr. Eaton further points out that Major Raines's Oregon specimens referred to *W. hyperborea* by Sir William Hooker, in his recent work on British ferns, do not really belong to that species; "they have not jointed stripes, nor a cilliate-cleft involucre, and belong to the *Physematium* section. I may state that my own specimens of *W. alpina*, from Norway, (Thos. Anderson, M.D.,) and Ben Lawers, Perthshire, (J. T. Syme, F.L.S.,) are very small fertile fronds, remarkably different in aspect from the comparatively large lax fronds from Gaspé (measuring nine inches in length). I therefore propose that the Gaspé plant should be distinguished as var. *Belli*, as I had described it in the "Synopsis of Canadian Ferns and Filicoid Plants"; but it must now be referred to *W. alpina*, not to *W. glabella*, as formerly. Although the latter species (*W. glabella*) is admitted by all authors as a Canadian fern, I know of no strictly Canadian habitat for it. Mr. Charles H. H chcock tells me that he collected *W. glabella* sometime ago at Willoughby Mountain, Vermont, where it has become extremely scarce.

9. THE COMPASS PLANT OR POLAR PLANT.—It is a misfortune of botany that more time is required to clear up doubts and point out errors than for the pleasanter task of making

new discoveries. Yet it is work that must be done, and it is usually in fact by this very process that discoveries are eliminated. Lately some attention has been given by a phenomenon said to be exhibited by *Silphium laciniatum* on the prairies, and the most contradictory observations have been recorded. In 1862 Mr. W. Gorrie called the attention of the Botanical Society of Edinburgh to various notices of this plant, such for example as the following:—

"But we had a guide to our direction unerring as the magnetic needle. We were traversing the region of the Polar Plant, the planes of whose leaves, at almost every step, pointed out our meridian. It grew upon our track, and was crushed under the hoof of our horses, as we rode onwards."—*The Scalp Hunters, by Capt. Mayne Reid*, p. 206.

"Whilst in the damper ground appeared the Polar Plant; that prairie compass, the plane of whose leaf ever turns towards the magnetic meridian."—*The City of the Saints, by R. F. Burton*, p. 60.

"Fortunately none go to the prairie for the first time without being shown, in case of such mishaps, the groups of compass-weed which abound all over the plains, the broad flat leaves of which point due north and south with an accuracy as unvarying as that of the magnetic needle itself."—*The Prince of Wales in Canada, &c., by the Times's Special Correspondent*, p. 300.

"On the uplands the grass is luxuriant, and occasionally is found the wild tea (*Amorpha canescens*) and the Pilot Weed, *Silphium laciniatum*."—*Emory's Notes with the Advance Guard*, p. 11.

"It is said that the planes of the leaves of this plant are coincident with the plane of the meridian; but those I have noticed must have been influenced by some local attraction that deranged their polarity."—*Lieut. Albert's Notes in the same work.*

"Patience," the Priest would say; "have faith, and thy prayer will be answered.
Look at this delicate plant that lifts its head from the meadow;
See how its leaves all point to the north, as true as the magnet.
It is the compass-flower, that the finger of God has suspended
Here on its fragile stock, to direct the traveller's journey
Over the sea-like, pathless, limitless waste of desert."

Longfellow's Evangeline.

What every body says must be true. The combined testimony of Mayne Reid, Burton, the Times's Special, and Longfellow, added to the common belief of prairie men, cannot be gainsayed. Yet a cautious botanist will suspect that after all, the concurrent testimony may resolve itself into a snow-ball fancy, that has gathered as it rolled from book to book, and that the popular authors quoted did not trouble themselves much about the accuracy of the fact. Prof. Asa Gray, our chief American botanist, does not confirm the exhibition of polarity by his observation of the plant in the Cambridge garden. In the same way, I could not make it out by observation of the plant for two years, although certainly in the single plant to which my observations were limited the *stem-leaves* did show a tendency towards a north and south direction. However in an "extra" from the American Journal of Science, given to me when on a recent visit to Prof. Gray at Cambridge, I find a communication from Mr. T. Hill, with observations made on the wild plants near Chicago,—Aug. 8, 1863. Only one plant, bearing four old leaves, gave an average angle with the meridian of more than 34°; their mean was 18° west. Of twenty-nine plants, bearing ninety-one leaves, the angles with the meridian were as follows: seven made angles greater than 35°; fifteen, angles between 35° and 20°; sixteen, angles between 20° and 8°; twenty-eight, angles between 8° and 1°; and twenty-five, angles less than 1°. Of the sixty-nine angles less than 20°, the mean is N. 0° 33′ E., i. e. about half a degree east of the meridian. The error of observation may have been as much as three times this quantity. One half of the leaves bear within about half a point of north, two-thirds within a point. In the Kingston specimen the first flower looked to the north, the others chiefly south.

10. Buxbaumia aphylla in Nova Scotia.—This rare and most remarkable of all the mosses grows on the hills three miles in the rear of the city of Halifax, Nova Scotia. It was found with perfectly formed but green capsules on December 26, 1863.

11. Parochetus communis.—A herbaceous leguminous plant, new to gardens, and bearing the above name, was exhibited at the November (1863) meeting of the Edinburgh Botanical Society. It resembles the common white clover, but has blue flowers, and is said to be very pretty. This plant was introduced to Canada last year, a fine crop having been raised from seeds received from Dr. Thomas Anderson, who obtained them at a high elevation on the Himalayas.

12. Acer Negundo, foliis variegatis.—In the *Verzeichniss* of our friend Mr. J. N. Haage, of Erfurt in Prussia, we observe a drawing and description of a beautiful variegated or silver-leaved variety of the *Acer Negundo*,—or as it ought rather to be called, *Negundo aceroides*. This elegant variety will form a welcome addition to the list of American ornamental trees. It is for sale in the European nurseries.

13. Canadian species of Equisetum.—The following are described in Trans. Bot. Soc. Ed.: *E. sylvaticum; E. umbrosum; E. arvense; E. arvense, var. granlatum;* (a new and remarkable form from the Trent, near Trenton); *E. Telmateja; E. limosum; E. hyemale; E. variegatum; E. scirpoides;* and *E. scirpoides, var. minor*, the last from Gaspé (Mr. Robt. Bell). *E. palustre* is understood to grow in the northern parts of Canada.

14. Sequoia Lawsoniana.—Messrs P. Lawson & Son of Edinburgh have raised a new Conifer from California seeds, which has been named *Sequoia Lawsoniana*.

15. Yucca filamentosa.—This fine southern plant is quite hardy in Canada. Its specific name refers to the numerous threads or filaments which hang from the margins of the leaves.

16. Clerodendron Thomsonæ, Balfour, (Mrs. Thompson's Clerodendron). This handsome plant was transmitted by the Rev. W. C. Thompson from Old Calabar, on the west coast of Africa, and flowered at the Botanic Garden of Edinburgh, in December, 1861. It is a shrubby twining plant, producing showy flowers, and will soon be seen in all our hot-houses. Prof. Balfour gave a full description of it some time ago, accompanied by a beautiful drawing from the pencil of Dr. Greville. (Trans. Bot. Soc. Edin., vol. vii, p. 2.) It had not then shown fruit, which however has been subsequently produced, and is now described, with elegant drawings. Prof. Balfour states that the fruit consists of four achens, which when ripe assume a shining black color externally. Between the achens, and attached to their surface, but not appearing on the peripheral side, there is a bright red cellular coat, which enlarges as the fruit ripens, separating the achens, which ultimately appear as four distinct seed-vessels, covered on their upper surface (commissure), with a succulent rugose mass of cells of a bright scarlet color. The surface oil-globule-bearing cells are described as of a glandular nature. We have here apparently a beautiful example of glan-

dular structure, presenting in an exogenous plant a perfect homology with the glandular structures of the fruits of monocotyledons, so well described by Brongniart, and serving to illustrate the theory (see Trans. Bot. Soc. Ed., v, p. 213), that all vegetable glands are epidermal structures. In several points of view then this is an interesting plant, and Dr. Balfour has done it ample justice in his admirable description.

17. Physostigma venenosum, Balfour.—The Poison Bean or Ordeal Bean of Calabar, *Physostigma venenosum*, Balfour, which is used in Africa as a state poison, a supposed means of discovering crime, and a certain method of punishing it, is likely to yield, in the hands of medical men, some return for all the evil it has done in the hands of the ignorant and superstitious Africans. Dr. Thomas R. Fraser finds that the bean acts as follows:

1. The kernel acts on the spinal cord by destroying its power of conducting impressions. 2. This destruction may result in two well-marked and distinct effects, either in muscular paralysis, extending gradually to the respiratory apparatus, and producing death by asphyxia; or in rapid paralysis of the heart, probably due to an extension of this action to the sympathetic system, thus causing death by syncope. 3. A difference in dose accompanies the difference in effect. 4. The functions of the brain may be affected secondarily. 5. It produces paralysis of muscular fibre, striped and non-striped. 6. It excites secretions, and especially the action of the alimentary mucous membrane. 7. Topical effects follow the local application of the watery emulsion and alcoholic extract; these are destruction of the contractibility of muscular fibre, and contraction of the pupil when applied to the eye-ball or eye-lids.

18. New Irish Lichens and Hepaticæ.—Dr. Benjamin Carrington, F.L.S., has described (Trans. B. Soc., vii, p. 3) the following new lichens: *Ephebe Moorii*, Carrington, a delicate little species found at Glena, Killarney, growing in shallow depressed patches, an inch or more in extent, on *Frullania tamarisci*, var. *microphylla*; *Lecidea scapanaria*, Carrington, Killarney, parasitic on the stem and leaves of *Scapania undulata*, var. *major*, and *S. æquiloba*. The same indefatigable botanist has given an elaboration of the Killarney Hepaticæ well worthy of study. Cryptogamic botany used to be a pleasant pastime; but

it now requires an exercise of the observing powers that none but genuine botanists can endure.

19. The Toot Poison of New Zealand.—Dr. W. Lauder Lindsay, F.R.S.E., has published a paper (read to the British Association) on the Toot Poison of New Zealand, a poison which has of late years committed great ravages among the flocks and herds of the settlers. It belongs to the class of *narcotico-irritants*. The poisonous parts of the plant to man are usually the seed contained in a beautiful dark purple luscious berry, resembling the blackberry, which clusters closely in rich pendant racemes, and is most tempting to children. The young shoots, which are tender and succulent, resembling asparagus in appearance and taste, are eaten by cattle and sheep. Robust cattle habituated to its use do not seem to be affected; but animals suddenly making a large meal of it after long fasting, or after long feeding on drier or less palatable materials, or after exhaustion by hard labour, hot dry weather, or a fatiguing sea-voyage, are sure to suffer from its use. It causes vertigo, stupor, delirium, and convulsions, curious staggerings and gyrations, frantic kicking and racing or coursing, and tremors. In man the symptoms are coma, with or without delirium, sometimes great muscular excitement or convulsions. During convalescence there is loss of memory, with or without vertigo. Dr. Lindsay states that in many cases of loss of cattle by individual settlers, the amount of loss from toot-poisoning alone had been from twenty-five to seventy-five per cent.

The destructive plant in question is named *Coriaria Tutu*, Lindsay. It is *C. ruscifolia* of Linnæus, *C. sarmentosa*, Forst., etc., names to which the author objects as inapplicable. The whole genus needs revision; most of the species are more or less poisonous. The New Zealand settlers owe a debt of gratitude to Dr. Lindsay for the trouble he has taken to investigate the Toot poison.

20. The Chinese Green Dye.—From a report of the Agri-Horticultural Society of the Punjab, just received from L. A. Stapley, Esq., it appears that that institution is in a thriving and active condition. At the Society's meeting on 22nd July, 1863, plants of *Rhamnus utilis*, which yields the celebrated Chinese green dye, were shown. It was resolved, with reference to the facility with which this plant appears to be propagated in the

Punjab, and to the great advisability of obtaining satisfactory information as to the second species of *Rhamnus*, necessary to the complete adaptation of the former plant to the purposes of dyeing as practised in China, that an application be made through the Punjab government, to obtain from the British Consular authorities in China, further and authentic particulars (also seeds) of the several species of *Rhamnus*, without which the dye cannot be prepared, as shown in the papers translated for the Agri-Horticultural Society of India, by Mr. Cope, and published in their journal. It is remarked with satisfaction that the seedlings before the meeting are the produce of seeds from plants grown in the Society's Badamee Garden.

21. Lakh Dye.—In the same report, D. F. McLeod, Esq., calls attention to the valuable insect producing the lakh and lakh dye of commerce. He states that it is indigenous to various parts of the Punjab, especially to the N. W. extremity of the Baree Doab, zillah Goordaspoor, and the S. W. parts of the Kangra zillah. There is some reason to believe that, at one time, the insect covered a larger space than it now occupies. There is a popular rumor that the Sikh government derived a revenue of one lakh of rupees from the farm of the exclusive privilege to gather the lakh; but this is probably an exaggeration. The subject is however one full of interest, and should draw the special attention of the Society. In the central provinces, where the insect exists in great abundance, it is propagated by artificial means, and grafted as it were on the tree. It feeds chiefly, down there, on the Dhak (*Butea frondosa*); but in the Punjab it is exclusively found on the Ber (*Rhamnus jujuba*). Two years ago Mr. McLeod had observed the insect to be spreading on Ber trees and bushes in his neighborhood. This year (1863) the insect has shown itself in large quantities, considerable enough to make it worth the notice of parties to purchase the right to cut the branches on which the insects are found. Reference to the exports of Bengal show that thousands of maunds are sent to Europe, either as lakh or dye, and its preparation is carried on in large establishments. The lower province insect feeds chiefly on the Dhak. Why should experiments not be made for grafting it on this tree, of which whole forests exist? His Highness the Rajah of Kupoorthulla has devoted some attention to the subject, and introduced the insect from Oudh into his Dhak forest lands near Phugwara. Experiments are likewise in progress

in the Punjab in raising silk and hops. Wild mushrooms are abundant in the rains at Shahpoor; of which, according to Dr. G. Henderson, there are two edible sorts,—one globular, and the other exactly like an English mushroom.

22. Improvement of Cotton in India.—Dr. Henderson reports that his experiments with the finer kinds of cotton, of which seeds have been imported, have been very successful. His remarks throw a welcome light upon the present aspect of cotton culture in India. He says that the cotton seed sent to him was sown in April, and succeeded wonderfully: many of the plants are over three feet high, and six feet in circumference round the bush. Some sea-island cotton sown a few days before has been giving an early crop for some time. The New Orleans seemed to thrive best: it has been in flower for a few days. The reason of the sea-island giving an early crop is believed to be that after frequent and regular watering, it was passed over once or twice, and the check thus caused during the hot winds made it flower. An early crop might in this way be got from all second year's plants before the rains come on, if it would not weaken the plants too much. Dr. H. visited some wells where Egyptian seed had been distributed, and found that very little had germinated, and also that the plants were mixed with native cotton. The Zeminders say what is very true, that they cannot afford to try experiments: they know exactly the value of country cotton, but had no experience of the American sorts. It seems that the best mode of securing a fair trial of American cotton by the Zeminders would be for government or local committees to adopt the same method as Mr. Wightman does,—to supply seed known to be good, to stipulate for its being sown in a particular way, and to guarantee a certain amount per beegah, so that if the crop failed, the Zeminder would not lose by it. If in each district eight or ten beegahs were thus grown, the natives would be able to judge for themselves as to the advantage of growing foreign cotton. Dr. H. sowed some New Orleans seed near a road leading to the Cutchery, and, as expected, the Zeminders often came to look at the plants, and asked questions about the new cotton.

23. Indian Bamboos.—Efforts are being made to extend the growth of the bamboo as widely as possible throughout the Punjab. The kinds of which seeds are being collected for distribution are these:

1. The hollow bamboo of the plains.

2. Solid bamboo of the lower hills, of which spear handles and clubs are usually made.

3. The Nirgali, or small bamboo of the hills, growing at elevations from 5,000 to 8,000 feet.

4. The Garroo, or still smaller hill bamboo, growing at higher elevations, probably up to 12,000 feet.

Enquiries have been set on foot to ascertain, if possible, from the people, the intervals which elapse between the seasons of flowering of the several varieties, a point on which the more observant ought to be able readily to furnish information; as after flowering and yielding seed, the entire tract of bamboo which has seeded simultaneously dries up and perishes, fresh plantations springing up from the seeds which have been scattered by the old stock.

24. Box wood and Olive wood for the Engraver.—The following remarks by Dr. Cleghorn, the chief botanist in India, accompanied samples of wood-engraving received from Dr. Hunter of the Madras School of Arts:—

"Some months ago I sent small logs of box and olive from Kooloo, and, as you perceive, both of these woods answer well for engraving. They show that the wood cuts smoothly, and has working qualities adapted for the graver to print from.

"The enclosed twig of box (*Buxus sempervirens*) is taken from a tree in Mr. McLeod's *arboretum* at Dharmsalla, a spot well worthy of a visit, containing many introduced Himalayan trees of great interest, as well as many European fruit-trees adapted to this hill station. It is perhaps the only collection of indigenous Alpine trees in the Punjab; the nearest approach to it being that of Mr. Berkeley at Kotghur. I hope the day is not far distant when the Punjab Agri-Horticultural Society may have a Hill garden affiliated with it, at one of the *Sanitaria* of the province.

"The Himalayan box appears to be identical with the tree common all over southern Europe, from Gibraltar to Constantinople, and extending into Persia. It is found chiefly in valleys at an elevation of from 3,000 to 6,000 feet. I have met with it from Mount Tira near Jhelum, to Wangtu Bridge on the Sutlej. It is variable in size, being generally seven to eight feet high, and the stem only a few inches thick, but attaining sometimes a height of fifteen to seventeen feet, as at Mannikarn in Kullu, and a girth of twenty-two inches as a maximum. The wood of the smaller trees is often the best for the turner and the wood-engraver. It is made by the villagers into little boxes for holding ghee, honey, snuff, and tinder. At the medical stores in Sealkote it is turned into pill-boxes; and it appears to be adapted for plugs, trenails, and wedges. The wood is very heavy, and does not float; it is liable to split in the hot weather, and should be seasoned, and then stored under cover.

"The Olive *Zaitoon*, which has also been tested for wood-engraving at the Madras School of Arts, is another plant of the Mediterranean Flora which range from the coast of the Levant to the Himalaya. It varies a good deal in the shape of its leaves and in the amount of ferruginescence; hence the synonyms *cuspidata* and *ferruginea:* but it does not appear to differ specifically from the *Olea Europea* of the Mount of Olives,—the emblem of peace and plenty. The finest specimens I have seen are in the Kaghan and Peshawur valleys, where the fruit resembles that of rocky sites in Palestine or Gibraltar. The wood is much used for combs and beads, and is found to answer for the teeth of wheels at the Madhopore workshops."

25. Nettle Fibre.—It is perhaps not generally known in Canada that the exquisitely beautiful fibre known as China grass-cloth, and so much in favor for the best kinds of ladies' handkerchiefs, is obtained from an Indian nettle. No doubt the American *Urtica gracilis*, which grows abundantly about the Falls of Niagara and elsewhere in Canada, might be turned to good account, were our Agricultural Associations to direct attention that way. Dr. Cleghorn tells us that the *Urtica heterophylla* (the species cultivated by Mr. McIver at Ootakamund) is plentiful in Simla, having followed man to the summit of Jako, attracted by moisture to an elevation unusual for any member of the family. It is found within the stations of Dalhousie and Dharmsalla, and at many intermediate points. The quantity is surprising, wherever the soil has become enriched by the encamping of cattle. The growth at this season also is luxuriant in shady ravines near houses, where there is abundance of black mould; but the sting being virulent, the plants are habitually cut down as a nuisance, both by private persons and municipal committees.

There are other plants of the nettle tribe, particularly *Bohmeria salicifolia*, "siharu," used for making ropes (to which attention has been directed by Dr. Jameson). This plant does not sting, and is abundant at low elevations.

Large prizes were to be given for quantities of the nettle fibres to be delivered at Lahore in October 1863. The fibre brings from £16 to £18 sterling per ton in London.

26. DIATOMS OF THE SOUTH PACIFIC.—Dr. Greville has described, with exquisite figures, (Trans. Bot. Soc. Ed.,) numerous new species of diatoms obtained from dredgings in the South Pacific. There are two new genera, viz.: *Stictodesmis*, Grev., and *Omphalopsis*, Grev., and thirty-one new species.

Halifax, N. S. Jan. 7, 1864.

(To be Continued.)

CAVE IN LIMESTONE NEAR MONTREAL.

BY H. G. VENNOR.

Under a similar heading to the above, this cave is noticed in the Canadian Naturalist and Geologist, Vol. III, page 192. To that article we would refer those interested, for the exact position of this cave. The party or parties, who then visited this curiosity—if I may so call it—found it filled with several feet of water, and were unable to give it any satisfactory examination. On the 11th of November last I visited the cave, and had no difficulty whatever in finding it. Of late years, the entrance has been considerably enlarged. Formerly, the opening was situated between the roots of a tree, which is yet standing in the vicinity; but some time since, the earth was slightly cut away, exposing the surface of the rock, and greatly enlarging the means of access to this cavern. From the outside, the limestone has a very rusty and weather-worn appearance, and is of a shaly texture. The whole surface is filled with the fossil shells and corals peculiar to the Trenton limestone. The mouth of the caves is about four feet high, by six feet in width. On entering, I was agreeably surprised to find that the water had entirely subsided into a narrow well, or fissure in the floor, some twenty feet distant from the mouth of the cave. Standing by this well, the room was about thirteen feet high by eight feet in width. The walls jutted out irregularly on either side, but gave the average width of eight feet. The ceiling was also of limestone rock, and coated over with stalactitic carbonate of lime, from which hung a few small stalactites. In the sides of the chamber were numerous deep fissures, hardly large enough to admit an arm, and lined with the same mineral.

In these fissures could be seen very perfectly the formation of satalactites and stalagmites,—the former meeting the latter half way. Some of the stalactites were of a beautiful needle-like shape, and about four or five inches long. These we could not procure, as they were beyond our reach; but they may be plainly seen by holding a candle in the crevice. Before passing farther into the cave, let us for a moment examine the well. It is affirmed by the people in the neighborhood that no bottom has yet been found to it. But on questioning them, we found that their bottomless measure was two pairs of reins tied together. It is however a difficult depth to measure, as it runs down very irregularly, and at angles. The water is clear, and very cold, and has a strange greasy touch. It is surprising to see its transparency, when it has this thick and oily touch; it yet remains to determine whether this well is fed by springs, or by the drippings from the roof of the cavern. Leaving the well, we push on, and after ascending a few feet, come to two passages, one leading to the right, the other to the left. The entrance to the one on the right is about two feet square, and leads into a small room or passage running into the rock. This passage is about thirty feet long, and two or three broad, ending in a narrow fissure which seems to run deep into the limestone. This fissure is too small for one to enter with any comfort, though I believe it widens some few feet farther in. Turning with difficulty, we retraced our steps, and came before the passage running to the left.

This at the entrance was two feet high and six feet wide; but on entering, we found ourselves in a small room, about eight feet high, and six wide. At its extremity another fissure ran down into the rock, which looked as if it had at one time been a pretty large passage. Indeed, so shaly and loose are these rocks, that by the action of water and the frosts, this cave may be, ere long, entirely blocked up. The *habitans* state that it was at one time much larger than it is now. In the first, or entrance-chamber, were found sticking to the roof, and sparkling with moisture, six beautiful species of moths: two of these, are now in the Society's collection. These moths were snugly ensconced in the cracks of the rock; sleeping quietly, until the genial breath of spring and the songs of returning birds should rouse them again to their out-door employments. Besides moths, bats also had taken up their quarters in this cave, and flew around, sadly disconcerted by our intrusion. In the paper alluded to in the beginning of this article, it was stated that if the water could be pumped out of this cave, bones might be found at the bottom. I may just mention, before concluding this brief description, that the cave is now entirely free from water, and that no bones have been found as yet; but a search into and amongst the loose soil at the bottom, may be, and I think would be, well worth attempting.

CONTRIBUTIONS TO LITHOLOGY.*

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Introduction.

In a recent paper on *The Chemical and Mineralogical Relations of Metamorphic Rocks* (Silliman's Journal [2], xxxvi, 214),† an attempt was made to define the principles which have presided over the formation of sedimentary rocks, and to explain the nature and conditions of their alteration or metamorphism. That paper may be considered as to a certain extent introductory to the present one, which will contain, in the first part, some theoretical considerations which it is conceived should serve as a basis to lithological studies. In the second part will be given a few definitions which may serve to render more intelligible the classification and nomenclature of crystalline rocks; while a third part will contain the results of the chemical and mineralogical examination of some of the eruptive rocks of Canada; and a fourth, some examples of local metamorphism. The most of the results appear in the recent published Geology of Canada.

I. Theoretical Notions.

I have already, in other places, expressed the opinion that the various eruptive rocks have had no other origin than the softening and displacement of sedimentary deposits; and have thus their source within the lower portions of the earth's stratified covering, and not beneath it. The theory which conceives them to have been derived from a portion of the interior of the earth still retaining its supposed primitive condition of igneous fluidity, is in my

* From *Silliman's Journal* Vol. xxxvii, page 248.

† *Canadian Naturalist*, Vol. viii, page 195.

opinion untenable. It is not here the place to discuss the more or less ingenious speculations of Phillips, Durocher, and Bunsen as to the constitution of this supposed fluid centre, nor the more elaborate hypothesis of Sartorius von Waltershausen as to the composition and arrangement of the matters in this imaginary reservoir of plutonic rocks. The immense variety presented in the composition of eruptive masses presents a strong argument against the notion that they are derived, as these writers have supposed, from two or more zones of molten matter, differing in composition and density, and lying everywhere beneath the solid crust of the earth; which, in opposition to the views of many modern mathematicians and physicists, the school of geologists just referred to regard as a shell of very limited thickness.

The view which I adopt is one the merit of which belongs, I believe, to Christian Keferstein, who, in his *Naturgeschichte des Erdkörpers*, published in 1834, maintained that all the unstratified rocks, from granite to lava, are products of the transformation of sedimentary strata, in part very recent; and that there is no well-defined line to be drawn between neptunian and volcanic rocks, since they pass into each other (vol. i, p. 109.) This view was subsequently, and it would seem, independently brought forward in 1836 by Sir John Herschel, who sought to explain the origin of metamorphism and of volcanic phenomena by the action of the internal heat of the earth upon deeply buried sediments impregnated with water. (Proc. Geol. Soc. of London, vol. ii, pp. 548, 596.) See also my papers in the Canadian Journal, 1858, p. 206; Quar. Jour. Geol. Soc. 1859, p. 488; Can. Naturalist, Dec. 1859; and Silliman's Journal [2], vol. xxx, p. 135.

The presence of water in igneous rocks, and the part which it may play in giving liquidity to all volcanic and plutonic rocks, was insisted upon by Poulett Scrope, so long ago as 1824, in his *Considerations on Volcanoes*. (See also Quar. Jour. Geol. Soc. London, xii, 341,) This view has since been ably supported by Scheerer in his discussion with Durocher. (Bul. Soc. Geol. France [2], iv, 468, 1018; vi, 644; vii, 276; viii, 500.) See also Elie de Beaumont, ibid., iv, 1312. The admirable investigations of Sorby on the microscopic structure of crystals (Quar. Jour. Geol. Soc., xiv, 453) have since demonstrated that water has intervened in the crystallization of almost all plutonic rocks. He has shown that the quartz both of granites and crystalline schists contains great numbers of small cavities partially filled with water, or with concentrated aqueous solutions of chlorids and sulphates of potassium, sodium, calcium, and magnesium, sometimes with free hydrochloric acid. Similar fluid-cavities were found by him in most crystals artificially formed in aqueous solutions; and were also observed in the minerals from the limestones of Vesuvius, where they occur in nepheline, idocrase, hornblende, and feldspar; the liquid in the latter crystals containing, besides chlorids and sulphates, alkaline carbonates. Mr. Sorby has also described the cavities filled with vitreous and with stony matters which he has observed in quartz, in the feldspar of pitchstones, in augite, leucite, and nepheline; and which are sometimes found associated with fluid-cavities in the same mineral. As these fluid-cavities enclosed the liquid at an elevated temperature, its subsequent cooling has produced a partial vacuum, which is again filled on heating the crystal; so that the temperature of the crystals at the time of their formation may be approximatively determined. Mr. Sorby concludes that every peculiarity in the structure of the quartz of the veins in Cornwall, "may be most completely explained by supposing that this mineral was deposited from water holding various salts and acids in solution, at temperatures varying from 200° C. to a dull red heat visible in the dark" (about 340° C.). At this highest temperature he conceives that other minerals, such as mica, feldspar, and tinstone were deposited; the latter mineral containing numerous small fluid-cavities. In like manner, he deduces from the fluid-cavities in the Vesuvian minerals just noticed, a temperature of from 360° to 380° C. The presence at the same time of bubbles or vapor-cavities, and of glass and stone cavities in these crystals shows them to have been formed "at a dull red heat under a pressure equal to several thousand feet of rock, when water containing a large quantity of alkaline salts in solution was present, along with melted rock, and various gases and vapors. * * * * I therefore think that we must conclude provisionally, that at a great depth from the surface, at the foci of volcanic activity, liquid water is present along with the melted rocks, and that it produces results which would not otherwise occur." (Loc. cit., p. 483.)

Mr. Sorby has, as we have just seen, determined the temperature requisite to expand the liquid so as to fill the fluid-cavities, provided they were formed under a pressure not greater than the elasadjacent broken silicious strata; thus assuming for small distances, the characters of an intrusive rock. For some figures and descriptions illustrating these broken and distorted strata, see Geology of Canada, pp. 27, 28. We may also allude in this connection to the observations of Dr. Hitchcock among the altered strata of the Green Mountains, which seem to show that the pebbles of gneiss and of quartz in certain conglomerate beds have been so softened as to have been flattened, laminated, and bent around each other. (Silliman's Journal [2], xxxi, 372.) Hence, while the tendency of the various observations above cited is in favor of the indigenous character of many rocks hitherto regarded as eruptive, we have at the same time evidence that these rocks are occasionally displaced. We should not therefore on *a-priori* grounds reject the assertion that any metamorphic sediment may sometimes occur in an exotic or intrusive form. A given rock, like limestone or diorite, may occur both as an indigenous and exotic rock; and different portions of the same mass may be seen by different observers under such unlike conditions that one may regard it as indigenous, and the other, with equal reason, may set it down as intrusive. It is evident then that to the lithologist, who examines rocks without reference to their geological relations, the question of the exotic or indigenous character of a given rock is, in most cases, one altogether foreign; and one which can frequently be decided only by the geologist in the field. Hence, although generally made a fundamental distinction in classification, it will be disregarded in the following sketch of the nomenclature of crystalline rocks.

I may here allude to a fact which I have already noticed, and tried to explain, (Silliman's Journal [2], xxxi, 414, and xxxvi, 220, *note*,) that throughout the great metamorphic belt which constitutes the Appalachian chain, exotic rocks are comparatively rare (at least in New England and Canada); but abound, on the contrary, among the unaltered strata on either side. Illustrations of this are seen in the valley of Lake Champlain, and in its northward continuation toward Montreal, in those of the Hudson and Connecticut, and in the northeastward continuation of the latter valley by Lake Memphramagog to the Bay of Chaleurs, which is marked throughout by intrusive granites. In accordance with the reasons already assigned for this distribution of exotic rocks, it is probable that a similar condition of things will be found to exist in other regions; and that eruptive rocks will, as a general rule, be found among unaltered, rather than among metamorphic strata. It is of course possible that a crystallization of the sediments may in some cases take place subsequent to the eruption of foreign rocks into their midst. The rarity of intrusive rocks among crystalline strata, not less than the unaltered condition of sediments which are traversed by abundant intrusive masses, is a strong proof of the fallacy of the still generally received notion which connects metamorphism with the contiguity of eruptive rocks.

II. Classification and Nomenclature.

It is proposed in this second part, to describe briefly the composition, structure, and nomenclature of the various crystalline silicated rocks, considered without reference to the distinction between indigenous and intrusive masses. Comparatively few of these rocks are homogeneous, or consist of a single mineral species, and the names which have been applied to varying mixtures of different species are of course arbitrary; and as they have often been given without any previous mineralogical study, it sometimes happens, that, as in the case of the rocks composed of anorthic feldspars and pyroxene, different names have been proposed for varieties very closely related, or differing from one another only in texture or in structure.

The minerals essential to the composition of the rocks under consideration are few in number, and are as follows: quartz, orthoclase; a triclinic feldspar which may be albite, oligoclase, andesine, labradorite, or anorthite; scapolite, leucite, nepheline, sodalite; natrolite, or some allied zeolite; iolite, garnet, epidote, wollastonite, hornblende, pyroxene, olivine, chloritoid, serpentine, diallage; muscovite, phlogopite, and some other micas; chlorite, and talc. To these may be added as accidental ingredients, the carbonates of lime, magnesia, and protoxyd of iron, together with magnetite, ilmenite, and sphene. The silicates which, like tourmaline, beryl, zircon, spodumene, and lepidolite, contain considerable portions of the rarer elements, and often occur with quartz and feldspar in granitic veins, whose origin has already been alluded to, enter at most in very small quantity into great rock-masses.

The varieties of structure in crystalline rocks are the more deserving of notice as they have led to a great multiplication of names. We may note first the granitoid structure, in which the mineral elements are distinctly crystalline, as in granite. From indigenous rocks, or sediments altered *in situ*, and exotic rocks, or sediments displaced and translated, forming eruptive and intrusive masses. Under the head of exotic rocks is however to be included another class of crystalline aggregates, which are for the most part distinguished by their structure from injected or intrusive masses. I refer to the accumulations which fill mineral veins, and which doubtless have been deposited from aqueous solutions. While their peculiar arrangement, with the predominance of quartz and non-silicated species, generally serves to distinguish the contents of these veins from those of injected plutonic rocks, there are not wanting cases in which the predominance of feldspar and mica gives rise to aggregates which have a certain resemblance to dykes of intrusive granite. From these however, true veins are generally distinguished by the presence of minerals containing boron, fluorine, phosphorus, cœsium, rubidium, lithium, glucinum, zirconium, tin, columbium, etc.; elements which are rare, or found only in minute quantities in the great mass of sediments, but are here accumulated by deposition from waters, which have removed these elements from the sedimentary rocks, and deposited them subsequently in fissures.

No one at the present day will probably be found to deny the plutonic origin of most non-stratified rocks, so that the once vexed questions of the neptunists and plutonists may be regarded as settled. If however we go back but a few years in the history of geology, it will be found that an eruptive origin was then claimed for many rocks which are now admitted to be indigenous. It is scarcely necessary to refer to the views of those who have maintained the exotic character of many quartzites and crystalline limestones, when a majority of writers, even to the present day, class serpentines, euphotides, and hyperites among eruptive rocks; although the experience of every field-geologist is accumulating, from year to year, a great mass of evidence in favor of the indigenous nature of all these rocks. The sedimentary and indigenous character of very many granites, syenites, and diorites will now no longer be questioned. Thus we find, for example, that the melaphyres of the Tyrol, which, in Von Buch's too-famous theory of dolomitization, were supposed to have been erupted together with magnesian vapors which effected the alteration of the adjacent limestones, have been shown by Fournet to be sediments of Carboniferous age, metamorphosed *in situ*,—indigenous rocks, which were altered before the Jurassic dolomites were deposited. (Bul. Soc. Geol. France [2], vi, 506–516). In like manner we find Scipion Gras concluding from his researches on the anthracitic rocks of the Alps, that the serpentines, euphotides, porphyries, and spilites, which are there found associated with crystalline schists, are all of sedimentary origin, but have been so profoundly altered *in situ* as to have lost nearly all traces of sedimentary origin. (Ann. des Mines [5], v, 475.) We might add that the tendency of recent investigations has been to show that the protogines, or granites of the summit of the Alps, are Tertiary strata altered in place; thus confirming the bold assertion made by Keferstein in 1834, that these granites are altered strata of *flysch*. (This Journal [2], xxix, 123, 124.) Lesley's recent investigations of the granites of the White Mountains of New Hampshire, show them to be clearly stratified sedimentary deposits in nearly horizontal layers. (American Mining Journal, 1861, page 99; Silliman's Journal [2], xxxi, 403.) The ophites (amphibolites) of the Pyrenees, which by Dufrenoy and other French geologists have been regarded as eruptive, and were by the former imagined to be in some mysterious manner related to the rock-salt and gypsum of the region, which he supposed to be, like the ophites, of posterior origin to the enclosing strata (Explic. de la Carte Geol. de France, i, 95), are according to a recent note by Virlet, not eruptive, but altered indigenous rocks; belonging, together with the associated gypsum and saliferous strata, to the Triassic series. (Comptes Rendus de l'Acad., Aug. 1863, p. 232).

It would be easy to multiply examples of this kind, which show that a careful study of very many of the crystalline rocks hitherto regarded as eruptive, leads to the conclusion that they are really indigenous rocks. At the same time, many of these indigenous rocks appear to have been at one time in a soft semi-fluid condition, which permitted movements obliterating the marks of sedimentary origin, and producing other results which show the passage into eruptive rocks. Thus the crystalline limestones of the Laurentian series in Canada are frequently interstratified with thin beds of gneiss and quartzite, both of which are often found broken, contorted, and even twisted spirally, in a manner which indicates great flexibility of the silicious layers, as well as violent movements in the calcareous rock. The latter is in some cases found in the form of thin seams or considerable dykes among the tic force of the vapor. This of course represents the lowest temperature at which the consolidation could have taken place, and varies from 340° to 380° in the Vesuvian minerals, and 356° in the quartz of the trachyte of Ponza, to a mean of 216° in the Cornish granites, to 99° in those of the Scottish Highlands, and even descends to 89° in some parts of the granite of Aberdeen. But this low temperature is improbable, and inasmuch as water and aqueous solutions are compressible, their volume would be considerably reduced under a great pressure of superincumbent rock. Mr. Sorby has therefore calculated the pressure in feet of rock which would be required to compress the liquid so much that it would just fill the cavities at 360° C. The numbers thus obtained will therefore represent the actual pressure, provided the rock was in each case consolidated at that temperature. It would thus appear that the trachyte of Ponza was solidified near the surface, or beneath a pressure of only 4000 feet of rock; while for the Aberdeen granite the pressure was equal to not less than 78,000 feet, and for the mean of the Highland granites 76,000. The Cornish granites vary from 32,400 to 63,600, and give as a mean 50,000 feet of pressure. In this connection Mr. Sorby remarks that from Mr. Robert Hunt's observations on the mean increase of temperature in the mines of Cornwall, a heat of 360° C. would be attained at a depth of 53,500 feet.

The observations upon the metamorphic crystalline schists in the vicinity of these various granites show that their constituent minerals must have crystallized at about the same temperature as the granite itself; affording, as Mr. Sorby observes, "a strong argument in favor of the supposition that the temperature concerned in the normal metamorphism of gneissoid rocks was due to their having been at a sufficiently great depth beneath superincumbent strata"; and he concludes that with regard to rocks and minerals formed at high temperatures, we have "at one end of the chain erupted lavas, indicating as perfect and complete fusion as the slags of furnaces, and at the other end simple quartz-veins, having a structure precisely analogous to that of crystals deposited from water. Between these there is every connecting link, and the central link is granite." When the water, which at great depths was associated with the melted rock, was given off as vapor while the mass remained fused, slag-like lavas resulted. If however the water could not escape in vapor, it remained, as we have seen, to take its part in the crystallization, in some cases forming hydrated minerals; and the excess of it, as Mr. Sorby suggests, passed up as a highly heated liquid, holding dissolved materials, which would afterwards be deposited in the form of mineral veins in the fissures of superincumbent rocks.

I have thought it well to give at some length the remarkable results and conclusions by Mr. Sorby, because I conceive that they have not as yet received the full degree of consideration to which they are entitled, and are perhaps little known to some of my readers.* The temperature deduced by him from the examination of the crystals of hornblende and feldspar from Vesuvius is curiously supported by the experiments of Daubrée; who obtained crystallized pyroxene, feldspar, and quartz, in presence of alkaline solutions, at a temperature of low redness; while De Senarmont crystallized quartz, fluor-spar, and sulphate of barytes in presence of water, at temperatures between 200° and 300° C. At the same time the deposits from the thermal waters at Plombières show that crystalline hydrous silicates, such as apophyllite, harmotome, and chabazite, have formed at temperatures but little above 80° C.

We conceive that the deeply buried sedimentary strata, under the combined action of heat and water, have, according to their composition, been rendered more or less plastic, and in many cases have lost to a greater or less degree the marks of their sedimentary origin, although still retaining their original stratigraphical position. In other cases they have been displaced, and by pressure forced among disrupted strata, thus assuming the form of eruptive rocks; which, becoming consolidated under a sufficient pressure, retain the same mineral characters as in the parent beds. It is only those rocks which, like lavas, have solidified at or near the surface of the earth, and consequently under feeble pressure, which present mineralogical characters dissimilar to those of the undisturbed crystalline sediments. With this exception, the only distinction which can be drawn between stratified and unstratified masses must in most cases be based upon their attitude, and their relation to the adjacent rocks.

In view of these considerations I have, in previous papers, adopted for geological purposes a division of crystalline rocks into

* See further the late observations of Zirkel confirming those of Sorby. Proc. Imp. Acad. Vienna, March 12, 1863; in abstract in Quar. Jour. Geol. Soc., vol. xix.

ite), natrolite, iolite, and magnetite are sometimes found as elements in granitic, gneissic, and syenitic rocks. The name of miascite is given to a granitic minature of orthoclase and black mica with elæolite, sometimes with hornblende, albite, and quartz.

The structure of these orthosite rocks gives rise also to a great variety of names; thus to coarsely lamellar granites the name of pegmatite is sometimes given, while fine-grained mixtures of orthoclase and quartz have received the names of granulite, leptinite, and eurite, or when apparently homogeneous and crypto-crystalline are called petrosilex. These latter forms often become porphyritic from the presence of crystals of orthoclase, giving rise to orthoclase-porphyry, or orthophyre. In some of these porphyries, as in those of Grenville, to be described in the third part of this paper, quartz is also present in distinct grains or crystals; while in some of the red antique porphyries the feldspathic base contains no excess of silica, and occasionally encloses crystals of oligoclase or of hornblende. In many cases the granites, syenites, orthophyres, and other orthosite rocks just mentioned are intrusive; while in other instances, rocks lithologically indistinguishable from these are indigenous, and becoming schistose pass into gneiss and mica-schist.

The rocks to which the name of trachyte has been given are generally composed in great part of orthoclase (sanidine). The typical varieties of these rocks are white or of pale colors, granular or finely crystalline, and frequently porous or cellular. They appear to consist of grains, crystals, or lamellæ of orthoclase, aggregated without any cementing medium, and to this seems to be due that roughness to which the rock owes its name. Oligoclase, quartz, hornblende, and mica are also met with in this rock, which becoming coarsely granular, passes into granite. Such is the case with the trachytes of the Sierra of Carthagena in Spain, described by Fournet as passing from a dull rough grayish feldspathic mass, into a highly crystalline aggregate of feldspar and mica, with or without hyaline quartz, enclosing hornblende, red garnet, and fine blue iolite. (Comptes Rendus, xliv, p. 1834.)

The trachytic texture is not confined to orthosite rocks. Abich has described under the name of trachy-dolerites a group of trachytoid anorthosites (dolerites). The cone of the Soufrière of Guadaloupe is described by Deville as a rough granular rock having the external characters of tràchyte, from which it is distinguished by its somewhat greater density (2·75). It consists essentially of labradorite, with a little quartz, pyroxene, olivine, and magnetite. (Bul. Soc. Geol. de France [2], viii, 425.) Humboldt designates the trachy-dolerites of Etna and of the Peak of Teneriffe as trachytes (Comptes Rendus, xliv, 1067); so that this word, like porphyry, comes to indicate nothing more than a peculiarity of structure, which may be assumed by various feldspathic rocks. The trachytic orthosites, as we have seen, pass into granites, from which they do not differ in chemical composition; and their differences in texture probably depend upon the fact that the one was solidified under great pressure, and the other near the surface, trachytes passing in fact into lavas. The observations of Sorby on the fluid-cavities in the crystals of granites and of trachytes are in point.

Among the intrusive rocks of Canada to be described are granitoid, compact, and earthy varieties of trachytic orthosites, besides trachytic porphyries. These rocks often contain disseminated earthy carbonates, sometimes in considerable amount; as Deville had already shown for some of the trachytes of Hungary, and as I have also observed for those of the Siebengebirge on the Rhine. Trachytes also hold in some cases disseminated portions of a zeolite, apparently natrolite; and through this mixture pass into phonolites, of which a characteristic variety will be noticed in this paper. Obsidian and pumice-stone, which are often associated with orthoclase trachytes, are related to them in composition; and pitchstone and perlite are similar rocks, differing however in containing some combined water. Rocks resembling pitchstone, and sometimes porphyritic from the presence of distinct crystals of feldspar, occur in the south side of Michipicoten Island, Lake Superior, but have not yet been examined. (Analyses by Jackson and by Whitney of the pitchstones of Isle Royale will be found in Silliman's Journal [2], xi, 401; xvii, 128.)

The presence of an anorthic feldspar, generally oligoclase, in many granites and trachytes, not less than the admixture of orthoclase crystals in some of the trachytic dolerites of Etna, serves to connect the orthosite with the anorthosite family. Great masses of indigenous rock in the Labrador series in Canada, are made up of almost pure granular labradorite, or related triclinic feldspars, and might be termed normal anorthosites. (Silliman's Journal [2], xxxvi, 224; Geol. of Canada, 588.) In most cases however, these feldhowever be found that the line between the two classes cannot always be distinctly drawn; inasmuch as rocks containing orthoclase and quartz often include triclinic feldspars such as albite and oligoclase, and by an admixture of hornblende offer a transition to rocks of the second class. On the other hand, quartz is sometimes found with triclinic feldspars and hornblende in the rocks of the second class. Besides these two feldspathic classes, there is a third small but interesting group, in which an aluminous silicate of high specific gravity, such as garnet, epidote, or zoisite replaces the feldspar wholly or in part. These minerals being basic silicates rich in alumina, the relations of this group are naturally with those of the second class, although varieties of these species are found in rocks which belong to the first class.

The silico-aluminous crystalline rocks may thus be conveniently divided into three families. The first of these includes those rocks in which the aluminous mineral is orthoclase (orthose), from which they may be conveniently designated by the name of the *orthosite* family. The second includes those in which the aluminous element is an anorthic or triclinic feldspar, and may be designated as the *anorthosite* family: chemically related to this are those rocks holding as one of their elements nepheline, leucite, or scapolite. The third family includes those rocks which contain an aluminous silicate of high density, as epidote, zoisite, garnet, andalusite, or kyanite, in place of a feldspathide. Iolite or dichroite, which enters into the composition of some orthosite rocks, appears from its atomic volume to be related to the feldspars, and should take its place along-side of anorthite and scapolite as a magnesian feldspathide, while beryl in like manner appears to be a glucinic feldspathide.

It is worthy of notice, that some feldspars having the crystallization and density of orthoclase, nevertheless contain large proportions of soda. The loxoclase of Breithaupt appears from the analyses of Smith and Brush to be a true soda-orthoclase (Silliman's Journal [2], xvi, 43); while the sanidine or glassy feldspar of many trachytes contains potash and soda in nearly equal proportions. The name of potash-albite has been given to some feldspars of this composition; but the trachytic rocks hereafter to be described contain feldspars, which, without being glassy, have the composition of sanidine, together with a cleavage and specific gravity which show them to belong to orthoclase, rather than to albite. The anorthic feldspars offer in their composition such gradations from albite to anorthite, that the various intermediate species which have been distinguished seem to pass into each other. (Silliman's Journal [2], xviii, 270, Phil. Mag. [4], ix, 262.)

Next to the feldspars in lithological importance are the two species, pyroxene and hornblende. These are sometimes found associated in the same rock, and the varieties of pyroxene known as diallage and smaragdite are frequently surrounded or penetrated by hornblende. This association of the two species should be kept in mind, inasmuch as the substitution of pyroxene for hornblende in anorthosites, has been made the basis of a subdivision in classification. (Silliman's Journal [2], xxvii, 339.) Among the micas found in silicated rocks, besides muscovite and a magnesian mica (phlogopite or biotite), are to be included the hydrated micas observed by Haughton in many of the Irish granites. Of these the one is margarodite, and the other a uniaxial black mica, also hydrated, which he has referred to lepidomelane. (Trans. Royal Irish Acad., xxiii, 593.) The presence of from four to six hundredths of water in the micas of these granites is important in connection with the evidence already given of the intervention of water in the formation of granitic rocks. These two hydrous micas were often found by Haughton to be united in the same crystal; and Rose has remarked a similar association of potash-mica and magnesian mica in certain granites. (Senft, die Felsarten, p. 206.)

A scientific nomenclature for compound rocks presents such great difficulties that we must be content for the most part with trivial names which have from time to time imposed. In the case of simple rocks, the terms quartzite, pyroxenite, anorthosite, and orthoclasite are sufficiently definite, or they may be farther characterized as normal orthoclasite, etc.; while quartzose, micaceous, and quartzo-micaceo-hornblendic orthoclasite would designate various compound rocks of which orthoclase is the base. Such names, however descriptive, will never replace the older terms granite, syenite, etc., which are employed to designate certain forms of orthosite rocks. The frequent association of a triclinic feldspar (oligoclase) with orthoclase in granite rocks, and the partial or total replacement of the micas generally present in these, by hornblende, by chlorite, or by talc, giving rise in the latter case to what is called protogine, are well known. Nepheline (elæothis, there is a gradual passage through granular into compact varieties of rock. Most of these are simply finely granular, and are rightly entitled to the distinction of crypto-crystalline; but others, like the pitchstones, obsidians, and lavas, are apparently amorphous, and are natural glasses. In some cases the constituent minerals may be so arranged as to give a schistose or a gneissoid form to a rock. This arrangement is generally to be looked upon as an evidence of stratification; but something similar is occasionally observed in eruptive masses. In the latter case it generally seems to arise from the arrangement of crystals during the movement of the half-liquid crystalline mass; but it may in some instances arise from the subsequent formation of crystals arranged in parallel planes.

See on this point Naumann *On the Probable Eruptive Origin of Several Kinds of Gneiss, etc.;* Leonhard and Bronn, Neues Jahrbuch for 1847, and Poulett Scrope, Geol. Journal, xii, 345. I consider however that their views are to be adopted with great reserve, and admitted only in a very few cases. The ribbanded structure of some porphyries and clinkstones, as noticed by Scrope, is undoubtedly the result of movements in the liquid mass, and the same is true of some of the granitoid dolerites to be described in the third part of this paper; but the eruptive origin assumed by Darwin, Naumann, and some others for great areas of gneiss and gneissoid granite, seems to a student of the crystalline rocks of this continent utterly untenable. As has been already remarked, the progress of each year's investigation restores to the category of indigenous rocks many of those previously regarded as eruptive, and will, I am convinced, confirm the principle which I have laid down of the comparative rarity of exotic rocks in crystalline and in metamorphic regions.

Occasionally the crystallization of a rock takes places around certain centres, giving rise to rounded masses which have a radiated or a concentric structure, and constitute the so-called globular or orbicular rocks. Distinct crystals of some mineral, generally feldspar, augite, or olivine, are often found imbedded in rocks having a compact base. To such rocks the name of porphyry is given, and by analogy a rock with a granular base enclosing distinct crystals is designated as porphyritic or porphyroid. Amorphous or vitreous rocks, as pitchstones, are in like manner sometimes porphyritic. The name of porphyry, at first given to a peculiar type of feldspathic rocks, has now become so extended that it is to be regarded as only indicating an accident of structure. The title of amygdaloid is given to various rocks having rounded cavities which are wholly or partially filled with various crystalline minerals. The base of these rocks is generally granular or crypto-crystalline; but is sometimes amorphous, resembling a scoria or vesicular lava, the cavities of which have been filled by infiltration. Such is doubtless the origin of some amygdaloids. In more cases however these cavities have probably been formed like those often found in dolomites, and in some other rocks, by a contraction during solidification. Porphyroid rocks, in which quartz, orthoclase, and other minerals are arranged in orbicular masses, are also sometimes designated as amygdaloids, and may be confounded with the two previous classes in which the imbedded minerals are the result of subsequent infiltration. Allied in strucure and origin to the last are what are named variolites or variolitic rocks. (See Geology of Canada, pp. 606, 607.)

The masses into which some aluminous minerals enter as a prominent element constitute by far the greater part of the rocks now under consideration. These are naturally divided into two classes, whose origin we have pointed out in a recent paper already referred to. (Silliman's Journal [2], xxxvi, 218.) The first of these is characterized by containing an excess of silica, with a portion of alumina, much potash, and small portions only of lime, magnesia, and oxyd of iron. The second class contains a smaller amount of silica, and larger proportions of alumina, lime, magnesia, and oxyd of iron, with soda, and but little potash. These chemical differences are made apparent in the more coarsely crystalline rocks, by the nature of the constituent minerals; and in the compact varieties, by differences in color, specific gravity, and hardness. Thus in the rocks of the first class the predominant mineral is orthoclase, generally associated with quartz, and the composite rocks of this class seldom have a density much above that of these species; or from 2.6 to 2.7. In the second class, the characteristic mineral is a triclinic feldspar, with pyroxene or hornblende, the feldspar sometimes predominant; while in other cases the pyroxene or hornblende makes up the principal part of the rock. The presence of these latter minerals generally gives to the fine-grained rocks of this class a dark color, a hardness somewhat inferior to the more silicious class, and a density which may vary from 2.7 to more than 3.0. It will spars are intermingled with some other mineral, commonly hornblende or pyroxene.

The name of diorite is by good authorities restricted to rocks whose predominant elements are triclinic feldspars with hornblende; while the names of diabase and dolerite distinguish those rocks in which pyroxene takes the place of hornblende. In some anorthosite rocks however, pyroxene and hornblende are intimately associated, so that a passage is established from diorite to diabase. The feldspar of diorites varies in composition from albite to anorthite, and is occasionally accompanied by quartz. This, though most frequent with the more silicious feldspars, is sometimes met with in diorites which contain feldspars approaching to anorthite in composition. Sometimes the two constituent minerals are distinct and well crystallized, constituting a granitoid rock: fine examples of this, hereafter to be described, occur in the intrusive hills of Yamaska and Mount Johnson. At other times the diorite is finely granular or compact, when its color is generally of a green more or less dark from the disseminated hornblende, and it takes the name of greenstone. The greenstones of the Huronian series are in part at least diorites, and probably indigenous; but a great number of the so-called greenstone-traps are pyroxenic, and belong to the class of diabase or dolerite. Diorite not unfrequently contains a mica, which is generally brown or black in color. Chlorite, magnetite, ilmenite, and sphene often occur as disseminated minerals, as also carbonates of lime, magnesia, and oxyd of iron. The finer-grained diorites are frequently porphyritic from the presence of crystals of feldspar or of hornblende. Occasionally this rock is concretionary in its structure, as in the orbicular diorite or napoleonite of Corsica; which contains a feldspar allied to anorthite, with hornblende, and some quartz. The norite from Sweden is a granular mixture of a similar kind, containing also mica; and the ophite of some writers is a diorite in which hornblende greatly predominates.

The rocks which are essentially composed of anorthic feldspar and pyroxene, present still greater diversities than the diorites, and have received various names based upon differences in texture and in the form of the pyroxenic element. It is here proposed to restrict the name of dolerite to such of these rocks as contain the black augitic variety of pyroxene, and to include the mixtures of triclinic feldspars with all the other varieties of this species under the head of diabase. The finer-grained and impalpable varieties of diabase have received the name of aphanite; which is often indistinguishable from the corresponding forms of diorite, and like these may become porphyritic, giving rise to the augite-porphyry of some authors. Different varieties of this porphyry have received the name of labradophyre, oligophyre, and albitophyre, according to the composition of the imbedded feldspar crystals. These are sometimes accompanied by crystals of augite, or are altogether replaced by them.

The name of hyperite or hypersthenite has been given to those varieties of diabase which contain hypersthene or diallage. These rocks occur abundantly in the Labrador series, where the hypersthene in them sometimes takes the form of a green diallage, or passes intó a finely granular pyroxene, and is associated with red garnet, ilmenite, and a little brown mica; in addition to which epidote is said to occur in the hyperites of the same series in New York, and olivine is mentioned as being found in the hyperites of Sweden, and of the Island of Skye. Hornblende is also in some localities associated with the hypersthene. The hyperites, although indigenous rocks in the Labrador series in Canada, are described as forming in other regions intrusive masses.

Those varieties of diabase or hyperite which contain diallage, have, by the Italian lithologists been called granitone, but by Rose and others have been described under the name of gabbro. This rock sometimes contains hornblende, mica, and an admixture of epidote. A compact white or greenish-white epidote, or zoisite, which has the hardness of quartz and a density of 3.3 to 3.4, is the mineral named saussurite. This with smaragdite, which is an emerald-green pyroxene, often minged with hornblende, and passing into diallage, forms the euphotide of Hauy. Compact varieties of labradorite and of other triclinic feldspars have by most of the modern lithologists been confounded with saussurite, and hence the name of euphotide is frequently given to the so-called granitone or gabbro, which is only a diallagic variety of diabase. The true euphotide often contains a portion of talc, and sometimes encloses crystals of a triclinic feldspar, apparently labradorite, thus offering a transition to diabase. See farther my researches on euphotide and saussurite; Silliman's Journal [2], xxvii, 339, and xxxvii, 426.

Under the name of dolerite, as already remarked, it is proposed to class such anorthosite rocks as contain a black ferruginous pyroxene or augite. These rocks, which are sometimes coarsely granular or granitoid in their structure, pass into fine-grained or compact varieties, which are distinguished by the names of anamesite and basalt. To these latter varieties belong a great part of the greenstone-traps, although in rocks of this texture it is often impossible to determine whether it is hornblende or pyroxene which is mingled with the feldspar. Olivine in grains or crystals frequently occurs both in the fine-grained basaltic dolerites and the granitoid varieties, giving rise by its predominance to what is called peridotite. Some fine-grained dolerites are porphyritic from the presence of black cleavable augite crystals, forming an augite-porphyry. Finely disseminated carbonates of lime and oxyd of iron are occasionally present in these rocks to the extent of twenty per cent., and even more. In like manner, magnetite and ilmenite, which are often associated, may constitute several hundredths of the mass. Many fine-grained greenstones contain, like phonolite, large portions of some zeolitic mineral, and they often abound in chlorite. The pyroxene in these rocks is sometimes replaced by a highly basic silicate. Some varieties of what has been called diallage may be represented as an aluminiferous pyroxene *plus* a hydrate of magnesia. At other times a mineral approaching in composition to a ferruginous chlorite (frequently amorphous) enters into the composition of these anorthosites, and even in some cases appears to replace altogether the pyroxene or the hornblende, constituting an aberrant form of diorite or of diabase, which is not uncommon among greenstones, and for which a distinctive name is needed. See on this point Geology of Canada, pp. 469, 605, and the remarks on melaphyre below.

The finer-grained dolerites are often cellular, giving rise to amygdaloids, whose cavities are generally filled with calcite, quartz, or some zeolitic minerals. To these amygdaloids the name of spilite is sometimes given. Earthy varieties of basalt, which are frequently the result of partial decomposition, constitute the wacke of some writers. It is doubtful how far many of these spilites and wackes have a claim to be considered as crystalline rocks, inasmuch as they appear in very many cases to be nothing more than aqueous sediments accumulated under ordinary conditions, or perhaps in some cases derived from volcanic ash or volcanic mud. As the other extreme of this series of rocks we may notice that dolerites often assume a trachytic form,—the trachy-dolerites already mentioned,—or constitute the lavas from modern volcanoes.

Among the compound rocks which are related to the preceding group by the presence of augite, may be noticed nepheline-dolerite, in which nepheline replaces the feldspar; and analcimite, a variety into which analcime enters in large amount. Scapolite also in some cases replaces feldspar, and forms with green pyroxene, a peculiar aggregate associated with the Laurentian limestones. Leucite enters as an important element in some dolerites, and even replaces wholly the feldspathic element, giving rise to what has been called leucitophyre or leucilite.

[Leucite is generally regarded as an exclusively volcanic mineral; but according to Fournet, it occurs like other feldspars in mineral veins, forming the gangue of certain auriferous veins in Mexico (Géologie Lyonnaise, page 261). According to Scheerer, leucite also occurs in drusy cavities with zeolites and quartz at Arendal in Norway; although it would seem to be rare in this locality since Durocher was not able to detect it. (Annales des Mines [4], i, 218). The conditions required for the formation of this feldspathide must be peculiar, since the volcanic rocks which afford it are confined to a few localities; and since while it contains a large amount of potash it is a basic silicate, and found among highly basic rocks, in which potash compounds are generally present only in very small quantities. The agalmatolite rocks, including dyssyntribite and parophite (Geology of Canada, page 484), are however basic aluminous silicates in which potash predominates, and might be supposed under certain conditions of metamorphism to yield leucitic rocks.]

The name of melaphyre, which is employed by many writers on lithology requires a notice in this connection. It was proposed by Brongniart as a synonym for black porphyry (mela-porphyre), and defined by him in 1827 as a porphyry holding crystals of feldspar in a base "of black petrosilicious hornblende." (Classif. des Roches, page 106.) Subsequent researches showed that some of these porphyries were really augitic; and Von Buch employed the name of melaphyre as synonymous with augite-porphyry, in which he was followed by D'Halloy. (Des Roches, p. 75.) In consequence of this confusion, and of the vague manner in which the term is used to include rocks which are sometimes diorites and sometimes varieties of dolerite or basalt, Cotta seems disposed to reject the name of melaphyre as a useless synonym, in which I agree with him. (Gesteinslehre, page 48.) More recently however, Senft (Die Felsarten, page 263) has endeavored to give a new signification to the term, and defines melaphyre as a reddish-gray or greenish-brown colored rock, passing into black, and containing neither hornblende nor pyroxene. The melaphyres of Thuringia and of the Hartz, according to him, consist of labradorite with iron-chlorite (delessite), carbonates of iron and lime, and a considerable portion of titaniferous magnetic iron. Hornblende and mica are present only as rare and accidental minerals. We have already alluded to this class of anorthosite rocks, as requiring a distinctive name; but from the historical relations of the word melaphyre, it seems to be an unfortunate appellation for rocks which are not black in color, and from which both hornblende and pyroxene are absent.

We now come to consider that third group of silicated rocks, in which the feldspathides are replaced by the denser double silicates of the grenatide family, garnet, epidote, zoisite, and perhaps idocrase. Red garnet enters into many gneissic rocks, and even forms with a little admixture of quartz, rock-masses. In some of these, as in the Laurentian series, there appears an admixture of pyroxene, forming a passage into omphazite or eclogite; which consists of smaragdite (pyroxene) and red garnet, sometimes mixed with mica, quartz, and kyanite, and passes through an increase of the latter into disthenite or kyanite rock. An aggregate of hornblende and red garnet forms beds in the Green Mountains, and an admixture of red garnet with lievrite and a little mica makes up a rock in the Laurentian series. This is evidently related to eulysite, a rock forming strata in gneiss in Sweden, and consisting of garnet, pyroxene, and a mineral having the composition of an olivine in which the greater part of the magnesia is replaced by ferrous and manganous oxyds. Related to this is an apparently undescribed rock from the Tyrol, of which a specimen is before me, consisting of red garnet, green pyroxene, and yellowish-green olivine, the latter greatly predominating; and also a coarsely crystalline rock from Central France, recently described by the name of cameleonite, and composed of olivine, with pyroxene, and enstatite, a magnesian augite; these minerals being accompanied by spinel, sphene, and ilmenite. I have already alluded to the true euphotides, in which a compact zoisite (jade or saussurite) takes the place of feldspar in a rock the other element of which is pyroxene, and have shown how the occasional presence of a triclinic feldspar connects euphotide with diabase. (Silliman's Journal [2], xxvii, 336.) In the same paper are described rocks made up of a white compact garnet with and without hornblende and feldspar, and also an epidosite, composed of epidote and quartz.

By the disappearance of the aluminous silicate from the rocks of the second and third groups, a passage is established to the amphibolites and pyroxenites; and these, through diallage rock, offer a transition to the ophiolites or serpentines. These relations are well exhibited in Eastern Canada, where the diorites or greenstones, which are sometimes highly feldspathic, pass into actinolite rock and hornblende slate on the one hand, and into diallagic diabase and diallagic ophiolite on the other.

These greenstones, which contain a chloritic mineral, and are often epidotic, pass gradually into compact or schistose chloritic rocks, frequently enclosing modules or layers of epidote, either pure or mingled with quartz. The relations between these various rocks are such that after a prolonged study of them I find it difficult to resist the conclusion that the whole series, from diorites, diallages, and serpentines, to chlorites, epidosites, and steatites, has been formed under similar conditions, and that they are all indigenous rocks. (Geology of Canada, pp. 606, 612, 652.) I have elsewhere expressed the opinion that these silicates are probably of chemical origin, and have been deposited from solutions at the earth's surface. The sepiolite or hydrous silicate of magnesia, which occurs in beds in tertiary rocks, the neolite of Scheerer, the silicates of lime, magnesia, and iron-oxyd deposited during the evaporation of many natural waters; and the silicates of alumina like halloysite, allophane, and collyrite, and that deposited by the thermal waters of Plombières, all show the formation and deposition at the earth's surface of silicates, whose subsequent alteration has probably given rise to many minerals and rocks. (Silliman's Journal [2], xxxii, 286; and Geology of Canada, pp. 559, 577, 581). At the same time the phenomena of local metamorphism furnish evidences that similar compounds have resulted from the action of heat upon mechanical mixtures in sedimentary deposits. (Ibid., p. 581.) A further consideration of this subject, and of the two-fold origin of many silicious minerals, is reserved for another place.

(To be Continued.)

ON OCEAN DRIFTS AND CURRENTS.

By J. Matthew Jones, F.L.S.

The currents of the ocean may well be classed among the wonders of the world; and the most inattentive observer of the great truths of nature, can hardly fail to be struck with admiration on contemplating their magnitude, and considering the benefits derived from such movements.

Throughout the Atlantic, Pacific, Arctic, Antarctic, and Indian Oceans, these currents pass in particular directions, and with greater or less force, purifying the mass of fluid, and rendering it habitable to thousands of marine forms, which would otherwise languish and die for want of suitable nourishment. Great are the struggles which take place between currents and counter currents, especially those of large extent, and many are the instances on record of vessels being carried by their influence far out of their destined courses, to be cast away upon shores supposed to be many leagues distant. Of late years, more attention has been paid to these phenomena, and the works of Rennel, Smyth, Maury, and others have gained them a notoriety they well deserve, for assuredly to their power may be attributed the positive existence of many islands now colonized by animal and vegetable life.

If we take up a hydrographical chart of the world, we shall at once perceive the course of the various currents which are known to navigators at the present day. *First*—we have the Gulf Stream, issuing from the narrow strait between the southern extreme of Florida and the Bahamas, passing, at some distance from land, the coast of the American States, and gradually expanding its limits as it progresses, until about the latitude of Cape Cod, it diverges to the northeast, and proceeding onwards to the northern limits of the Banks of Newfoundland, meets the cold waters of the great Arctic current, which comes down from Davis Straits. Its rate is here lessened; but although the course is slow from this point, it steadily advances until it reaches the shores of Great Britain and Northern Europe. *Secondly*—we have the North African current, which sets from the latitude of the Azores, and taking the coast-line of Western Africa, proceeds along the shores of that country to the Gulf of Guinea, and even farther north. This stream, however, appears to divide its waters about the region of the Canaries, and sends a westerly branch towards the West Indies. *Thirdly*—we have the South Atlantic current setting from the Arctic Ocean, pouring its volumes between St. Helena and the main, until arriving at the northern edge of the North African current at the equator, it diverges to the westward, and flows into the Equatorial current which advances in a similar direction to the northern coast of Brazil, and sweeping past the coasts of Cayenne and Guiana, bends round the Gulf of Mexico, and heated in that vast cauldron to a high degree of temperature, rushes with great velocity through the Florida passage, and becomes the celebrated Gulf Stream. *Fourthly*—The main current of the Pacific is that known as the Peruvian current, which originates in the Antarctic drift current, and runs parallel with the South American coast from about the fortieth degree of south latitude to the northern shores of Mexico, whence it deviates, and rushes on to the westward across the Pacific, laving the shores of the whole intertropical islands until it arrives at New Guinea, and Australia, where it meets the counter currents from the Indian Ocean. *Lastly*—We have the Arctic current of the Atlantic, which sets from Baffin's Bay on the west, and Spitzbergen on the east side of Greenland, joining its parts at the northern extremes of the latter country, and as one vast stream, running its course to the Banks of Newfoundland, where it meets a barrier to its farther progress in the heated waters of the Gulf Stream.

Although the currents just enumerated include all the greater passages, yet there are divers others of less magnitude and extent which render service in disseminating around reproductive matter for the colonization of distant positions. In the Indian Ocean, for example, we have two currents running parallel with the continent of India, and another between the island of Madagascar and the adjoining coast of Mozambique, each exerting an influence on the country they pass. These, with the connecting and contra currents occurring in several positions, may be supposed to represent in some degree that progressive motion which agitates the wide expanse of ocean in different quarters of the globe.

Having thus far given a brief account of the positions and courses of these currents, let us consider their effect upon islands lying in or near their course, but far removed from any continent: but as it would extend this paper to an unusual length if we were to enumerate the many islands in each ocean which may be classed in the list, it will perhaps be advisable to select the more interesting localities where such effect is rendered more apparent, and where occurrences periodically take place, proving by clearest evidence the real existence of such positions, and the animal and vegetable life found upon them.

Probably we could not select a more perfect example of current-formed islands than the Bermudas, and as we have made their natural history our particular study, perhaps we may be allowed to express our opinion, founded upon fact and the clearest evidence, as to the origin of that remarkable group, which, with the exception of St. Helena, is supposed to be the most remote from land or island of any other in the world.

It will be well in the first place to explain the situation and nature of this group, in order that subsequent allusions to the same may be clearly understood.

The Bermudas, or Somer's Islands, consisting of four principal, and several smaller islands, lie off the coast of Carolina (the nearest land) at a distance of about six hundred miles; from Cape Sable, the northern extreme of Nova Scotia, about seven hundred and twenty miles; and in a northeast direction from Atwood's Keys, Bahamas, six hundred and fifty miles. They are of low elevation; the highest land, on which the light-house is built, being only two hundred and fifty feet above the sea level. The formation is entirely of calcareous sandstone, derived from broken shells, and corals, which varies in consistency in different parts of the islands. On surveying the group, we find the whole more or less clothed with cedar, save here and there, where cultivation occupies the ground, or the drift sand blown from the shore, has overwhelmed both cedar grove and arable land, and continues its way, as is the case in Payet's Parish, nearly across the island from side to side. The group is contained in an area of about twenty miles by three, and a bird's-eye view of the whole, gives it the appearance, as says an old author, "of a shepherd's crook." A belt of coral reefs extends all around the islands; on the north, to a distance of ten miles or more from shore; to the westward, about five miles, taking in Long Bar and the Chub Heads; while to the southward and eastward the open sea meets with no barrier until within a few hundred yards of land.

Having thus shortly described the situation and appearance of the Bermudas, we will now consider their origin.

A submerged rock, series of rocks, or any inequality which tends to raise the usual line of bed near the water level, whether in ocean; lake, or river, situate within the influence of a current, cannot fail to present an obstruction to the free passage of material; as you may glean in a minor form, from observation in any brook or water-course, however small it be. The moving waters impeded on their way, whirl and eddy around the obstacle, sticks and leaves are collected together, sand and earthy matter wherewith the water is impregnated, add their mite to the general mass, until a small island is formed, aside, or in mid-stream, which, if undisturbed, will gradually increase until strong enough to resist the force of the element in which it is situated; seeds are conveyed thither either by currents or foreign aid, and upon the accumulation of sand, stick, and earth, generate vegetable productions, which in their turn decay and become vegetable mould, serving to enrich the deposit, and afford nourishment to other plants in rotation.

If we perceive currents in lake, river, or brook forming deposits of matter, on their sides or in their midst, why may we not grant the same power to currents in the ocean? And if this power be granted, which is clear it should, we have only to recognize, in the first place, the presence of some inequality of the ocean bed under the spot now occupied by the Bermudas, whether owing to volcanic action or otherwise it matters not; secondly, a vast accumulation of sand and drift matter thereupon; and thirdly, the presence of the coral zoophyte to complete a solid fabric to within a few inches of low-water mark. Drift timber and gulf weed (*Fucus natans*) then arrested on their course, the latter material by thousands of loads monthly in certain seasons, would help to raise the whole above high-water mark, until sand and shell cast ashore by the waves and blown along the surface, forming rounded hills; sea birds making guano deposits; plants and shrubs springing up from seeds either brought by migratory birds* or carried on the current, would give a stable foundation and a

* The transportation of seeds by migratory birds has long engaged the attention of naturalists. The case may occur in two ways, either by undigested seeds passing through the body of the bird, or by earth containing seeds adhering to the feet. A wader has been shot in Nova Scotia, having in its crop undigested seeds of the rice of the Southern States of America.

resting-place for animal life. The surface of the land would gradually change as increased masses of sand became drifted in various positions, the underlying body of loose particles would harden by natural process, and in time form solid rock, while the accumulations of vegetable matter buried beneath such hardened rock would decompose, and form red earth; and where these deposits become liable to the action of the tides from below, the earthy composition would be cleared away, and caverns form in the place, all of which conditions occur in the Bermudas at the present day.

The Bermudas, although not placed within the full force of the Gulf Stream, are nevertheless close enough to be affected by its current, which, after a continuance of southwest winds, affords, by the occurrence of drift seeds and other matter from the Carribean Sea, ample evidence of its contact with, or very near approach to the group; and if facts of this import should not be considered sufficient to establish a clear case, the whole marine fauna, which is true West Indian, may be brought forward in support of the assertion.

But to give the process of formation of a group of islands of current origin more in detail, let us consider the remarkable process carried on in the building of reefs by the coral zoophyte. It is to this organism, low in the scale of nature, that the Bermudas are indebted for the position they hold in the midst of an ocean at all times and seasons liable to great commotion. A mass of simple sand-banks would assuredly be swept away, or at all events would never afford sufficient protection to tropical and boreal plants as they do at present. No cedar groves could exist so near the shore as they do, unless a barrier was made to the forward progress of those huge rolling seas, which, in severe weather, may be seen dashing on the outer reefs of the south shore, and spending their fury in casting high in mid air their columns of whitened foam.

The coral zoophyte, which has done so much for the islands of the Pacific, has conferred an equal, if not greater, benefit upon the Bermudas, building up around the whole coast huge walls of calcareous matter formed by the decease of countless generations of madrepores with their ever-accompanying mollusca and serpulæ, welded together, from which basis springs another generation of the same forms, to die in their order, and present a further ground work for the labors of future families.

To show more clearly the beneficial effects of these barrier-reefs in preventing the total annihilation of all vegetable productions, we have only to draw your attention to the present state of the district known as "The Sand Hills" in Payet's parish, about the centre of the main island, where the barrier reef is close in shore, and does not present a sufficient breakwater to prevent the full force of the waves throwing up vast quantities of sand upon the shore, which, acted upon, by the heavy gales from the southward, is blown in clouds to the top of the hill, some hundred and fifty feet above high-water mark, and burying whole groves of cedar and cottages, is rapidly extending its limits, and will ere long commit still greater damage by covering land now under cultivation. This present fact is sufficient to prove the use of barrier-reefs to oceanic islands, and also more clearly the use of oceanic currents in bringing to such positions animal life capable of effecting so much good by preserving a luxuriant vegetation from utter destruction.

As we have in considering our question touched upon the formation of coral reefs, perhaps it would not be uninteresting to state a few particulars in regard to the growth and habits of the coral zoophytes, and the different forms which are found inhabiting the same reef in the Bermuda waters.

There are five species of coral growing on the reefs, while in the sheltered sounds and harbors two or three more are found. The finger-coral (*Madrepora palmata*) appears to be the most abundant, crowding its palmate processes in every direction under water, and before it has been cleaned, it has a buff color, and when touched by the hand has the peculiar slimy feel common to all corals, and formed by the presence of the animal which secretes the hard calcareous mass. Some specimens of this species are extremely beautiful, presenting every shape and form which palmate processes can exhibit. At the extremities, digits of all lengths crown the ridge, while from the flattened sides arise in many cases extra palms digitated in like manner. The whole structure is remarkably porous. A species of *Madrepora* known as the star-coral (*M. oculina*) is also found on the outer reefs, though by no means so abundant as the former. It is by far the prettiest-formed coral in the Bermudas, and when cleaned, presents a series of the most exquisite white branches covered with elevated cells. In the water it has a green appearance, and is coated with the usual slime. In some situations it grows short and bushy, while in others its stems are elongated to some extent. There are three varieties of this species: (1,) with the cells greatly protruding; (2,) with the cells nearly even; and (3,) having them strongly depressed. There are two species of *Meandrina* found on these reefs,—*M. cerebra*, commonly known as brainstone from its singular appearance, and another species clearly different from the preceding, and allied to *M. Dædalea* of the Indian Ocean. The *Madrepora cerebra* grows to a large size, sometimes three feet in diameter, and is usually rounded in form; while the latter is rarely found more than six inches across, and growing in some cases within a foot of the surface on reefs, and in rock-pools even less. Two species of *Astræa* occur, sometimes covering the rock like a mass of sponge. These astroid corals are frequently found in a semi-fossil state, imbedded in the reef, and forming the base of masses of living madrepores.

On breaking into one of the reefs left dry at lowest tide, you find it composed of the following: the hard compact interior of calcareous rock, exhibiting under the lens a mass of minute portions of shell, sand, and broken coral, mixed with particles of pink-colored nullipores; the exterior presenting an irregular honey-combed appearance, some of the recesses containing sea-water and dotted with small specimens of the frilled *Meandrina* and small-eyed *Astræa*, and adhering to the sides of these miniature pools several species of corallines and *algæ* shooting out from beds of scarlet, and sober-colored sponges and ascidians, over which crawl the slug-like forms of the many-spotted *Doris* and sea-hare (*Aplysia*), and the massive shell-bearing *Purpura deltoidea;* while in the crannies and sinuous passages are snugly ensconced numbers of purple *Echini* and hair-clad annelides; the whole more or less covered with a mantle of iridescent sea-weeds.

Such is the state of affairs on the reef: now let us proceed to take a survey of the productions, animal and vegetable, brought thither by the current of the Gulf Stream.

As before remarked, the marine fauna of the Bermudas is almost wholly West Indian. The first, if we except a few transient visitors, are all found in the Carribean Sea. The mollusks, with one exception only, according to Tristram, are all inhabitants of the same district, while the remaining invertebrata of all orders present a similar state. Many fishes are brought to the group, sheltering and feeding amid the vast fields of gulf-weed (*Fucus* *natans*), and several species of crustaceans reach the islands by the same source. Myriads of the Portuguese man-of-war (*Physalia pelagica*), the oblique-crested *Velella* (*V. vulgaris*), and two species of *Ianthina* (*I. fragilis* and *I. globosa ?*), with their bubble-like rafts, are cast ashore, while hundreds of the pearly *Spirula* (*S. Peronii*) float about untenanted by their rightful owners. These are all from the southward. Then ashore we find the land-crab (*Gecarcinus ruricola*) burrowing in the sand-hills; and running along the shore-rocks, the nimble and prettily marked *Grapsus pictus*, both West Indian forms. To these may be added many others all evidently descendants of an original stock brought thither by the current of the Gulf Stream.

As regards the botanical features of the islands, several trees, shrubs, and plants occur of West Indian character, some of which, springing as they do from positions close to high-water mark, denote their current origin. We may notice the calabash (*Crescentia cujete*), the sea-side grape (*Coccoloba uvifera*), the Prickly Lantana (*L. aculeatu*), the Locust (*Hymenœa coubaril*), the Cochineal plant (*Cactus cochinillifer*); and many other species may be enumerated in support of the probable influence of the Gulf Stream. Two or three kinds of large beans are frequently found cast upon the beach: one called pin-box by the inhabitants, is the seed of a large species of trailing-vine (*Entada gigantea*), bearing huge scymitar-shaped pods; and is common in some of the West Indian islands, especially Jamaica, where Colonel S. Heath of the Royal Engineers informs us he has observed it growing in the mountains near the military station at Maroon Town, some two thousand feet above the sea level. Drift trees, sometimes of large size, with the roots attached, are also floated ashore; and some few years ago, according to the observant naturalist Hurdis, who resided several years in the Bermudas, two or three cedar trees of dimensions far exceeding those of any specimens to be seen on the islands, were found at some depth below the surface of a marsh which had been reclaimed from the sea, and which from their appearance were of foreign origin, and had doubtless been carried by the current from some part of the adjacent continent. These drift trees are in many instances the means of introducing pebbles and small portions of rock adhering to their roots; and it was with no little surprise that during our wanderings along the shores of the island we found these stones, of entirely different consistence to that of the sandstone in which they lay imbedded, in the shore-rock about high-water mark; nor could we at all account for such a singular circumstance, until we were informed by a geological friend that stones had been found among the roots of trees cast away on other oceanic islands, when a clue to the mystery was at once afforded us.

Thus we see in some measure the effect of ocean currents upon islands like those of the Bermudas, far removed from continents; and the case is the same in other parts of the world. Take for example the Keeling or Cocoa Islands, which are situate in the Indian Ocean at a distance of about six hundred miles from the coast of Sumatra, which owe their vegetation to seeds transported by currents from that island, Java, and Australia, and on whose shores are found stones and pebbles as in the Bermudas. Canoes of undoubted Javanese construction have also been found cast ashore; and many other instances are adduced by Chamisso, Darwin, and others, of the effect of currents upon these islands.

If such cases can be adduced of the introduction to distant islands of the ocean of whole faunas and floras, why may we not infer that in many cases islands like those of the Pacific have been peopled by the human race in a similar manner? We too frequently hear of sad cases of the survivors of abandoned vessels remaining on the ocean in open boats for a fortnight, or three weeks, or even longer, drifted along by the winds and currents in various directions. Canoes laden with people have been drifted from island to island in the Pacific, although hundreds of miles from each other, as is well known; while, according to Robertson, the fresh bodies of two men, of a race unknown to Europeans, were cast ashore, after a series of westerly gales, upon the Azores, doubtless from North or South America, proving that they had nearly completed their long drift voyage in their canoe before some untoward accident befel them and prevented their arriving alive.

We cannot therefore see, if human life can be prolonged under such circumstances, why we may not grant the drift and currents of the ocean a still greater usefulness in that of carrying to other lands a precious burden of human souls, to populate in process of time whole continents as well as islands; and, instead of looking for different centres of creation, to grant that one alone was made in conformity with the statements of holy writ.

(*Read before a meeting of the Nat. Hist. Society of N. Brunswick*, 29th *January* 1864.)

NOTES ON THE SILICIFICATION OF FOSSILS.

By T. Sterry Hunt, M.A., F.R.S.

Fossils replaced by silica are very abundant among the paleozoic limestones of Canada. Some portions of the Corniferous limestone are little more than layers of silicified shells and corals, with a small amount of intermingled carbonate of lime; and beautiful examples of silicification are also found in various localities throughout the limestones of the Trenton and Quebec groups. The silicified fossils are confined to certain planes; unaltered calcareous shells and corals being often found in the same limestone bed, half an inch above or below a layer holding silicified fossils; and even in these the replacement is sometimes confined to a portion of the shell or coral. A careful study of a series of these silicified specimens shows the operation of three distinct processes. First, the replacement of the fossil, giving rise to an exact copy of it in chalcedonic quartz; second, the incrusting by chalcedony of a fossil thus replaced; and third, in some cases the filling up of the cavity of the replaced fossil, with chalcedony or with crystalline quartz. The corals from the Corniferous limestone present examples of the first process, and are besides often filled or lined with crystals of quartz. The same thing is to be seen in various gasteropods from the Birdseye formation. Of these, the silicified shells, from which the limestone has been removed by an acid, preserve all their superficial markings; but are often lined with crystalline quartz, although at other times filled with the sedimentary limestone. In two instances, where these shells had been fractured, the fissure has been filled up with a tissue of chalcedony identical with that replacing the shell. This chalcedony is generally found to have a botryoidal surface, and a concentric structure, which however in some cases can only be discovered by the aid of a glass. Specimens of orthoceratites from the same formation show the exterior, as well as the septa and the siphuncle beautifully replaced by silica. In some silicified gasteropods it is seen, after removing the calcareous matter by an acid, that the silicification is chiefly confined to the two walls of the shell, which are completely replaced, while the middle portion remains calcareous, or is but partially penetrated by silica. The exterior of these silicified shells is sometimes incrusted with mammillary masses of chalcedony a tenth of an inch or more in diameter. This is an example of the second process, which is well illustrated by a fine specimen of a large and as yet undescribed species of Metoptoma from the Birdseye formation, to which my attention has been called by Mr. Billings. It was found reposing on its base, and filled with the sedimentary limestone, which was removed by an acid, showing the interior of the shell with some small adhering Serpulæ, which are also silicified. The exterior of the shell was completely covered with a rough warty coating of chalcedony, which has evidently spread in concentric circles from certain points, and is from five to ten hundredths of an inch in thickness. This crust, which readily separates, has been detached from a portion of the surface of the shell; which is found to have been completely replaced by chalcedony, and retains all its delicate markings. From the more frequent absence of this exterior coating of chalcedony from silicified fossils, we are inclined to look upon its deposition as a process subsequent to the replacement. In some cases however it takes place upon non-silicified specimens. Thus a Stromatopora having been cut in two, and submitted to the action of an acid, it was found that the silica was confined to an exterior crust, and to occasional grains and portions disseminated through the calcareous mass of the fossil. It is further to be remarked, that the limestone strata which contain the silicified fossils are associated with beds or masses of hornstone, in which these fossils are sometimes partially imbedded.

The facts detailed above (a part of which will be found in the Geology of Canada, p. 629) point to the conclusion that the replacement of the fossils, as well as their incrustation and filling-up with silica, took place before they were imbedded in the calcareous sediments, and that it was dependent on the presence of silica dissolved in the waters of the time. The mode in which the first process, or that of replacement, has been effected is however still obscure. In vegetable structures, which are very often silicified, such a replacement is comparatively rare. The pores of the wood become filled with silicious matter, while the woody fibre, in a more or less altered state, remains, and may be extracted, as Goeppert has shown, by dissolving the silica with hydrofluoric acid. This organic matter is often changed into coal, or even, according to Dr. Dawson, in some Devonian woods into a graphitic substance;

while Goeppert mentions its change into bitumen, and also observed a resinous matter in the pores of silicified conifers. He found that in some cases, as in certain agatized woods from Hungary, the organic matter had almost, or altogether, disappeared, leaving spaces which were empty, or filled only with water. Bead-like drops of silica were occasionally found by him upon the bundles of ligneous fibres. He also observed in some cases an incrustation of hyalite on the exterior of some specimens of silicified wood. (Goeppert, Plantes Fossiles, livr. 1, part 3.)

The silicified woods from Antigua, unlike any of these described by Goeppert, exhibit a replacement of the woody tissue by silica; some of them however still retaining portions of organic matter. In a specimen of exogenous wood from that locality, which I have lately examined with Dr. Dawson, the medullary rays are filled with silica showing traces of cells, and the ducts are also filled with silica. The whole of the woody fibre has moreover disappeared, and its place is occupied by silica, which is distinguished by a slight difference in color from that filling the place of the vessels. In this case, it would appear that the process of silicification consisted of two stages; the first being the filling up of the pores by silica, followed by a removal, by decay, of the organic matter, leaving a silicious skeleton like that of the Hungarian woods noticed above, after which the empty spaces in this were filled by a further deposition of silica. It is probable that processes similar to those connected with silicification take place in the so-called petrifaction of organic remains by carbonate and sulphate of lime, sulphate of barytes, oxyd of iron, and metallic sulphurets.

In this connection, may be mentioned the observations and experiments of Pengelly, Church, and others on the so-called Beekite. This name has been given to mammillary chalcedonic concretions around a nucleus of coral, sponge, shells, or even of limestone, which occur in the Triassic conglomerates of Torbay in England. This nucleus in some cases has disappeared, but in others remains in greater or less part unchanged, or has been partially silicified. These concretions apparently result from a similar incrusting process to that which I have described in Stromatopora and Metoptoma. Mr. Church has examined these bodies with care both chemically and microscopically, and in the L. E. & D. Phil. Magazine for February 1862 ([4], xxiii, 95) has given his own and others' observations, with a number of figures. He has also described in this paper the results of some experiments on the process of silicification; for further details of which see The Chemical News, vol. v, 95. Mr. Church prepared a solution of silica in water by dialysis, according to Graham's method (L. E. & D. Phil. Mag. [4], xxiii, 295), and found that when this solution, containing about one two-hundredths of silica, and impregnated with a little carbonic acid, was filtered through fragments of coral, a large portion of carbonate of lime was dissolved, and the whole of the silica removed. Similar results, though to a less extent, were obtained with shells. In another experiment, a fragment of a recent coral was fitted into the neck of a funnel, and a solution prepared as above, with a little carbonic acid, and containing one hundredth of silica, was allowed to drop on the coral, and after slowly filtering through, was found, as in the previous experiment, to have abandoned the whole of its silica, while the coral had lost nearly all its lime, although retaining its structure in a great measure. It was however covered with a thick film of gelatinous silica." Mr. Church farther observed that the addition of small portions of the solid carbonate of lime, barytes, or strontia to a strong solution of pure silica, caused it to gelatinize immediately; and according to Graham, solutions of these carbonates have the same effect. The concentric structure which is characteristic of chalcedony, was observed by Mr. Church in the silicious deposits from the Geysers of Iceland, and from the hot springs of Luzon in the Philippine Islands, as well as in menilite; and Mr. J. H. Gladstone, in a note to Mr. Church, in the paper already cited from the Philos. Magazine, refers to a similar structure as having been observed by Mr. Rainey in carbonate of lime formed in animal tissues: it is also artificially obtained when carbonate of lime is slowly deposited in the presence of gum or albumen. Mr. Church has since described (Chem. News, vi, 306) a curious example of the deposition of silica. A basket of eggs was recently found in a chalk-pit near Winchester, where it had been buried beneath the broken rock for, it is supposed, four or five centuries. The organic matter and the calcareous shell of the eggs had both disappeared, their places being occupied by chalcedony; "which seemed farther to have been deposited upon the willow twigs composing the basket, incrusting it so well that the real nature of the latter is evident to this day."

I have thought it well to bring together these observations since, for although they do not explain all the phenomena of silicification, they go far towards showing the conditions under which silica can be precipitated from its solutions in natural waters, and deposited either upon or within organic bodies, or in the forms of opal, chalcedony, and hornstone. See farther Silliman's Journal [2], xxviii, pp. 377, 381; and Bischof, Lehrbuch, ii, 1241.

Montreal March 25, 1864.

NATURAL HISTORY SOCIETY.

ANNUAL CONVERSAZIONE.

"The Second Annual Conversazione of the Montreal Natural History Society was held in the rooms of the Society on the 2nd instant, and was, we are happy to say, highly successful. We learn with pleasure that since the last annual social meeting the Society has made very steady progress, the year not having been excelled, or even equalled, by any other in its history for the amount of scientific work done, and the successful introduction of new and valuable features, which it is believed will be sources of permanent benefit to the Society. But while the Society congratulates itself on this satisfactory state of affairs, there is of course room for still further prosperity, were the members and the friends of the cause to come forward more readily and evince greater interest in its advancement. At the regular meetings a number of interesting papers have been read, of which mention has been made at various times in these columns; and many elaborate articles, representing great scientific research, and having an important bearing on the arts of life, and on the material improvements of the country, have been contributed to the Canadian Naturalist. The Geology of our own country, in which every one must feel more or less interested, has received a large share of attention; and on points of the geology of the United States connected with Canadian geology, important contributions have also been received. In fact, in all the branches of study embraced by the Society, many new facts have been made known, which looked at merely in a scientific aspect, should be highly esteemed; but the pursuits of the naturalist are also of great utility to the country in their economical applications, thus giving the Society a strong claim to the support and consideration of the public, independently of the purely scientific discoveries, or of the pleasures to be derived from the collections and lectures. A committee of the Society has, for instance, been engaged in promoting measures for the more effectual protection of the smaller insectivorous birds which protect us against insect ravages; whilst another committee has been investigating the causes of the decay of the apple-orchards, for which the island of Montreal was once celebrated. Discussions have also arisen at the meetings respecting the use of Canadian fibres in the manufacture of fabrics and of paper. Nor should we omit to mention another important part of the work of this Society, namely that of popularising natural science, thus rendering it more attractive, and causing its results to be more extensively known. This end is sought to be attained by the popular course of Somerville lectures, free to the public, and by throwing the Museum open on easy terms. One of the new features worthy of special attention is the engagement of a scientific curator, Mr. Whiteaves, under whose care large portions of the collections have been arranged in such a manner as to assist very materially in the study of natural history. There have been added to the Museum within a short time, many valuable contributions of marine shells, and some interesting specimens to the collections of birds and fishes.

"Many of the gratifying features which we have here briefly noticed, in order to show the work that the Society is engaged in, and what has been done, are attributed to the favorable impression made by the first Conversazione, held last year; one direct result of which was that a member liberally offered to commence a list with $200 to pay off the remaining indebtedness of the Society."

The chair was taken at eight o'clock by Dr. Dawson, President of the Society; there being seated on the platform the Lord Bishop of Montreal, Metropolitan, Rev. Mr. Ellegood, Rev. Mr. Kemp, Rev. Dr. DeSola, Hon. Mr. Sheppard, Prof. Miles, Stanley Bagg, Esq., W. H. A. Davies, Esq., John Leeming, Esq., and others. The Hall was crowded throughout, many being unable to obtain seats. The fine band of the Royal Artillery was present, by the kind permission of Col. Dunlop, R.A.

The introductory address was delivered by the President of the Society, Principal Dawson, LL.D., who said: "Ladies and Gentlemen, the members of the Natural History Society again welcome you to their annual conversazione, and trust that on this as on former occasions, you will sympathize with our pursuits and enjoy the entertainment which we have provided. I have no doubt that many of you regard us as very simple though harmless enthusiasts, pleased with a butterfly or a flower, delighted with a new shell or coral, going into ecstacies over the discovery of some unheard-of worm or microscopic animalcule smaller than a grain of dust. But admitting all this, and that our pursuits may not be worthy of comparison with the grave and weighty matters which engage your attention, we have still something to say for ourselves. If enthusiasts, we are not selfish; indeed I may say that we are somewhat amiable. A great authority in such matters has said that a true naturalist is never an ill-natured man; and we show our good nature by gathering here all our precious treasures, and exposing them to your inspection, and by providing in our Museum a refuge for every destitute specimen, that might otherwise go to waste or be neglected in some obscure corner. Indeed, I fear that we sometimes carry this to an extreme, and even render ourselves troublesome by insisting that you should look through our microscopes or examine our choice specimens, when you would rather be engaged about something else. We further, in these artificial days, keep up a testimony in behalf of nature. We maintain its pre-eminent loveliness, standing up for the lily of the field, even against all the glory of modern art. We invite attention to the plan and order, to the design and contrivance, which exist in nature, and thus do what little we can to magnify the works of God. Further, we are always ready to inform you as to any little practical matter that lies in our way. If you are puzzled by any strange bird or beast, or by any unaccountable phenomenon in air or earth, we are always ready to do our best to explain it. If any impertinent insect or fungus ravages your farm, garden, or orchard, we can tell you all about its habits, and how to get rid of it. We can, with the aid of our friends of the Geological Survey, inform you as to the mineral resources of the country, and can guard you against that perversion of mining enterprise, whereby some simple persons contrive to bury their money under ground without any rational hope of ever extracting it again. Besides all this, in our lectures, our monthly meetings, our published proceedings, and our museum, we provide you with many sources of pleasing and profitable recreation. Doing all this and more, in a quiet unobtrusive way, we think ourselves entitled to ask your kind countenance and aid in this our annual celebration. I have only to add, that a committee of members of the Society has labored to make our rooms and programme as attractive as possible, and that we have to thank many kind friends for contributions to your entertainment this evening."

Dr. Dawson introduced to the audience one of the pioneers of Natural History in this country—

Hon. Mr. Sheppard, who said: "On this occasion, the anniversary of the Natural History Society of Montreal, it has fallen to my lot to address to this goodly assemblage of the patrons of science, a few remarks and remembrances of the state of natural history and of its progress in Canada during the preceding half century, which it has been supposed my long standing as a student of nature enables me to submit to your patient hearing. These observations must necessarily be short, seeing the varied programme provided for the evening. In order to do this subject justice it will be necessary to go back to the early settlement of the country, when the Jesuit missionaries visited the wilds of America with the intention of Christianizing the natives. These missionaries were a learned and observant class of men; and their opportunities of becoming acquainted with the natural productions of the country, were greatly facilitated by their close intercourse with the Indians, following them in their periodical migrations, and sojourning with them in their encampments. They collected a vast amount of information from their native friends about the animals, and especially about the plants, many of which were known to possess healing properties, and to be useful in the few arts that the Indians were acquainted with. The results of these researches were, at a later period, collected and embodied by Charlevoix in his History of Canada. They are well worthy of being consulted. Towards the end of the last century Canada was visited by André Michaux the elder, coming from the north through Hudson's Bay, across the country by lakes Mistisions and St. John, down the Saguenay and up the north shores of the St. Lawrence, disappearing southward at some point unknown to us. It must have been very interesting to him to note the gradual change of the vegetable productions in his progress south from the barren grounds of the stunted birch, the vast collections of lichens and mosses which cover the surface of those dreary regions, to the noble oaks and maples on the shores of the St. Lawrence.

Michaux published the result of his observations in a Flora of America; but it is very meagre, compared with later works on that subject. Michaux the younger never visited Canada that I am aware of, but derived his information respecting our trees from his father. Francis Masson, that celebrated collector for the Royal Gardens at Kew, who introduced so many of the floral beauties of the Cape of Good Hope, visited Canada about the beginning of the present century. He passed a good portion of his time in Montreal; and oh how I did yearn for the benefit of his acquaintance, with a view to information on plants of the country, but all my sighing and yearning were doomed to end in disappointment. He died here about the year 1804, at the house of Mr. John Gray, at Côte St. Catherine, a benevolent and much respected merchant. The mention of John Gray reminds me that he kindly fostered the Rev. James Somerville while in a state of mental aberration. With Mr. Somerville I was much acquainted; he was devoted to the study of natural history. It will be recollected that this gentleman was a patron and benefactor of this Society. We now come to the name of Frederick Pursh, the celebrated botanist, who made his appearance in Canada in 1815. I became acquainted with him, and derived much valuable information from him about plants. He visited Anticosti in 1817, and brought back a large collection of living plants, rare in other parts of the country, some of which I cultivated in my garden; but the greater portion of them perished in the packages in which they were brought up. Among those which survived were *Ligusticum Scoticum*, a beautiful *Thalictrum*, which he named *T. purpurascens*, and an *Allium*, identified with *A. schœnoprasum*. Pursh's Flora of North America is a carefully got-up book, and was the standard text-book till Gray's appeared. Pursh died here about 1821, at the house of Robert Cleghorn, Blink Bonny, a nurseryman, and a good botanist,—a contemporary of Loudon. Poor Pursh was thriftless; in his declining years living mainly on the hospitality of his friends. Colonel Hamilton Smith, the learned historian of the natural history of man, visited Canada in 1817, seeking information in science generally. I became acquainted with him, but his sojourn here was very short.

Now, ladies, allow me to say a word of encouragement for you. What will you not succeed on attaining when you set your hearts on its accomplishment, as the example of the Countess Dalhousie will show. This lady became an accomplished botanist, and was an indefatigable collector of plants. She presented to this Society a large herbarium of Canadian plants, beautifully preserved; she collected many living plants, and sent them home to ornament the gardens and grounds of Dalhousie Castle; and she succeeded in imbuing her lady friends with a love of botany; some of whom made marked advances in this branch of natural history, particularly one, who subsequently sent many specimens of Canadian plants to Sir Jackson Hooker, to assist him in the compilation of his great work the Plants of British North America, in which her name is duly recorded as a contributor. The example of Lady Dalhousie is well worthy of imitation by those having leisure for study.

And now permit me by desire to endeavor to throw some light on the origin and progress of the Literary and Historical Society of Quebec, the elder sister of the Society. Strange to say, its formation was brought about indirectly, by a political movement, in this wise. It is no doubt known to many of you that the late John Neilson was the owner of the Quebec Gazette, established in 1764, now in its hundredth year. In virtue of an Act of Parliament, it possessed the privilege of publishing all official documents as they occurred. Neilson was a great politician, and was opposed to Lord Dalhousie in some points of government. This opposition Lord Dalhousie could not tolerate, and he came to the determination of establishing a paper which he could control, calling it the Quebec Gazette by authority, and he caused Dr. Fisher, a co-editor of the New York Albion, to come and take charge of it. Dr. Fisher had been a member of the Literary and Historical Society of NewYork; he persuaded Lord Dalhousie to get up a society with similar title and objects in Quebec. This was done, Chief Justice Sewell becoming the first President, and W. Green, a native of this city, the secretary. The Society was in the first instance composed of high officials and courtiers, and the fee was fixed at a high rate, for some end which can only be guessed at. Papers were read before the Society. The President gave his "Dark Days of Canada"; Captains Bayfield and Baddely read valuable papers on the Geology of Canada, and Mr. Green presented his papers on Textile Plants, and on the plants used in dyeing by the Indians. Shortly after the formation of that Society, some of the younger inhabitants of Quebec, perhaps thinking that they had been slighted, formed themselves into a society under the name of the "Society for the Promotion of Arts and Science in Canada." Lord Dalhousie refused his countenance to this new institution. Several papers were read, and a successful progress became manifest. After a while, a disposition on the part of the Literary and Historical Society to conciliate the new one, and even to advocate a fusion of the two, became apparent. This was ultimately effected, retaining the original title. The union of the two societies was productive of good, the working members becoming more numerous. Some of their labors appear in the transactions of the Society. On the accession of Sir James Kemp to the government of the Province, he very liberally bestowed to the Society a copy of that splendid work of art, Claude's *Liber Veritatis;* also a transit instrument, and an excellent telescope. Here it may be mentioned that M. Chasseur, a naturalist of Quebec, had formed a museum as a matter of speculation, principally composed of birds; but finding that it did not answer his expectation in point of revenue, he persuaded the Legislature to purchase the collection; and it was placed under the care of the Literary and Historical Society, in addition to their own museum, which had assumed a respectable condition. When in 1838 Lord Durham was sent out to conciliate the people, and restore Canada to a state of peace, he did at least one good thing. Led by the title of the Society to suppose that literature and history were its sole aim, he brought out a large and select collection of the ancient Greek and Latin historians, and presented it to the Society, for which he is entitled to praise. This valuable addition to the library was received thankfully, and it furnished the means for several reviews and criticisms by that very learned and esteemed member of the Society, Dr. Wilkie. At later periods that Society has been very unfortunate, having been no less than three times burnt out; losing much of its accumulation of objects of natural history, books, and apparatus, thus receiving a severe check in scientific pursuits; but it is now gradually recovering from its losses, and again rising into a state of activity. Before concluding, a word of commendation must be said on the Geological Survey of the Province, now for so many years so well and so efficiently conducted by its learned and amiable head, assisted by an active and scientific staff. Their joint labors have been eminently successful, as is abundantly shown by the very complete Geological Museum in this city; by their periodical reports of work done, now consolidated into one large volume, which, of course, will be studied by all scientific devotees, a monument of the industry of the Commission of Survey, and an evidence to the civilized world of the varied labors and scientific capabilities of the surveyors, well meriting the applause and gratitude of the Province, to which they are fully entitled. Shall I say a word on the subject of this Society? If permitted, it must be but a word, for you are all better acquainted with its formation and operations than I can pretend to be. The Society was formed shortly after that of the L. and H. Society; at the instance, I believe, of the late Dr. Holmes and some congenial spirits. In the first few years of its existence its progress was not very rapid, all up-hill work, as the Doctor informed me, the work resting on a few of the members; but if so, that languor has been sucessfully shaken off; its progress and prosperity have been of the most satisfactory nature. As a contrast to the difficulties for the acquirement of scientific information met with at a remote former period, already alluded to, allow me to state some of the great facilities which are now offered to the student of Natural History. In many parts of the Province there have been established Colleges for the education of youth, in which the Natural Sciences are taught by learned professors, with the advantage of extensive museums. I will only mention some of them, without entering into particulars. Beginning in the lower part of the province and proceeding upwards, we have Laval, McGill, Lennoxville, Queen's, Toronto, and others. As regards this city, let me mention with commendation McGill College. Here for the professed student every facility exists: regular lectures are delivered on all branches of Natural Science, aided by a very complete museum, with a library of books of reference. To the occasional student, this Society possesses all the advantages required; an extensive and well-arranged museum, regular stated meetings, attended by all the scientific men of the city, a well-conducted magazine, open to contributors generally, a courteous and scientific curator, a large and commodious building fit for all the purposes of the Society; and if I may judge by the extent of the present goodly assemblage of patrons, there seems great reason to look forward to further satisfactory progress necessitating the extension of accommodation, bespeaking the approbation of future dwellers in this growing and beautiful city, followed by the respect of the scientific world at large."

The President then announced that instead of the chemical experiments by Professor Robins following here, as set down on the programme, an address would be given by Prof. Miles of

Bishops' College, Lennoxville; since the gases emitted in the performance of the experiments might not tend to improve the ventilation of the room. PROF. MILES then spoke as follows:

"Mr. President, it has afforded me great pleasure to receive an invitation to join in this gathering of the members, friends, and visitors of the Natural History Society.

"As one of its numerous guests this evening, I beg to express my sincere thanks for the privilege of participating in a treat so richly and so variously furnished,—one which, while it appeals to the understanding, delights the imagination and the senses. But in endeavoring to respond, at a brief notice, to a request that I should address you, I should begin, if the plea were good for anything, or if it were judged to be in good taste, by asking you to remember how formidable a thing to some is the prospect of being required to make a speech. In place of that, however, I find it more natural, as it is doubtless more becoming, to obey the stimulus arising from a hearty sense of sympathy as regards the objects of the Natural History Society—to look to the feelings which must animate all who are assembled here to-night—cultivators, lovers, and patrons of science—gathered together here socially for the purpose of testifying an appreciation of those objects—for the purpose, in fact, of testifying *respect for science*, and an admiration of the useful and beautiful arts and improvements in art which science is continually furnishing.

"To these considerations I think, sir, I cannot be in error, when I add the mention of another motive in influencing us all who have come to participate in this evening's recreation; namely, a desire to express our recognition of those services which have rendered the Natural History Society what it is—whether of those who have given without stint, time, labor, and skill to its advancement, or of those other promoters who have, in various ways, contributed to the same end, by donations of money, of books, of works of art, and of specimens for the enrichment of the Society's collections.

"Encouraged by reflections of this kind calculated to loosen the tongue, and to place even an unpractised speaker at his ease, I am thankful for the opportunity of expressing my own gratification at what I see and hear to-night, and should rejoice indeed if, it may be at a fitting moment, I could be so fortunate as to say only a few useful words in furtherance of a cause we all desire to promote.

"There are established here societies—quite a goodly number of them—embarked in the execution of projects of benevolence, education, religious, mental and bodily welfare, and I have understood that Montreal is in this behalf not one whit behind other notable cities in her Majesty's dominions. But I do think, sir, without any disparagement of the aim and work of those other combinations of effort which have been alluded to, that one of the very chief ornaments of this city, and one of the most efficient promoters of progress, is the Natural History Society. Embracing in its list of members, living and deceased, a good number of persons of high reputation that extends far beyond the immediate scene of their labors, it can and does command that sort and degree of respect which gives weight to its proceedings, and which could not attend the efforts of any number of merely local magnates. The domain of the Society's researches being the boundless field of nature, and in a comparatively new country where almost every day new developments strengthen the confidence that is entertained in the magnitude of its natural resources, the Society may be expected in the success of its work to render services of the greatest value to the whole community by being instrumental in bringing those resources more and more into notice. I ought, perhaps, to apologize for presuming on your indulgence when I venture to make remarks of this kind—when I suggest that the expectations of the public may possibly extend much further than some would at first sight admit to be legitimate as regards the labors of one society. But I shall be pardoned, I think, when it is borne in mind how few and slender as yet, and as compared with older countries, are our organized means for the promotion of various special branches of science. The day to us has not yet dawned for venturing to take in hand the organization of distinct societies, to promote astronomy, chemistry, botany, meteorology, entomology, and a number of other leading branches upon which the progress of natural history is more or less essentially dependent. It must be obvious that the friends of science in this country are naturally led, through the force of circumstances, to depend upon such a body as the Natural History Society of Montreal for fostering and keeping alive amongst us a general scientific spirit, and a tone of natural science in all its branches and operations to take up work which elsewhere would be allotted to other associations. For these and like reasons it must be gratifying to the members of this society to feel that whatever they can do in behalf of science generally, even in cases where there is apparently only an indirect connection with the particular branches they combine to prosecute, is necessarily of advantage to the community; and that their labors, of whatever kind, are sensibly appreciated, is amply demonstrated in the large and interested circle of friends whom the attractions of this annual conversazione have brought together this evening.

"Sir, I hope I shall not be found unmindful of the nature of this social occasion upon which I feel it would be unfitting to claim the attention of the audience for a long time. It would be no less inappropriate or unprofitable I believe for me to attempt to engage that attention, even for a short time, by the discussion of any purely technical matters appertaining to the several branches of natural history. My further remarks shall, therefore, be brief, and shall be devoted to one of the most important and interesting of the Society's undertakings,—*its collection of specimens, illustrative of facts and phenomena of natural history.* In this department almost every person is able to put his hand to the work, and to further its progress; and I might add, that in such collections there is almost always a place waiting to be filled up by contributions such as would entail upon the individual friends of science, in most cases, at least, but a small sacrifice. It is perhaps needless to observe that specimens of objects of natural history subserve the purposes of attracting attention, exciting interest, and impressing the memory in a manner that corresponds with the effects produced by suitable experiments devised and executed in illustration of any law of nature or natural phenomena. As it would be unreasonable to expect a student of chemistry to comprehend, realize, and retain in his memory through mere words of description the phenomena attendant upon the mutual action of alkalies and acids, so would it be too much to presume upon attaining a rational knowledge of the peculiarities of an owl or of the substance india-rubber in the absence of visible examples of these objects. Drawings and models, if well executed, may to some extent supply the deficiency. But as we all know the work of the artist cannot attain to the perfection realized in nature; and it may be safely asserted that the impressions producible by verbal description, even when accompanied by good drawings, is neither so vivid nor so permanent as that which is created by the sight and handling of the objects. In fact, one common result of an accurate description or drawing of a natural object is to make us wish to *see*, if possible, the object itself. Again, if the sight of a specimen in a collection—be it a stuffed bird, or a mineral, or a valuable natural product in any one of its stages of conversion to the use of man—be found to augment the beholder's previous knowledge of it, or to set him right in regard to any erroneous impression he may have entertained; if it serve to support or confute any theory, or to suggest any idea that is afterwards worked out into useful results; or in fine, if it excite a spark in the mind which kindles into the desire to go forth and study the works of nature in any portion of her realm, there is one of the chief ends of such a collection attained.

"It is well worthy of note, that the variety of trains of thought and of associations roused by the sight of an object presented as a specimen is as great as that which exists in the mental qualities, bias, and occupation in life of those who examine it. In this connection I am tempted to quote the language of Sir John Herschel. Commenting upon the different ideas attached by different persons *even to the name* of a common substance, he says: 'Take for instance iron. One who has never heard of magnetism has a widely different notion of iron from one in the contrary predicament. The vulgar, who regard this metal as incombustible, and the chemist, who sees it burn with the utmost fury, and who has other reasons for regarding it as one of the most combustible bodies in nature;—the poet, who uses it as an emblem of rigidity; and the smith and engineer, in whose hands it is plastic and moulded like wax into every form;—the jailor, who prizes it as an obstruction, and the electrician who sees in it only a channel of open communication by which that most impassible of obstacles, the air, may be traversed by his imprisoned fluid, have all different notions of the same word. The meaning of such a term is like a rainbow,—every body sees a different one, and all maintain it to be the same.'

"The only or principal effect upon some minds derived from inspecting a collection of specimens appropriately arranged, is believed by many to be a sort of passive gratification traceable rather to the influence of a tasteful artistic display, than to the recognition of any positive result of useful knowledge. It may be so: with pre-occupied minds, or through habitual indifference to what passes, some persons may agreeably though cursorily inspect a museum without carrying away any new information. Still the effect, so far as it goes is good—they suffer no harm; and seeing that what is thus to their notice presented is not displeasing, there is the hope that on some future occasion they may be induced even to contribute to that which so much pleases and instructs others. But the number of such persons—who can go through, perhaps, an extensive museum without deriving any benefit whatever, is probably very small; and if there be any, he or she is at least in no worse position than a certain eminent navigator who minded exclusively his own nautical business, and returned home from his voyages in child-like ignorance of the artful ways of mankind—so that his friends jokingly said of him, 'he has been all round the world, but never in it.'

"I am sure, sir, that it would be tedious to listen to details of the advantages proposed and expected to be realized by a society or institution that embraces among its purposes the making of a collection of specimens. In most of the older museums very small attention was commonly paid to the points I have alluded to, what have been callen industrial and economic purposes. The beauty, the richness, the rarity, and curious nature of the objects illustrated, were commonly the main agencies by which the attention and admiration of visitors were moved. No one could say justly that these attributes are not perfectly legitimate, and worthy of especial provision in a public museum, viewed as a repository of what is considered valuable on account of its rarity, or because suggestive of interesting or important historical incidents. The majority of people for a very long time to come will probably regard with deep interest such objects as the spurs of King Henry the Fifth, the watch used by Oliver Cromwell, the snuff-box of Napoleon Bonaparte, the sword of General Wolf, and the relics of personal effects belonging to Sir John Franklin and his followers, recovered some years after their lamented owners had succumbed to their fate amid the arctic snows. The bare sight of these things rouses in most of us very strong emotions. As long as the world endures, human nature will ever cherish the preservation of articles of this kind. But it is much less common now than formerly to allot a large share of space in a museum to their preservation and exhibition: a more utilitarian disposition is everywhere prevalent—and collections of specimens are expected to be composed of something more than what may be denominated curiosities.

"But a brief visit to the Museum of this Society, which I may be permitted to say I have now the opportunity of seeing for the first time in the more extensive and appropriate building provided for it, has afforded me so much pleasure that I cannot help saying a few words on what appears to me on this occasion worthy of mention, a very important principle for governing the making of such collections—and it must be very gratifying to all lovers of natural history to see the principle adhered to in the structure of this Museum so far as it has progressed. The principle I allude to is that of utilizing the objects of a collection strictly with a view to the purposes aimed at—exhibiting only specimens as perfect as possible of their several kinds, not neglecting artistic display, but at the same time sacrificing even that (when necessary) to the conditions of order in a series, position, and other requirements for rendering illustrative objects of natural history really useful. Most modern collections made under favorable auspices are known to follow this out in a degree that was deemed useless, or which, perhaps, was not even thought of in former times. I could name, sir, I think more than one old-established museum where no expense has been spared, and yet where attention to this feature has been sadly neglected, occasioning injury to science, and exciting wonder in the minds of intelligent and scientific visitors, who go into them, perhaps, anticipating instructive information. Doubtless this is sometimes the result of sheer neglect; but more frequently it must arise from the too great liberality and abundance with which particular classes of specimens have been contributed. It is not so much the extent of a museum that renders it useful in the cause of science, as attention to unity of purpose, and to natural conditions. A bird, for example, poorly stuffed, mounted in an unnatural position, placed in a bad light, or thrown amongst others without heed of its species, however remarkable its prototype in nature may be, is but ill-suited to encourage the study of ornithology, or to illustrate the collateral facts of science which students of natural science are usually anxious to verify. The grand rule so valuable, and carried out by careful people in their ordinary arrangements, 'a place for everything, and everything in its place,' is eminently of consequence in the disposition of the objects of a museum.

"For reasons such as are feebly indicated in the above remarks, it is remarkable that people who are partial to ornithology are sometimes heard to declare that they derive more real benefit and more pleasure from inspecting a comparatively small collection judiciously arranged, and well mounted—as for example the birds in the University of Edinburgh College Collection—than from the examples in the great British Museum itself.

"In the nucleus of a future extensive museum embraced by the geological collection, the examples of animals, of birds, reptiles, and fishes, and in the herbarium belonging to this Society, I feel sure, Sir, there are offered opportunities which must furnish on all points most valuable helps to students of natural history in this country; and thus positive utility as well as the cause of theoretical science cannot fail to be subserved."

General chemical experiments, of an interesting description, were then performed by Professor Robins, accompanied with appropriate explanations.

During the remainder of the evening the entertainment was contributed to by Mr. Hearn, optician, who exhibited a series of dissolving views; and by the band, who gave several other choice selections. The visitors also examined with much pleasure the various interesting objects in the Society's collection, and a number of microscopes and other scientific instruments displayed in the library.

THE MAPLE-LEAF CUTTER.

At a late meeting of the Natural History Society, a communication was read from Rev. Mr.Constabell of Clarenceville, describing the ravages of an insect whose larva burrows in the maple leaves, cutting out circular pieces, which are used as coverings to protect the larva while eating the parenchyma of the leaf.

From the specimens exhibited, it appeared that the insect is a little moth, *Ornix acerifoliella* of Fitch, well known in the State of New York, though apparently not hitherto recorded in Canada. Fitch states that it is not ordinarily very destructive, but that in some seasons it appears in great numbers, and inflicts considerable ravages, especially on detached maple groves. He recommends that cattle should be turned into the affected groves in autumn, in the hope that their treading would destroy the pupæ, which at that season are lying on the ground, wrapped in their coverlets of cut leaves.

J. W. D.

REVIEW.

GEOLOGICAL SURVEY OF CANADA. Report of Progress from its Commencement to 1863. Lovell, Montreal.

This large octavo, of 983 pages, illustrated with 498 wood-cuts, and to be accompanied by an atlas of maps and sections, presents a condensed view of the work of the Canadian Survey from its commencement in 1843. It gives the results of the combined labors of Sir W. E. Logan, Mr. Murray, Dr. Hunt, and Mr. Billings, a staff not to be surpassed either in ability or energy, and aided also by several able assistants, of whom Mr. Richardson and Mr. Bell stand first. It is also to be observed that the generous and liberal disposition of the Director of the Survey has kept him in friendly relations with every one of any note as an unofficial observer on Canadian Geology; and that in his Preface he enumerates and frankly acknowledges all the services, large or small, rendered by such persons before the institution of the Survey or during its progress.

The work commences with an account of the Physical Geography of Canada, presenting in few but well-chosen words the general features of the country. A few pages are then devoted to the nomenclature of the geological formations; after which begins the main portion of the work, devoted to a detailed description of the formations occurring in Canada, beginning with the Laurentian, the oldest of them all, and ending with the Devonian; the superficial geology being given in a separate chapter at the end. The fossils are carefully noticed under each formation, with illustrations of characteristic species.

The second leading division of the work is a description of Canadian minerals, embracing many new facts of interest, ascertained by the Chemist of the survey. Then follows by the same hand what may be regarded as a treatise on rocks, which is probably the most valuable and reliable memoir on this important subject in our language.

This part of the Report ends at page 670; and beyond this, as becomes a public survey, the remainder is occupied principally with economical geology. Every useful rock or mineral occurring in the country is noticed; with details as to the places and conditions in which it is found, and the extent to which it is worked;

and much useful information is given as to the modes of rendering such deposits useful elsewhere.

The value of this work to Canada can scarcely be over-estimated. It must be regarded as of vast importance, whether we consider readers abroad or at home, whether we consider scientific objects purely or those which are practical. Its mechanical execution is an evidence of the progress of the arts among us. Its publication to the world is a proof of the interest taken in science in this country, and of the enlightened patronage afforded by the Government to such investigations, and at the same time, of the immense value of our mineral resources, as well as of the extent to which they have already been made available. It gives for the first time to geologists abroad the means of making themselves thoroughly acquainted with the geology of this country; and it thus places Canada on a level with those older countries whose structure has been explored, and the knowledge of it made the common property of the world. In some departments of geology, it even makes Canadian rock-formations rank as types to which those of other countries will be referred. This is especially the case with regard to those oldest of known rocks, the Laurentian series, whose intricacies have for the first time been unravelled by the Canadian survey, their mineral character explained, and the earliest known traces of animal life obtained from them; so that the term *Laurentian* is applied as the general designation for the most ancient formations of Europe as well as of America. To the people of Canada, the publication of this Report must mark an era both in science and practical mining. Any one desirous of studying geology, has here to aid him a detailed account of the structure of his own country; an advantage not hitherto enjoyed by our self-taught geologists, and one which in a reading country like this, must bear good fruit. The practical man has all that is known of what our country produces in every description of mineral wealth; and has thus a reliable guide to mining enterprise, and a protection against imposture. Even in the case of new discoveries of useful minerals which may be made, or may be claimed to be made, after the publication of this Report, it gives the means of testing their probable nature and value, as compared with those previously known.

No one, in short, need henceforth have any excuse for professing ignorance of the labors of the Geological Survey, or for representing it as a useless expenditure of the public money. Persons not interested in science or in practical mining might heretofore have been excused for not having read the annual reports of progress, with their dry details and want of suitable illustrations; but after the publication of this attractive volume, such want of knowledge can no longer be tolerated; and it is to be hoped that no public speaker or writer will venture so to proclaim his own ignorance as to pretend that Canadian Geology is one of those little matters which have, in the midst of more important affairs, escaped his attention, or to underrate the labors of those who have devoted themselves to this great work.

We do not propose to give any summary of the Report, or to give extracts from it. It should be in the hands of every reading man in Canada; and as a further inducement to this, we close with the following extracts from the Preface, in relation to the arrangement of the Museum of the Survey, which is one of its most creditable and useful achievements:

" One of the duties imposed by the Government upon the Survey, at the time of its institution, was the formation of a Provincial Museum, which should illustrate the geology and the mineral resources of the country. This object has been constantly kept in view; and since a suitable building has been placed at the disposal of the Survey, the Museum has gradually assumed a value and importance which at the present time render it second to few on the continent for the special purpose to which it is devoted. The Museum is separated into two parts. One of these is devoted to Economic Geology, and in it are displayed specimens of such rocks and mineral substances as can be applied to the useful purposes of life. These are subdivided into two classes; one of them containing the more important metals and their ores, and the other what may be termed the non-metalliferous mineral substances. These various materials are again classified technically, pretty much in the way in which they are described in the twenty-first chapter of this volume; each specimen being placed under a label giving its locality, and the geological formation to which it belongs. The various substances are as much as possible reduced to forms showing their uses, thus at once making the design of the arrangement intelligible. In this division of the Museum there is a classified collection of all our mineral species; and another of our rocks, more particularly those of a metamorphic or of an intrusive character. This part of the Museum it is proposed to illustrate further by geological maps, sections, and models.

"The geographical distribution of any series of formations can scarcely be followed out correctly over a large area without a preliminary knowledge of the true geological superposition, or the natural order in which these formations have been deposited. It is now well established that throughout a very large proportion of the whole series of rocks composing the earth's crust, the best means of determining their succession is by their fossils; it being a fundamental principle of geology that different formations are characterized by different groups of organic remains. The study and determination of fossils thus becomes an indispensable part of a geological survey. But these organic forms are so many and so various, and pass into one another by such insensible gradations, that to make them truly available requires the special attention of a person versed in natural history, and indeed of one who pursues an uninterrupted study of that department of natural history which is devoted to these ancient forms. Hence the necessity of attaching a palæontologist to every important geological survey; and hence no geological museum can be complete without a full and properly classified collection of described organic remains from the fossiliferous rocks of the area which it is designed to illustrate.

"The second division of the Museum is thus devoted to the palæontology of our formations. In this division the fossils are displayed in groups, which succeed one another in the order of the formations, beginning with the most ancient. In each group the specimens are arranged in a natural-history order, commencing with the simplest or lowest forms, and rising to the highest; and to each specimen there is attached a label giving the generic and specific names of the fossil, with its geological formation and its locality. In order that there may be no mistake as to the fossil indicated by the label, the specimens are freed as much as possible from all other fossils. In order at the same time to save space, the specimens have been as much as possible reduced in size. In this operation the services of Mr. T. C. Weston, a lapidary, have been made available; and his skill has also been applied to slitting many of the cephalopods and other fossils, and rocks, for the purpose of showing their internal structure. By this reduction in the size of the specimens we have been able to arrange a much greater number in our limited space than would otherwise have been possible.

"The number of species of fossils displayed in the Museum is about 1500. Figures engraved on wood of 543 of the more characteristic of these, are given in the present volume. These are chiefly by Mr. J. H. Walker of Montreal, with a few by Mr. A. W. Graham and Mr. G. G. Vasey; the whole from excellent drawings by Mr. H. S. Smith. With a few exceptions, the species here figured are distinct from those which have already been given in the Decades of Canadian Organic Remains, published by the Survey. Of these, I, III, and IV have appeared, and it is expected that Decade II, already referred to, will shortly be published. For the descriptions of Decade I we are indebted to Mr. J. W. Salter, palæontologist to the Geological Survey of the United Kingdom. It contains twenty-one species from the Birdseye and Black River formation, the figures of which are drawn by Mr. C. R. Bone, and engraved by Mr. W. Sowerby. Decade II will contain fifty-one species of graptolitidæ, by Prof. James Hall of Albany. Decade III contains twenty-nine species of Lower Silurian cystideæ and asteridæ, described by Mr. Billings, and one species of cyclocystoides, by Messrs. Salter and Billings; with fourteen species of Lower Silurian bivalved entomostraca, by Mr. T. Rupert Jones, of the Geological Society of London. The figures are drawn on stone by Messrs. C. R. Bone, J. Dinkle, Tuffen West, G. West, and H. S. Smith. Decade IV contains forty-three species of Lower Silurian crinoidea, described by Mr. Billings; the figures drawn on stone by Mr. H. S. Smith, and printed by Mr. G. Matthews of Montreal. As already stated, Mr. Billings has described altogether 526 species of fossils. Those not included in the Decades have been published in the Canadian Journal of Toronto; the Canadian Naturalist and Geologist of Montreal; in the Annual Reports, and in the volume entitled Palæozoic Fossils of Canada, published by the Survey.

"In the collection of the Survey there are probably at the present time about 500 species of fossils still remaining undescribed. The publication of these will be an additional contribution to the general fund of palæontological knowledge; to which, as it has been of great utility in our own investigations, we are bound to add what we can for the benefit of others. But independent of the instruction derived from fossils as guides to ourselves, and proofs to others in regard to the succession of our rocks, there is a higher consideration attached to them than their mere utilitarian application. For, as remarked by Conybeare, they bring us supplementary information of numerous species which have long vanished from the actual order of things; and by their resurrection they unexpectedly extend our views of the various combinations of organic forms. In many instances they supply links otherwise wanting, in uniting the different terms of the series in an unbroken chain, and thus aid in the elucidation of those general laws of natural history, the investigation of which is always of so much interest to enlightened minds."

The maps and sections required to complete the work will be published in the course of this year. Through the kindness of Sir W. E. Logan, we have been permitted to examine the portions of them already prepared. One of them is an exquisite miniature geological map of Canada and the neighboring regions, giving a wonderful amount of detail in small space. Others are maps of special districts and formations; as, for instance, of the remarkable convolutions of the Laurentian rocks in the region of the Ottawa, and of the distribution and subdivisions of the Huronian system. There are also sections on several of the most important lines, which are of especial value and interest in consequence of their being drawn to a true scale, so as to present an accurate view of the actual relations of the rocks. These will of course, when completed, greatly enhance the value of the work.

MEETING OF BRITISH ASSOCIATION.

Zoology and Botany.

Professor Balfour, in his opening address, after stating that the subjects to be discussed in this Section were biological ones, proceeded to remark: "Although our Section is separated for convenience from that of geology, nevertheless they have important bearings on each other. The study of Palæontology cannot be presented without a thorough knowledge of the anatomy, mode of growth, and geographical distribution of the plants and animals of the present epoch. In fact, the study of fossil plants and animals ought to constitute a part of every course of Botany and Zoology. Geology, in place of being reckoned a distinct science, may be considered as the means by which the departments of Mineralogy, Botany, and Zoology are combined in one harmonious system, embracing the natural history of the globe. Rash geological statements and conclusions often arise from imperfect knowledge of the sciences included in our Section. Fronds of ferns of different external forms have been described as distinct fossil species or even *genera*, the geologist not knowing that very different forms of frond are exhibited by the same species of fern in the present day. Again, another error has arisen from the same form of frond being considered as indicating the same species, whereas the same form does occur in different *genera* in the present flora—and these can only be distinguished by the fructification, which in fossil ferns is rarely seen. So also the same forms of shell may belong to different *genera*, the only distinction being founded on the teeth, or on some other character of the *animal* inhabiting the shell; and such characters are, of course, totally lost in the fossil. Again, the presence of a palm-leaf might be considered by the geologist as indicative of a very hot climate, from his not knowing that some palms occur at high latitudes, and others are met with in mountains associated with cool forms of coniferæ. These and numerous instances might be adduced to show the necessity of a perfect acquaintance with the present fauna and flora in all their details before the geologist can determine fossils, or the character of the climate of Palæontological epochs. There is a mutual bearing of all the natural sciences on each other, and the student of nature must take a comprehensive grasp of all. The natural sciences have always occupied a prominent place in the proceedings of the British Association. The subject is in itself popular, and is interesting to all classes. Much has been said in this Section to advance the sciences of Zoology and Botany, and to stimulate naturalists in their investigations. A great feature of the association which require special notice, is the procuring of reports in different departments of science, and the aiding and encouraging of naturalists in carrying on researches which require much labor and experience for their prosecution. Many a deserving young naturalist has thus been enabled to advance science, and lay the foundation for future fame and promotion. Another important feature of the Association is the bringing together men of science and promoting free personal intercourse. Perhaps more good has been done by this than even by the reading of papers. Interchange of thought by oral communication, and the opportunity of frankly stating difficulties and of asking questions, are most valuable to men of science, especially when they are congregated from various parts of the world. Friendships, too, are cemented, and asperities are softened by coming into contact with fellow-laborers in the same great field. No doubt there have been occasioned unpleasant altercations at our meetings; but even these have been ultimately turned to good account. Explanations are made, opinions are canvassed, and truth is finally elicited. For, as iron sharpeneth iron, so the countenance of a man his friend. But iron does not sharpen iron unless it is brought into contact with its fellow, and one be made to act sharply and keenly on the other. In former days keen disputes took place among geologists in reference to the formation of rocks. The igneous view, propounded by my distinguished relative, Dr. James Hutton, was supported warmly by some, while the aqueous view was espoused by others. At length, truth was elicited, and the minds of geologists now, to a certain extent, correspond. The relations and positions of rocks, the continuity of formations, Cambrian and Silurian rocks, coal and shales, glacial motions, the definition of species, their permanence or versaltility, and their origin, embryogenesis in plants and animals, flint hatchets, the age of man, and many other points, structural and physiological, have been, and now are, still discussed with great keenness and even with accuracy. But, out of all this, as in former cases, truth will at length come forth. The storms which now and then agitate the natural-history atmosphere will purify it. Like the mists on the mountain, which bring out in bold relief the noble rocks and ravines of the craggy summit, so these disputes, even while they are carried on, bring out some phenomena of interest which had been previously invisible. The lightning's flash in the dark cloud may discern to us some prominent object which had been invisible in the calm sunshine. But ere long the storm will cease, the mists will be dissipated, and then the unclouded summit will appear in all its majestic clearness. So when the obscurity cast around science by the disputes of combatants shall have passed away, the truth will shine forth to the calm eye of the philosophic observer in all its beauty. In such polemics we are not to fight merely for victory, or for the advancement of our own fame, but for the great cause of truth, which alone will prevail at last. No studies are better calculated to promote friendly intercourse. The investigation of God's works is well fitted to calm unruly passions, and to promote humility and harmony. In speaking of the effects of the practical prosecution of Botany, the late Dr. Johnston of Berwick remarks: 'There is a pre-arranged and beneficial influence of external nature over the constitution and mind of man. He who made nature all beauty to the eye, implanted at the same time in His rational creatures an instinctive perception of that beauty, and has joined with it a pleasure and enjoyment that operate through life. We are all the better for our botanical walks, when undertaken in a right spirit: they soothe, soften, or exhilarate. The landscape around us becomes our teacher, and from its lesson there is no escape; we are wooed to peace by the impress of nature's beauty, and the very air we breathe becomes a source of gratification and pleasure. The companionship of those who are prosecuting with zeal and enthusiasm the same path of science is a delightful feature of such excursions. The feelings excited on these occasions are by no means evanescent: they last during life, and are recalled by the sight of the specimens which were collected. These apparent insignificent remnants of vegetation recall many tales of adventure, and are associated with the delightful recollection of many a friend. Many a time, while carrying on our botanical researches in the wide field of nature, and visiting the Alpine districts of this and other lands, have I felt the force of these remarks. On the last occasion that I presided over Section D at Liverpool, in 1854, I was associated with my late deeply-lamented colleague, Edward Forbes, who was President of Section C.; and, on looking back to his career, I feel, that I cannot give a better example of a true naturalist—one who took a wide and expanded view of nature in all her departments, and at the same time exhibited such a genial spirit as endeared him to all. I have elsewhere remarked that with all his knowledge, he combined an affability, a modesty, a kindness, which endeared him to every one. No student of nature was beneath his notice; no feat recorded by a pupil, however humble, was passed with neglect. He was ready at all times to be questioned, and was prompt to point out any spark of merit in others. He had no jealousy, and never indulged in attacks upon others. He gave full credit to all; and he was more ready to see the bright than the dark spots in their character.

Even to those who criticised him severely he bore no ill-will, and he certainly did not return railing for railing. Over and again was I associated with him in scientific rambles and in meetings of naturalists; and I have seen the tact with which he subdued the *perfervidum ingenium* when misdirected, and calmed the turbulent spirit when self-esteem prevailed over the due acknowledgment of another's merits. He was truly unselfish, and never failed to recognize and encourage merit wherever he could detect it. He had a truly generous spirit, and was totally devoid of narrow bigotry. He was desirous of promoting science, independently of all selfish views. He loved it for its own sake. Would that his example was more followed by all of us! When we look at the changes which are constantly taking place in the views of naturalists as science advances, we cannot but feel the need of modesty in the statement of our opinions. While we give our views and the reasons for adopting them, let this be done without dogmatism or asperity. Let us remember that our conclusions may be modified or altered by future discoveries. Such anticipations, however, should not paralyze our efforts. Science is advancing, facts are being accumulated, and, year after year, a noble structure is being reared on a sound foundation. It requires now and then a master-mind to bring out great generalizations, and to give a decided impetus to the work. Facts must be carefully weighed, and knowledge must be accurate and extensive; otherwise a genius in science is apt to bring forward rash generalizations, and to indulge in unfounded speculations. The imagination is disposed to run riot when a grand vista seems to open before it, and it flies on heedlessly to the terminus without surveying the intermediate ground. We do not ignore speculation; but we recommend, at the same time, cautious induction—a sifting of facts and of their relations to each other. Natural History sciences are now assuming an important place in education. They are not confined, as formerly, chiefly to medical men, but they enter more or less into the preliminary studies of every one. While Classics and Mathematics ought to have an important place in our schools and colleges, Natural History cannot now be neglected. Universities which formerly ignored it, are now remedying their error in this respect; and we may ere long hope to find it occupying a still more important position in educational institutions. The possession of university honors is now connected, to a certain degree, with a knowledge of nature; and a master of arts, as well as a doctor of medicine, is supposed to know something of the objects in the material world with which he is surrounded. The establishment, also, of special degrees in science is a step in advance, for which we are indebted to the University of London. Natural sciences are particularly valuable in mental training. They promote accuracy of observation and of description. They teach the student to look at the objects around him, not with an idle gaze, but with an intelligent discrimination. They ensure correctness of diagnosis, and encourage orderly and systematic habits. The British association, in its perambulation, does much good by bringing such subjects prominently under the notice of directors of educational institutions in various parts of the country. It stirs up many to see the value of this kind of knowledge, and gives practical illustrations of its bearing on the ordinary business of life. Thus the Association has an important influence on the town in which it meets, not merely by what it does during its sittings, but also by its after-efforts on the population. The very preparations made in the locality for the meeting have often been productive of much permanent good. They have been instrumental in bringing together collections which have formed the nucleus of a local museum. And they have been the means occasionally of introducing sanitary measures of the highest benefit to the inhabitants." In conclusion, the President remarked upon the reciprocal relations of science and theology.

Physiology.

Prof. Rolleston, in opening the proceedings of this section, remarked that last year Dr. Sharpey delivered an address on the progress which physiology had made during the previous twenty years; and before the British Association last year, moreover, Professor Huxley delivered an address on the divisions and departments of the science, with its methods and prospects. His own aim would therefore be to avoid the territories which had thus been occupied; and he proposed to pass in review such writers as had written works to which reference was likely to be made in the section, and such publications as might probably become the subject of discussion. First, he would mention works intended for the general public; and secondly, specify works of a more strictly scientific character in the three departments of experimental physiology, structural and comparative anatomy, and the microscope, and then he intended to make a few observations upon the general and upon the educational value of physiological study. Of physiological and anatomical works intended for the general public, there were happily now a considerable number. Among those of a popular character he might specify *The Intellectual Observer*, *The Popular Science Review*, *The Natural History Review*, and *The Annals and Magazine of Natural History;* the three first of recent date, but the last a long established and still excellent publication. The scientific societies publish so many proceedings in octavo, with illustrations, that there did not exist the same necessity in England as on the Continent—a fact which their foreign friends would do well to remember, while the physiologists of England were free to acknowledge the many and valuable services rendered by German and other Continental works. He thought he ought, also, to mention American literary contributions, and to specify *The Smithsonian* and *The Philadelphian Journal of Science*, the French *Annales des Sciences Naturelles*, and the Würtzburg and Berlin *Archives*. Physiology and scientific zoology had been expounded with singular clearness and accuracy to the general public by Mr. Lewes; and anatomy was largely introduced into the pleasing fishermen's book, *The Angler-Naturalist*, by Mr. Cholmondeley Pennell. A short sketch, such as Mr. Pennell's, of the economy of the Bird, would be a most valuable addition to our ordinary ornithologies and oologies. He said oologies, for even in the egg of the bird the special needs of the forthcoming bird seemed to be more especially provided for than in the eggs of other families much higher in the scale. Passing from works of general to works of more strictly and severely scientific interest, he must observe that a high place was due to the lectures of Professor Huxley on the Classification of Animals; and it spoke well for the enlightenment of the readers of the *Medical Times* and of the *Lancet* that the editors of those journals had felt it desirable to cater for their tastes by publishing those lectures on pure science. Turning to works on Experimental Physiology, he was reminded of vivisection; a word which had been rendered familiar to the ears of the public during the last few weeks by the letters and discussions that had appeared in the *Times* and other papers. Addressing himself to one of the questions it suggests, he would ask—Is it possible that a want of humanity is a common fault of physiologists? He was not by any means so sure that "want of decency is want of sense"—as Pope had said —as that a want of humanity is a want of culture. Rudeness, ignorance, want of education, were much more surely connected with cruelty than was cowardice. All children pretty nearly were cruel—that is to say, they were capable of performing acts which adults, at least of the upper classes, shrink from. Most, if not all, persons in the lower order of society concerned in the capture of animals were pretty nearly invariably cruel; and, if reproved for cruelty, they would often be unable to understand what was meant. Gamekeepers, again, killed anything which possesses life, unless they knew they could be prosecuted for so doing, or were paid for preserving it. Cruelty, then, usually flowed from want of thought, want of culture, and want of refinement. Was it probable, then, that men of a science demanding much thought, much culture, and not a little education, should resemble persons lacking all these things in the very points most directly characteristic of such deficiencies? Let him state, too, great facts against which no amount of writing or of demonstration could be of any avail, except by ignoring them. The facts were—first, experiments on living animals very frequently cause their death instantaneously; secondly, when this is not the case, there was chloroform, which was almost invariably employed. In vivisection, as it was called, frequently the first step was the destruction of life, and that in a way as speedy, to say the least, as by the ordinary methods of destruction at the command of either the sportsman or the butcher. Now, surely a life might as well be sacrificed for increasing knowledge as for the production of flesh-food, or for what was called sport. Experiment, too, was tedious and toilsome, and was, therefore, rarely undertaken out of wantonness, or for the gratification of malignity. Undertaken for the ends of science, it had as good a claim to our sympathy as the practices of the "gentle craft" of anglers, to say nothing of those of the destroyers of warm-blooded animals. Vegetarians, it was true, but they alone, could meet this argument on principle. They could say, "Your 'Tu quoque' has no gagging force when used to us; we deny that two blacks make one white. You cannot experiment as you choose—find out how to create life; and nothing can justify you in taking it away." He did not see how this could be met, at least on vegetarian principles. But from what he had already seen in Newcastle, he judged that the vegetarian members of this Association were not many. In the other case, chloroform obliterated the sense of pain, and the use of chloroform was now rarely omitted. The utility of vivisection had been strikingly proved in two classes of diseases—diabetes and epilepsy. The latter, frightful to witness, was yet more frightful to suffer—violence and danger for the moment, and dreariness of prospect for the future, and of the way to meet it vivisection had given us at last a hopeful, because a rational, foreshadowing. To diabetes—an equally terrible if less shocking malady—the applicability of vivisectional results was even more direct than in reference to epelipsy, thanks to the studies of Dr. Pavy. He would just say further, that, when vivisection was being denounced as causing pain and suffering in a world already so full of both, it would be well to consider that, in this question, as well as in all other human questions, we had to deal with complex considerations, and to weigh them one against the other. Absolute certainty was not looked for in morals, absolute demonstration was not given us in religious questions, and absolute freedom from evil was not given to us in any course of practical action we adopt. Vivisection produces a certain amount of pain; but is this pain voluntarily and of deliberate purpose produced in a few laboratories, greater in amount, in intensity, in duration, than the mental pain, moral distress, and bodily agony endured in many a cottage, many a palace, by the victims of the very two diseases which, in these last years, vivisection has most assisted medicine to combat? He felt it to be his duty to make this apology for vivisection. Having done so, he passed on to the subject of structural anatomy, and specified the names of numerous writers upon it—both English and Continental. He next dwelt upon the professional and popular advantages of physiological study, and of a biological training—observing that a thorough scientific training tends, necessarily, to engender modesty and distrust of one's self. He believed he had the authority of their own elder Stephenson for saying that to worldly success there is no gift so necessary as the gift of something quite different. The bar, the senate, and the hustings delight in verbal antithesis, sharp distinctions, and sweeping assertions, which nature abhors. She knows little of antithesis—she works by gradations; and he who has studied her truthfully knows that the universality of assertion is generally in the inverse ratio of knowledge. For success, then, in the brilliant lines of life, the study of nature did not constitute the best possible training; but for success in the scientific careers he had specified, it would be wasting words to say how necessary a biological training is. After referring to Baron Liebig's new book, "The Natural History of Husbandry," and expressing the assured conviction that the popular dogmas of Phrenology would be shown to be radically false by the advancement of physiological knowledge, he then went on to show that profusion not parsimony was the law of nature, and concluded by saying that many causes could be working together to one result. Referring to the possibility of persons considering "the struggle for existence" to be a principle antagonistic to that of "special providence," he said that the incompatibility of the two agencies had no truer foundation than could be laid in the arbitrary teaching and unsupported hypothesis of ages skilled in the piecing together of word mosaics, but wholly devoid of scientific method. We have wider knowledge, we ought to have truer philosophy, than our forefathers; it would be an anachronism indeed to suffer the figments of the schoolmen to prejudice us against the work of the modern physiologist.

On some Fossil and recent Foraminifera collected in Jamaica, by the late Mr. Lucas Barrett, F.G.S.

By Professor T. Rupert Jones, F.G.S., and W. K. Parker, Esq.

In 1862 Mr. L. Barrett, F.G.S., late Director of the Geological Survey of the West Indies, gave Messrs. Jones and Parker some fossil and recent foraminifera from Jamaica, comprising a few new forms; some that were previously but little known, and some in finer condition of growth than usual. The recent specimens, from their ascertained habitats, illustrate, to some extent, the conditions under which the fossil forms were deposited.

One sample of these fossil Jamaican foraminifera consisted of several specimens of *Amphistegina vulgaris;* and another of a few of the same species, with one *Textularia Barrettii* (a new variety of *Textularia*). No locality nor geological horizon was indicated for these. A third sample, from "South Hall Cliff," consisted of two large specimens of *Vaginulina legumen.* Fourthly, a much larger series of Foraminifera, from the "Pteropod-marl" of Jamaica, affords *Nodosaria Raphanistrum, Dentalina acicula, Vaginulina striata, Frondicularia complanata, Cristellaria Calcar, C. cultrata, C. rotulata, C. Italica, Orbito-*

lina vesicularis, *Bulimina ovata*, *Cuneolina pavonia*, *Vertebralina striata*, and *Lituola Soldanii*. These, however, can be regarded only as an incomplete Rhizopodal fauna.

From the recent foraminifera obtained by the late Mr. Barrett from different sea-zones, between 15 and 250 fathoms, on the Jamaica cost, we learn that *Amphistegina vulgaris*, *Textularia Barrettii*, *Dentulina acicula*, *Frondicularia complanata*, *Cristellariæ* and *Lituola Soldanii* indicate at least 100 fathoms, and probably more, as the depth at which the Pteropod-marl and the Amphistegina-beds were deposited in that region. Pteropods are found in some sea-muds at similar depths.

Of the recent Jamaican specimens (evidently only the larger and more conspicuous members of a rich Rhizopodal fauna), some were taken at from 15 to 20 fathoms, namely, *Quinqueloculina agglutinans*. *Q. pulchella*, *Orbiculina compressa*, and *O. adunca*; some at from 50 to 100 fathoms, namely, *Orbiculina compressa*, *Dentalina acicula*, and *Orbitolina vesicularis*; and several others at from 100 to 250 fathoms, namely, *Dentalina acicula*, *D. communis*, *Cristellaria rotulata*, *C. cultrata*, *C. Calcar*, *Frondicularia complanata*, *Amphistegina vulgaris*, *Palytrema miniacea*, *Bigenerina nodosaria*, *Verneuilina tricarinata*, *Textularia Trochus*, *T. Barrettii*, *Cuneolina pavonia*, *Lituola Scorpiurus*, and *C. Soldanii*.

Cuneolina, a rare form, hitherto known only by figures and description given by d'Orbigny, proves (as suspected) to be a modification of *Textularia*; and *T. Barrettii* is intermediate between it and *Textularia* proper. The *Frondicularia* are remarkably large and beautiful; and the *Cristellariæ* and *Dentalinæ* are also large and relatively abundant.

This fauna is almost identical with the fossil foraminifera of the Tertiary "Pteropod-marl" of Jamaica, above mentioned, specimens from which also were given by the late Mr. Barrett in 1862 to the authors of this notice.

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SECOND SERIES.

NOTES ON THE GEOLOGY AND BOTANY OF NEW BRUNSWICK.

By Professor L. W. Bailey.

In a Report which I have had the honor to lay before His Excellency the Lieutenant-Governor of the Province relating to the mines and minerals of New Brunswick, some reference has been made to the results obtained during a tour from Fredericton to Bathurst, and by an examination of the rivers of Tobique and Nepisiquit. Much of the information thus obtained being unsuitable for the more especial purposes of that Report, I have, at His Excellency's desire, determined to compile the more interesting facts for presentation to the Society of Natural History. This paper, therefore, is intended as a Supplement to the Report above alluded to. It is my object to write down in as connected a form as possible, the various rambling observations of a scientific characacter made during a canoe exploration of the streams above-mentioned. Much of the country travelled over has not been heretofore scientifically examined; and although my trip was of too hurried a character to admit of very careful examinations, it is hoped that some of the results obtained may not be without interest and value.

Leaving the village at the mouth of the Tobique, on the 29th of June, in company with three volunteer friends, and four Indians, with their canoes, we reached the sources of that river on the 5th of July. This stream, or a portion of it, having already been the subject of a former exploration, I shall endeavor to make my observations on its character as brief as possible.

The proper outlet of the Tobique River is not apparent at its mouth, the land being low, and the stream much hidden by overgrown alluvial islands. To the geologist the true embouchure is the remarkable spot called the "Narrows," situated but a short distance above the Indian village. These narrows constitute one of the most curious and beautiful scenes to be found in the Province. The rocks which here cross the bed of the river, and which are well exposed in the perpendicular cliffs 150 feet high on both sides of the stream, are composed of slates and schists, filled with seams of quartz and limestone, and pursue a course about N. 34° E. The channel is very tortuous, and in most parts deep, having an average width of about 150 feet. The navigation of the stream is at all times difficult, requiring the utmost skill of the Indians, but during periods of freshet, becomes perfectly impassable. It is probable that a fall once existed at this place, and that the present gorge, which is about a mile in length, has been left by the gradual wearing away of the strata, until the course of the river becomes comparatively unimpeded.

Between the Narrows and the Red Rapids, which are about 11 miles distant from the mouth of the river, the land is of moderate elevation, occasionally becoming bold and picturesque. Some five miles above the Narrows, the stream passes near the base of high and precipitous cliffs of ferruginous rock, overhung with cedar, while the opposite shore is low and covered with a mixture of hard and soft woods. Occasionally terraced banks are evident, but they are much less numerous, and less remarkable than those on the river St. John. In no case did I observe more than one at the same spot, and they, as a rule, were of but little elevation. Four miles above the Narrows, a small stream, called the Pokiok, joins the main river, entering on the west bank by a fall through rock apparently dipping about sixty degrees to the northwest. Through all this district the land appears fertile, and the vegetation luxuriant. Among the trees noticed were elms and mountain ash of enormous size, cedar, spruce, fir, birch, thorn, and poplar. Of herbaceous plants I noticed the following: *Tiarella, cordifolia*, *Trillium erectum*, small, yellow lady's slipper; *Cypripedi-*

um parviflorum, *Iris versicolor*, *Anemone Pennsylvanica*, *Cornus Canadensis* (in flower very abundant), *C. stolonifera*, *Streptopus amplexifolius*, *Clintonia borealis*, *Viburnum opulus*, *Sanicula marilandica*, *Veronica Anagallis*, *Ranunculus acris*, *Thalictrum dioicum*, and *Primula Americana*.

The wild onion (*Allium Schoenoprasum?*) was also common upon the shore, with butter-cups, dandelions, violets, wild roses, and strawberries. Grasses and ferns were also abundant on strips of intervale, but I did not have leisure to determine them. The latter were especially luxuriant, frequently attaining a height of four and five feet. Among them I recognized *Pteris aquilina*, *Onoclea sensibilis*, *Struthiopteris*, and *Osmunda regalis*. The slates and limestones, which occupy the lower portion of the stream, are succeeded, about a mile and a half below the Red Rapids, by the outer beds of the Tobique Red Sandstone District, which, gradually widening, attains a very considerable development, and finally disappears in the neighborhood of the Blue Mountains. The soil rapidly assumes a deep, red tint, and strata of reddish sandstones are exposed in cliffs upon the shore. The red tint first becomes apparent upon the right bank of the stream; but at the Red Rapids, the sandstones, associated with coarse, red conglomerates, cross the bed of the river, with a strike about N. 70° E., and are exposed upon either bank. It is at this spot that the formation should properly begin in the coloring of our geological maps.

The Red Sandstone District of the Tobique is one of great interest and value. The rocks composing it are red and variegated sandstones, limestones, and conglomerates, with salt springs and beds of gypsum. The strata are nowhere much disturbed, and in general are of very moderate elevation. In many places the red sandstones are well exposed in the bed of the river, and being nearly horizontal, form a smooth and polished bottom. The soil of the district is excellent, and probably few portions of the Province offer so many inducements for settlement.

Near the Wapske or Wapskabegan, one of the largest tributaries of the Tobique, the red sandstone strata are well exposed in nearly horizontal beds, dipping to the southeast at an angle of only five degrees. At the mouth of the Wapskabegan they are again exposed, and are interstratified with fine beds of white and pink and reddish gypsum. These are probably but a continuation of those referred to, and the line of strike between the two is N. 62° E., the dip being as above, about five degrees to the southeast. The gypsum is both compact and fibrous, and could be very readily removed for local use or transportation.

About two miles above this river, the red sandstone strata are again exposed, associated with gypsum, in what are known as the "Plaster Cliffs," attaining an elevation of 135 feet. The beds are nearly horizontal, and are apparently divided by frequent joints. The cliffs are very precipitous, in some parts overhanging the stream, and are in a very crumbling and dangerous condition. They are succeeded by other sandstones higher up the stream, with much less gypsum, and having a strike nearly north and south. They here form the bed of the river; and it seemed as we passed over them as if our canoes were gliding along a pavement of massive freestone slabs, polished by the action of the water, and here and there worn into holes by the eddies and pebbles. It is a little singular that, at the Plaster Cliffs and elsewhere, although the gypsiferous sandstones attain on the left bank of the stream an elevation of more than a hundred feet, and rise precipitously from the water, they do not appear at all upon the right, or only in beds a few feet above the level of the river.

In the geological reports of Dr. Gesner allusion is made to the existence of limestone beds about one mile above Plaster Island, and to the cavernous nature of the shore. I was unable to detect the locality referred to. We passed a spot where land travelling certainly appeared difficult and dangerous, but I saw nothing indicating the existence of former caves. Neither did I observe the stalactites, referred to by Dr. Gesner, as abundant upon the shore; but, at a spot about ten or twelve miles above the Wapske, and in the neighborhood of the Little Agulquac, I had the pleasure of finding great numbers of limestone geodes, in loose beds, overlying horizontal strata of reddish sandstones. These sandstones are divided by parallel joints, having a strike N. 62° E. (the same as that at the Wapskabegan), and form the bed of the river. The geodes are of about four inches diameter, and are lined upon their interior with fine large crystals of dog-tooth spar. This locality will afford excellent cabinet specimens.

From the Agulquac to the immediate vicinity of the Blue Mountain range, the soil continues reddish, sandstone boulders lie in the bed of the river, and immense beds are occasionally exposed. The sandstones *in situ* are distinctly seen at the Horse Island, a little more than fifty miles above the mouth of the river, and again at the Two Brooks, from which a fine view is afforded of Blue Mountain in the distance. About here I observed lying in the bed of the stream a number of boulders of milk-white quartz, highly crystallized within, but on the exterior much water-worn and rounded. The soil is apparently fertile, and the river abounds in rich intervale islands, sustaining a luxuriant vegetation. Besides many of the plants already named, I gathered by the side of the stream a single specimen of the Nodding Trillium, *Trillium cernuum*, a plant which has not, so far as I know, been found in any other portion of the Province—also *Polygonatum multiflorum*.

Higher up the stream a more distinct view of the Blue Mountain range becomes apparent. Its central peak is sharply conical, its sides making an angle of about 120°. It rises immediately from the river bank, and at its base is exposed high precipices of thinly wooded trap. A portion of the mountain is undoubtedly red sandstone, but the precipitous cliffs and *taluses* along its flanks distinctly indicate the trappean character of the summit. Near its base are seen cliffs of bright red sandstone, which I found to be calciferous like those farther down the river; but they did not, like the latter, contain distinct geodes.

Between the Blue Mountain and Nictau or Forks the land in the vicinity of the river is low, and fertile, presenting to the geologist but little of interest. At one spot only, a ridge, composed of dark, heavy, and compact rock, very much broken and distorted, crosses the bed of the river. It is apparently grauwacke, but lacks the mica of the latter.

Near the Nictau or Forks several streams combine to form the main river. The two main branches, flowing the one east and the other west, after uniting turn abruptly, and pass off to the southward. The River Marmosekel also here joins the main river.

After leaving the Nictau, and pursuing the left branch (so called, although geographically the right), the character of the country rapidly changes, becoming comparatively sterile, and supporting a much more Alpine vegetation than the district below. The trees are principally pines, firs, and cedars, covered with a long, pendant lichen (*Usnea barbata*, attaining a length of four or five feet), and the ferns are generally low, presenting little variety. One of the most common was *Onoclea sensibilis*. A few miles above the Forks, heavy beds of slates or flags cross the stream with a strike N. E. and S. W., dipping to the northwest at an angle of 45° and more, breaking the course of the river, and producing a fall of about one foot. The water at this point is rapid, but after passing the exposed rocks again becomes deep and tranquil. In this portion of the stream the land is low, with few trees, but is thickly covered with blade alder bushes; the soil as far as visible, being principally sand and gravel. The course of the river is very tortuous, running successively to all points of the compass. To the right of its general course, at a distance of about a mile, a high ridge is apparent for many miles, pursuing a course about N. 30° E. Gravel beds are very numerous, and occasionally large boulders are found in the stream. The pebbles composing the former are principally slaty; but rounded lumps of milky quartz are also common, with a variety of silicious rocks, among which we found a fine-tinted, transparent cornelian, jasper, and a little chalcedony.

In the vicinity of a small stream called the Cedar Brook, which enters the river from the northeast, we passed over strata of fine, dark slate nearly perpendicular, and having a strike about N. E. and S. W. These slates are visible for some distance, and have seams of white quartz, and sometimes of limestones, running through them. Near here I examined the plants upon the bank, and observed *Trientalis Americana*, *Clintonia borealis*, *Oxalis acetosella*, *Smilacina bifolia*, *Linnaea borealis*, *Cornus Canadensis*, *C. stolonifera*, *Viburnum opulus*, *Sagitta sagittifolia*, *Streptopus distortus*, wild currants and raspberries, *Thalictrum* (four or five feet high), *Mitella nuda*, and *Smilacina stellata*.

The Little Tobique receives its waters from a chain of romantic lakes, completely shut in by high granitic mountains. The first of these is about two miles long and one broad, and lies at the very base of Bald or Sagamook Mountain, one of the highest peaks in New Brunswick. It is but one of a continuous chain, but rising abruptly from the lake seems to stand aloof from its less elevated companions. It is of a gently swelling outline, and, although distinc'ly covered with vegetation at its summit, exposes on its sides broad and precipitous cliffs, laid bare by the action of slides, which have probably suggested its rather inappropriate name. With three others of the party I ascended the mountain, and was well repaid by the extensive view afforded in every direction. The height, as given by Gesner, is 2,240 feet; but as he did not, I believe, visit the mountain himself, I am unaware of his authority for the assertion. I should suppose the summit to be about one-fourth of a mile above the surface of the lake, but had no means of measurement.

The ascent of the mountain is a remarkably steep one, being as much as 45° by actual clinometer measurement. It rises immediately from the side of the lake (not at a distance of several miles, as represented in all the maps of the province), and shows upon its flanks three distinct zones of vegetation. The first of these zones consists of a dense growth of pines, firs, and cedars, and extends about a third of the distance up the mountain side. The second is principally composed of white and yellow birch, with a few cedars and alders, and reaches to a very considerable elevation. The third zone is confined to the summit, and a small portion of the sides, being covered wi h a low dwarf growth of shrubs, with a few stunted birches and spruces. At many points near the summit there is no vegetation at all, the rocks being laid bare in extensive slides, and the fragments being piled upon each other in the wildest confusion. At several points, generally immediately above these slides, perpendicular masses or needles project from the general slope of the mountain, and can only be reached with difficulty. The mountain, so far as I had an opportunity of examining it, is composed of a compact red feldspar rock or felsite, and is very homogeneous in character. The entire slope of the mountain is strewed with large broken blocks of the same material, which, being overgrown with moss, and often covering deep holes, make the ascent a somewhat dangerous as well as difficult one. Boulders of similar material were also noticed far down the valley of the Tobique. I have already alluded to the three zones of vegetation on the mountain, which are equally noticeable during an ascent, or when viewed at a distance from the lake below. The herbs and shrubs noticed were about the same as those observed on the Little Tobique. The Labrador Tea (*Ledum latifolium*) was very common, increasing in quantity as we approached the summit, while *Cassandra caliculata* was also found growing abundantly. I noticed also *Trillium erectum*, *Oxalis acetosella*, *Trientalis Americana*, *Aralia nudicaulis*, *Cornus Canadensis*. *Clintonia borealis*, *Streptopus amplexifolius*, *Sagittaria sagittifolia*, *Smilacina bifolia*, quantities of *Vaccinium ulig nosum*, and *Gaultheria hispidula*. Lichens were also abundant, especially *Cornicularia* and *Cenomyce rangiferina*.

There are several islands in Nictau Lake, which, pre enting as they do, great contrast to the mountain-peaks around them, should not be passed over without notice. One of these only, where we encamped for the night, I had an opportunity of examining, but the others are probably of a like description. The island referred to is about fifty feet in length and thirty in breadth, rising to a height of about ten feet above the lake, and presenting at its top a nearly smooth and level surface. The material composing it is a compact slate, and the line connecting this with the other islands above mentioned would be about N. E. and S. W. There is no continuation of such material observable on the Bald Mountain side of the lake, nor is it probable on the other, there being nothing visible but high and rugged peaks, undoubtedly igneous. I did not, however, examine the shore. The sides of the island sink nearly perpendicularly into the lake, and the depth of water surrounding them must be very considerable, as we were unable to reach bottom with our longest fishing lines.

The vegetation of the island is scanty, but quite different from anything else seen in this section of the province. There are no full-grown trees upon it, but only one or two dwarf spruces and pines, with an occasional cedar. Of herbs and shrubs I noticed the following: *Ledum latifolium*, *Sisyrinchiumanceps*, *Vaccinium Pennsylvanicum*, *V. Vitis Idaea*, *V. uliginosum ? Solidago lanceolata ? Potentilla Norvegica*, *Corydalis glauca*, and *Sambucus pubens*.

The occurrence of these islands, rising like needles from the bottom of the lake, and so far as visible of an entirely different character from the mountain-peaks around, is not a little singular and difficult of explanation.

The character of this portion of the province can well be studied from the summit of Sagamore Mountain. It is essentially a high table-land, sloping gradually towards the St. John, yet in its higher parts everywhere broken up into lofty hills and mountains. I was unable to ascertain any prevailing direction for the chains, peak after peak appearing wherever the eye was turned. The general direction of the lakes is about east 20° south, their form being quite irregular. The Bald Mountain range seems to pursue a course nearly parallel. This is undoubtedly the highest land in the province, and, I have heard it stated on good authority, that, with the aid of a glass, one can see to the north the mountain range of Gaspé, and again in the extreme southwest, the lofty summit of Katahdin.

The Nepisiquit, like the Tobique, has its source in a chain of romantic lakes, surrounded by lofty granite mountains. The lakes in neither case are perfectly distinct, being rather simple *expansions* of single lakes. There are three of these expanded sheets at the head of the Tobique, and four at the sources of the Nepisiquit. The portage connecting the two lines of water-shed does not exceed three miles, and now here attains an elevation of more than fifty or sixty feet.

The general direction of this transit is a little south of east, and it is merely an obscure and little-frequented footpath through the woods. The soil seemed fertile, and the vegetation varied—the plants noticed being about the same as already given. The ascent from the Nictau Lake is very gradual, and near the middle of the portage the land is low and swampy. From here it again ascends until very near the Nepisiquit Lake, when it falls rapidly away to that level. I should suppose that the latter lake occupies a somewhat higher level than those on the Tobique. There are no rocks apparent anywhere on the line of crossing.

During this portion of our tour, the members of our party were greatly tormented by the incessant biting of black flies and musquitoes. The development of insect life in this portion of New Brunswick is very remarkable, and the number of insects and the ease with which they can be obtained would fully satisfy the most ardent entomologist. All the orders of insects seem to be represented, and by a great variety of genera and species. Butterflies of all shades and varieties of gaudy coloring, eight or ten different kinds of flies, gnats, mosquitoes, spiders, caterpillars, gadflies, dragon-flies, and beetles are found in the greatest profusion. I sometimes saw fifty or more butterflies swarming at rest upon a single rock, and allowing one to pick them up by the handful. Every day, and indeed almost every hour of the day, produced some new individual; and one of our party, who was a great entomologist, met with numbers which he had never seen or even read of before. A very valuable and interesting collection might be here made. The best season for such a purpose would be about the beginning of July, as they afterwards become much less numerous, and in August almost disappear.

The Nepisiquit Lakes are four in number, connected with each other by narrow straits. A line connecting them all would run nearly east and west. They are not so deep as those of the Tobique; the bottom in the Third Nepisiquit Lake being in many places, even near the centre, not more than two feet below the surface, while from the little island in Nictau Lake we were unable to reach bottom with twenty feet of line. The former are, like the latter, shut in by mountain ranges, but their elevation is not so great as those already described. Along the shores of the Nepisiquit Lakes I observed *Iris versicolor* and *Typha latifolia* growing abundantly, also *Nuphar advena*, *N. Kalmiana*, *Equisetum limosum*, *E. sylvaticum*, and *E. uliginosum*.

The Nepisiquit passes out from the lakes much more quietly than the Tobique, and descending by a rapid but unbroken current passes around the base of handsome hills, clothed with a rich green covering of birch and spruce. The land close to the river is low and covered with alder bushes, but some lofty mountains appear to the southward. The stream pursues at first a nearly uniform course a little west of south, without winding much, like the Tobique. Its bed is strewed with large and travelled granitic boulders, which though not wanting on the Tobique were much less numerous than here.

The mountains just alluded to, pursue a course, as nearly as I could make out, a little north of east, crossing the river, which works its way around their base. They are undoubtedly granitic, and in many places expose upon their flanks high and rugged cliffs of a brick-red color, giving at first the appearance of a red sandstone district. The boulders, however, which occur in the bed of the stream, distinctly indicate their character, being composed of a corse-grained feldspathic granite or *granulite*.

Near the base of one of these cliffs we were borne by the current, and so remarkable were its characters, that I at once determined to give it a more careful examination. Landing for this purpose, and approaching with one companion and an Indian guide, what we supposed to be the natural slope of the mountain, we were suddenly stopped by a tremendous chasm, which unexpectedly lay open before our feet.

The defile is about fifty or seventy feet deep, with almost precipitous sides, and furnishes a picture of singular wildness. The two sides of the chasm were in the most marked contrast. That by which we approached was steep and broken though covered with vegetation, while the opposite slope, which was almost perpendicular at its base, and which reached high up the mountain sides, was one dense mass of large detached blocks of reddish granite, or else the original rock from which they had been torn. On this side of the chasm scarcely a trace of vegetation could be seen, as far as the eye could reach.

The two sides of this singular defile are as strongly contrasted in their mineralogical characters as in the features just described. The first or lowest side is composed of a fine compact greyish syenite, much weathered on the surface, and covered with vegetation; the other is of the same material as the boulders I had already found farther up the river, viz.: a coarse-grained feldspathic granite or granulite. There is no mica present in it, and but little hornblende. It is but little weathered, looking fresh and red, and, as before stated, is almost destitute of vegetation. The direction of the defile, at the point where we examined it, was nearly east and west, but soon turned off to the northward, when it could be no longer traced from where we stood. I would gladly have occupied a longer time in its exploration, but could not well afford the delay. As a point of reference for this vicinity, of which so little has heretofore been known, I have ventured to call this singular range the "Feldspar Mountains" in allusion to the mineralogical character of its principal rocks. The locality is about fifteen miles, as near as I can judge, above the Forks of the Nepisiquit River. On my journey to and from the mountain I found the following plants: *Kalmia angustifolia*, *Ribes rubrum*, *Epilobium spicatum*, *Linnaea borealis*, *Oxalis acetosella*, and others.

Below the Feldspar Mountains for a distance of many miles, the country is high and rugged, and presents an indescribably desolate appearance. As far as the eye can see, the mountain slopes have been stripped of their vegetation by extensive fires, and nothing but the charred trunks of decaying trees is now visible. Mountains are seen in every direction, the principal chain pursuing a course parallel to that of the river, about east and west. The latter descends rapidly, gliding almost in a straight line, and without a fall, down an inclined plane of three or four degrees. Boulders of feldspathic and syenitic rocks are at times very numerous; and from the fact that we passed them only at intervals, according to the windings of the current, I am inclined to think that they cross the stream in regular trains, pursuing a uniform general direction, a little south of east. These boulders are of the same material as that of the mountains I have described above, and increase in numbers and magnitude as one descends the stream. A few miles below the Forks (where the soil is alluvial, and supports extensive groves of elms) these boulders attain an enormous size, and cause numberless falls and rapids in the current. Many of them are injected with veins of milky quartz, and at times appear to be jointed. They continue to increase in quantity until one reaches a spot called the Indian Falls, where rocks *in situ*, together with huge granitic boulders, block up the stream and produce a fall of four or five feet. This is succeeded about half a mile below by another of similar elevation, the space between the two being filled with dangerous rapids. The rocks appear laminated and contorted, and are filled with veins of injected quartz, and pass the stream in a line running about 10° west of North. A portage was here necessary, during which I observed the following plants: *Wild-roses*, *currants*, and *huckleberries*, *raspberries*, *white* and *red clover*, *Epilobium spicatum*, *Potentilla arguta*, *Sagittaria sagittifolia*, *Kalmia angustifolia*, *Chrysanthemum leucanthemum*, *Allium Schoenoprasum*, *Spiraea salicifolia*, *Pyrola elliptica*, *Platanthera*, *orbiculata ?* and *Smilacina stellata*. A short distance below the Forks I noticed also, *Archangelica*, *Diervilla trifida* (not seen on the Tobique), and *Caltha palustris*.

About twenty miles above the Grand Falls of the Nepisiquit we passed the first formations of distinctly stratified rocks, consisting of slates and ferruginous slaty sandstones, much broken and contorted. They seemed to run nearly east and west, and dip northward (?) at a sharp angle. Some of the beds of slate appear to be of excellent quality.

These rocks are visible for a considerable distance, and have a strongly ferruginous color. At one point a high cliff, composed of them, projects into the stream, and was so intensely red, as to induce me to stop for the purpose of examination. I at first supposed it to be a bed of haematite, but it proved to be merely a magnesian slate, with only an external resemblance to the above named one. Much of it is soft and crumbling, and might, perhaps, be employed as a mineral paint. Some of it is probably *manganesian* also, and resembles the slates at the Tatagouche mines, in the vicinity of Bathurst. The latter are probably but continuations of the same series.

Below this point, the bed of the river is strewed with small and rounded boulders, of the size of paving-stones, and presents a very singular appearance. They are of three kinds, a bright red (feldspathic), a dark (syenitic), and green stone, and being polished brightly by the water, suggest the idea of a mosaic pavement. More ferruginous strata soon appear, dipping westward, and granitic boulders again become common. Granite ridges soon appear *in situ*, and seem to have displaced and to have been thrust through the other strata. The stream becomes rapid and violent, the vegetation of its banks poor and stunted.

The above-named rocks continue for a short distance only. About five or six miles above the Grand Falls, they are succeeded by beds of slates and slaty sandstones, with some limestone, dipping into the bed of the river at an angle of 60° to the north, the river here running about northeast. The course of the stream is nearly at right angles to the strike of the slates, which form precipitous cliffs, perhaps seventy-five or one hundred feet in height. Like the similar gorge at the mouth of the Tobique, this spot is called the Narrows, and can only be navigated by the most skilful Indians.

Between the Narrows and the Grand Falls, sandstone beds appear with a strike about north and south, and dip to the westward at a high angle.

The Grand Falls of the Nepisiquit are too well known to require description here, their beauty and the excellent salmon-fishing at their base having long since attracted travellers to the spot. Geologically, the fall has been the result of the gradual wearing away of consolidated strata; the direction of the current having been probably determined by some pre-existing fissure in the beds. The rocks composing the gorge below the falls (which is about half a mile in length) are composed of contorted ferruginous slates, having a strike nearly north and south, and a dip of 50° to the westward. Through these slates the water has worked its way, gradually widening the channel, and running for a portion of its course directly opposite to the dip of the strata, but towards the lower part making a sudden turn southward, and then nearly following their strike. On the rocks below the falls I noticed in flower, *Campanula rotundifolia*, *Potentilla arguta*, and wild roses. Many of these rocks are filled with numerous crystals of cubic pyrites.

Leaving the gorge, we soon passed over more sandstones and slates, still dipping westward. At a place called "The Great Chain" they have a dip of about 60° to the west, and cross the stream with a strike about north and south, forming a series of falls and rapids. With these sandstones are associated chloritic and talcose slates, conformable with them. At this point, besides the two plants above named, I noticed, *Allium Schœnoprasum?* *Sisyrinchium anceps*, *Diervilla trifida*, *Aralia nudicaulis*, *Streptopus distortus*, *Linnaea borealis* *Clintonia borealis*, *Iris versicolor*, *Cornus Canadensis*, *Platanthera dilatata*, *Archangelica*, *Achillaea*, *Lactuca elongata*, *Thalictrum dioicum*, *Apocynum androsœmifolium*, *Oenothéra chrysantha*, *Stellaria*, and *Aspidium spinulosum.*

A few miles below the Great Chain, more laminated sandstones cross the stream, with a strike N. 40° W., with a nearly perpendicular dip, highly silicious, and filled with crystals of sulphuret of iron. They soon change their course, taking a strike N. 20° E., and are much folded and contorted. With these are associated ferruginous slates, and the whole have a reddish appearance from the oxidation of their contained iron. The stream is narrow, and passes rapidly between the rocky banks.

Still descending, beds of impure iron-stone and ochre, with micaceous iron, appear on either shore, being of a soft and crumbling character. Several of the cliffs exposed upon the shore are of a bright red color. They may be seen on the left bank to overlie nearly horizontal beds of ferruginous sandstone, with small conglomerate and pebble beds, these latter in turn resting upon granite. The rocks appear to be much rounded and water-worn, even at an elevation of ten or fifteen feet above the present level of the river. The reddish beds seem to lie in a great basin formed by the underlying granite, or rather the latter forms a series of anticlinal axes, the slate and sandstone beds reposing on their flanks.

The granite beds are divided into huge blocks by parallel vertical joints, and thus present upon their river face the appearance of a wall. Their surfaces are perfectly flat; and those which form the river bed, being polished by the wear of the current, look like a massive pavement. It is in passing over these pinkish granites, that the river is wearing out the curious channels of the Pabineau Falls.

The granites at the falls are distinctly jointed, the line of the joints running due north and south. The course of the stream is parallel to these, and has probably been determined by one or more existing in its bed. The spot is one of the most singular I have seen in the Province.

Between the Pabineau and Bathurst our journey was made by land; the navigation of the river, which is one series of rapids, called the "Rough Waters," being too dangerous for canoes. From good authority, however, I have learned that the granite beds at the Falls are succeeded by slates and schists (to some extent copper-bearing); and these again underlie, near the mouth of the river, the red sandstones and conglomerates which form the north-eastern boundary of the New Brunswick coal-measures. The latter are seen near the Nepisiquit bridge, on both sides of the river; but it is not probable that they extend far below the city of Bathurst. On the left bank, near the bridge, is a curious spot, where coal (lignite?) and copper ore are intimately associated, and interstratified with sandstones, clay, and conglomerates. It was in consequence of the discovery of copper at this point, under these singular circumstances, that examinations were made for that metal farther inland, which examinations led to the discovery of the present mining-districts on the Tatagouche River. These latter are situated in bluish and dark brown slates, having a strike E. 10° S. and a southerly dip of 50°. They are probably continuous with the beds south of Pabineau, and extend for a distance of ten or twelve miles along the coast, above Bathurst, being exposed on the Nigadoo and other minor streams of that region. They seem to be highly metalliferous.

I have now given with considerable detail the results of a fortnight's ramble on these hitherto little-known rivers. Their examination was necessarily a hurried and imperfect one, the distance travelled over being not less than two hundred miles; and the results are only presented now, that a more just and accurate view may be entertained of this interesting region.

To those who are familiar with the geology of New Brunswick, it will have already become apparent that much of what has now been stated differs widely from the formerly entertained notions as to the structure of this portion of the Province. That these differences may be the more readily appreciated, I have appended to this article a carefully colored map of the district, showing as far as possible the order of succession of the rocks here exposed. The following are the most important differences between this and preceding maps:

1st. Upon Dr. Robb's map the whole course of the Tobique, with the exception of the Red Sandstone District, is colored as if passing through Upper Silurian rocks. In reality most of the country between the Blue Mountain Brook and the Forks is of a trappean character.

2nd. The calciferous slates of the Narrows are separated from the Red Sandstone district by ferruginous slates and dark sandstone. The calciferous slates and the sandstones have a northeasterly strike, and similar rocks are again seen above the Forks, with the same strike. They are probably continuous.

3rd. The exact limits of the Red Sandstone District, on the line of the river, are the Red Rapids and the Blue Mountains,

4th. The Blue Mountain and Bald Mountain rise directly from the waters of the lake or river, not at the distance of several miles, as represented on other maps.

5th. On the map of Dr. Robb no distinction is made between trappean, syenitic, and feldspathic rocks. In the accompanying map, the Blue Mountains, which are trappean, are distinguished from the Bald Mountain and Nepisiquit ranges, which are chiefly feldspathic. There is an island of slate in Nictau Lake.

6th. The upper half of the Nepisiquit, on Dr. Robb's map, is marked as running through upper Silurian strata. On the contrary the whole district, colored yellow on my map, is feldspathic, consisting partly of *granulite* and partly of *syenite*, more particularly the former. Rocks of this character, forming lofty mountain ranges, cross the stream in a northeasterly direction, and are seen nearly as far as the Indian Falls. At the latter place highly altered rocks cross the stream, with a strike 10° west of north.

7th. The granite band which has been supposed to cross the Province from the Chepatnecticook Lakes, and which on Dr. Robb's map has the same width at the Nepisiquit which it exhibits elsewhere, really narrows in the vicinity of that stream to a very small strip, and probably soon disappears. Owing to the tortuosities of the river, these rocks appear at several successive points, and at first would lead one to believe in the existence of several granitic anticlinal axes. From the fact however that all the slates seen above the Pabineau have a westward dip, it is probable that only one band is successively exposed. Where this band finally disappears is a matter of much doubt, but it will not probably be found far beyond the position which I have assigned to it. The metalliferous slates which rest on its northern flanks re-appear on the Tatagouche River, and, as already remarked, the latter are probably continuous with those on the Nepisiquit. Possibly the granite, after passing the Pabineau, is well exposed again; but this remains to be determined.

I have only to add that my observations were, as a rule, made from a rapidly moving canoe, and must only be regarded as approximately accurate. Where the character of the country could not be ascertained, from the occurrence of belts of intervale, or the presence of alluvial matter, or boulders, the map has been left devoid of color. The granitic region assigned to the serpentine on the map is copied from that of the late Dr. James Robb.

(*Read before the Natural History Society of New Brunswick*, 12*th February* 1864.)

ON THE CHEMISTRY OF MANURES.

We extract from the Report of the Second Class of the International Jury of the Great Exhibition of 1862, the following paper. The Reporter, Prof. A. W. Hofmann, F.R.S., tells us that having invited Mr. F. O. Ward to furnish him with a succinct view of the question of manures in their relations to agricultural chemistry, the following essay was the result; which Prof. Hofmann characterises with justice as "one of the ablest and most philosophically-conceived compendiums of a complex and difficult subject which has ever come under his notice." He therefore adopted and endorsed his coadjutor's work; adding for incorporation with it, much valuable information of a special kind furnished him by Messrs. Lawes, Gilbert, Gruning, and others. With these explanatory remarks, we invite the attention of our readers to this remarkable essay, premising only that we have omitted for the sake of brevity certain portions, inserting in their places an abstract of them in brackets, and have also appended a few notes.—EDITORS.

EARLY HISTORY OF MANURES.—Manures, in the form of cattle-dung and ordinary farm-yard composts, have been known and employed from time immemorial for the fertilization of the soil; but the manures termed "artificial," which have their origin elsewhere than in the farm itself, and are for the most part of concentrated and portable character, have but of late years come largely into use. Nevertheless the manufacture of these manures, and the trade to which they have given rise, already rank amongst the most extensive of modern industries.

[The author here gives a brief history of the various processes proposed and patented in England for the preparation of artificial manures during the first third of this century. They were but three in number, of which two were for the utilization of night-soil, while a third proposed the use of a mixture of oyster-shells and gypsum. In the course of the eighteenth century three patents for manure were obtained, one of which described a mixture of sea-salt, saltpetre, lime, and Rhenish tartar, declared to "possess a magnetic quality whereby it attracts fertility, etc."]

COURSE OF EARLY SCIENTIFIC RESEARCH.—In the mean time, however, a vast store of scientific information, tending more or less directly to the elucidation of this important subject, had been in slow and silent course of accumulation, by the successive labors of many eminent experimentalists.

Not to go back further than the last century, nor even than its latter half, we shall find concentrated in this brief period, a series of brilliant discoveries, bearing more or less directly upon the manurial and agricultural questions, but far too numerous even for the most cursory narration here. Space would fail us even to enumerate the names of European celebrity that adorned this memorable epoch; but if we had to select half a dozen of the most illustrious to represent the philosophical activity, British and continental, of the period, we would venture to single out on the one hand, Black, Priestley, and Cavendish — and on the other, Lavoisier, De Saussure, and Berthollet.

During the fifty years in question the nature and composition of *air* and *water*, of *carbonic acid* and *ammonia*, (the four main forms of volatile plant-food,) were discovered, their gaseous elements isolated, and their properties determined.

The sciences of geology and meteorology at this period also began to take shape and form; enabling an insight to be gained into the origin and nature of cultivable *soils*, and into the *climatic* conditions of plant-growth.

At the same time the laws of the physical forces, particularly those of light and heat, began to be better understood, as well in their general relations, as in their special influence on plants.

The introduction of more accurate chemical methods permitted, meanwhile, a closer investigation than had before been possible, of the tissues and products of plants, and of the various transformations which those products undergo during the several stages of vegetal development.

The sound physico-chemical principles thus established had the happiest influence on physiological investigations. The organs of plants and of animals were studied in a clearer light than before; and their respiratory, assimilative, and excretory processes, together with the relations established by those processes between the three great kingdoms of nature, were gradually made out.

Among the many illustrious men who assisted in working out these great results, Lavoisier probably deserves the highest place; not, perhaps as the largest contributor of new truths to the accumulating store,—though his contributions of this kind were many and brilliant,—but because his vivid imagination, and the eminent generalizing powers with which he was endowed, enabled him to co-ordinate all the scattered researches of his time, and to display innumerable isolated facts in their true subserviency to general laws; so as (among other things) largely to extend our knowledge of the cosmic equilibrium on which sound husbandry can alone be based. Everything, indeed, that Lavoisier did bore the impress of his master-mind. He it was who first applied the Balance to the study of the phenomena of Life. He it was who first showed that while plants evolve oxygen, animals, on the contrary, consume it; carbon being oxidized or burned in their bodies as oil is burned in a lamp. His lofty tone of thought, and eloquent language, powerfully impressed his contemporaries; and chiefly to his influence and example the admirable researches of his age owe their high scope and scrupulous precision. Science never endured a severer loss than when Lavoisier met his untimely fate. But his great spirit lived after him; and researches bearing upon the noble themes he had loved to treat were carried on with, if possible, increased activity after his death. The scientific records of Europe were soon crowded with fresh masses of undigested discovery; and in a few years such another mind as his was wanted, to grapple with the growing mass of detail, and once more to create order out of the scientific chaos.

Early in the present century England, in her turn, produced a master-mind,—that of the illustrious Sir Humphrey Davy,—vast in scope and luminous in conception, as any, the greatest, of foregone times. Davy was well fitted to wear the fallen mantle of Lavoisier, and to continue his great work. It is accordingly to Davy's genius we owe that memorable treatise—truly described by Liebig as "immortal"—the "Elements of Agricultural Chemistry."

In that imperishable work all the scattered results of foregone research in this branch of science were collected and reduced to a system, which was extended and enriched by the author's own capital researches; whereof, perhaps, the most signal (in this department of science) were his analytical investigations of soils (types of all that has since been done in that way); his capital determinations of the composition and transformations of vegetal products; and his admirable experiments on the nutrition of plants, as well by leaf as by root.

To the powerful impulse and just direction impressed by Lavoisier in France, and Davy in England, in subsequent investigations of like kind, may be ascribed in a great measure their vigorous and successful prosecution by philosophers contemporary with ourselves. Of these an encyclopædic list cannot, of course, be given here; and among so many equally illustrious names, it would be difficult to single out a few, as types to represent the rest. Suffice it to say, that to the exertions of these able men we owe a large proportion of the experimental data, on which, as on a firm foundation, the edifice of modern agricultural science, physical, chemical, and physiological, has, so to speak, been, stone by stone, built up. Honor and gratitude to those who have patiently hewn out those stones from the quarry of undiscovered truth!

But as the true value of the quarried stones is only made apparent by their judicious collocation in the edifice according to the plan of the architect, so also do experimental data, separately accumulated by the toil of many, only appear in their true value and significance when comprehensively embraced, co-ordinated, and, as it were, fused into a harmonious whole, by the fiery genius of one master-mind. Such a mind was Lavoisier's in the last century; such a service was rendered by Davy to our fathers; and such, to ourselves, are the mind and the service of Justus Liebig.

Thus have France, England, and Germany, in the course of about a century, successively produced the three great Lawgivers of Modern Husbandry.

It was in the year 1837 that the British Association for the Advancement of Science, perceiving the immense accumulation of facts, for the most part unsystematized, which had already taken place in organic chemistry, and was annually increasing therein, invited Justus Liebig, who had already attained to eminence by his extensive researches in this branch of science, to write a report upon its then condition; which honorable duty the illustrious philosopher undertook. In the year 1840, Liebig, in fulfilment of this engagement, produced his memorable work on "Organic Chemistry in its Applications to Agriculture and Physiology." In ordinary hands such a report would, in all probability, have been but a compilation, more or less compendious, of facts already known, and conceptions already proposed for their co-ordination. But the original genius of Liebig, essentially philosophical and constructive, impressed upon his work a very different character.

He began by sweeping away the fallacious theoretical views which were at that time in vogue,—particularly the so-called "Humus theory,"—and replacing them by a theory of his own, wider in scope, and more conformable with truth. With this, the so-called "Mineral theory," as a general clue for his guidance, Liebig was enabled to thread the labyrinth of intermingled facts and fallacies, which had necessarily resulted from so many investigations, inductive and deductive, carried on for so many years, by so many independent thinkers and experimentalists, and recorded in so many scattered memoirs. All of these he was enabled to weigh and appreciate, by the criterion of a new law, or rather system of laws, themselves evolved during his large induction, and established (in a great measure) by help of the very facts they served to elucidate and connect.

Profiting by the controversial criticism which his book, on its appearance, did not fail to provoke, Liebig made it more perfect in successive editions; and extended it by additional volumes, some modestly entitled "Familiar Letters," some promulgated as codes of Natural Law, but all forming parts of a connected series, in which, as in a mirror, is displayed the progressive development of Liebig's views, in the light of his own and of contemporary researches. By these labors, pursued with unwearied industry during upwards of twenty years, Justus Liebig has unquestionably shed upon his all-important theme a flood of light, as copious and brilliant to the full as that which it successively received, in former days, from the luminous minds of Lavoisier and Davy. Indeed, of the affiliation of his labors to those of his immediate predecessor, Liebig himself, in the dedication of his work to the British Association, speaks with becoming humility and justifiable pride:—

"I have endeavored," he says, "to follow the path marked out by Sir Humphrey Davy, who based his conclusions only on that which was capable of examination and proof. This is the path of true philosophical inquiry which promises to lead us to truth, the proper object of our research."

Of Liebig's views, and of the rapid and profound revolution of opinion they brought about, occasion will arise to speak in a subsequent page. Meanwhile, it may suffice to remark that, amongst other things, they completely overthrew the conceptions previously entertained as to the nature and operation of manures.

[Here referring again to the history of patent manures in England, the author remarks, that, as a result of the newly-awakened interest in the subject of scientific agriculture, no less than ninety-six patents for manures were registered between 1850 and 1855; and he estimates that the whole number of such patents registered from 1842 to 1862 was at least 200.]

This long series of inventions comprises plans and processes for turning to account, as manure, almost all the known forms of animal waste and ejecta: such as, for example, the night-soil and sewage of towns; the rags of woollen, silken, and leathern clothing; the débris of manufactures in which horn, bone, hides, bristles, gut, and other organic and nitrogenous materials are used; the spent animal or bone charcoal of the sugar refineries, and other phosphatic residua; the ammoniacal liquors of gas-works; the alkaline wash-waters of soap, dye, bleach, and many other factories; —in a word, several hundred forms of residua,—nitrogenous, phosphatic, and alkaline,—formerly cast away as worthless rubbish.

These, the respective patentees propose to subject to various processes, mechanical, physical, and chemical: such as, for example, in the case of liquors, to concentration by boiling down, or precipitation by chemical agency; in the case of solid residua, of crushing, grinding, or other process of comminution; or to chemical disintegration by powerful solvents, acid or alkaline according to the circumstances in each case; or to maceration in water; or to torrefaction by fire; or to digestion, at low or high pressure, sometimes in moist, sometimes in dry or super-heated steam.

Several of the patents include recipes for mixing the products thus obtained with each other, or with products of a different origin, to adapt them (as the inventors allege) for special crops or for peculiar soils. Many of these proposals possess merit; though a still larger number exhibit ignorance on the projectors' part; while a certain percentage almost seem to have been concocted with a view to profit by the ignorance of others.

SUPERPHOSPHATE OF LIME MANUFACTURE.—First in importance, and *nearly* first also in chronological order, among the manure-patents enrolled since the publication of Liebig's book in 1840, stands the celebrated patent granted in 1842 to Mr. J. B. Lawes,* for converting tricalcic into monocalcic phosphate by means of sulphuric acid. The invention of this process, so far as it applies to the treatment of recent bones, is not claimed by Mr. Lawes, but belongs to Justus Liebig, who suggested it in his great work already quoted. As this suggestion has become the foundation of the modern industry of manures, and its authorship has been the subject of controversy, the Reporter feels bound to record, in the foot-note below, Liebig's own words on the subject.†

The great merit of Mr. Lawes consists, first, in his having extended the application of sulphuric acid to phosphates of *mineral*

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* Lawes (J. B.), Patent No. 9353, May 23, 1842.

† "The form in which they [bones] are restored to a soil does not appear to be a matter of indifference. For the more finely the bones are reduced to powder, and the more intimately they are mixed with the soil, the more easily are they assimilated. The most easy and practical mode of effecting their division is to pour over the bones, in a state of fine powder, half of their weight of sulphuric acid diluted with three or four parts of water, and after they have been digested for some time to add 100 parts of water, and sprinkle this mixture over the field before the plough. In a few seconds, the free acids unite with the bases contained in the earth, and a neutral salt is formed in a very fine state of division. Experiments instituted on a soil formed from *grauwacke*, for the purpose of ascertaining the action of manure thus prepared, have distinctly shown that neither corn nor kitchen-garden plants suffer injurious effects in consequence, but that, on the contrary, they thrive with much more vigor."—"Organic Chemistry in its Application to Agriculture and Physiology," pp. 184, 185.

origin, such as apatite, and to the *fossil* bone-phosphate known as coprolite; and, secondly, in his having devised means and appliances for carrying out the manufacture on an industrial scale. Those upon whom it has devolved to organize a new industry, and to overcome the difficulties that spring up, unforeseen, at every stage of such a work, will know how to appreciate at their just value Mr. Lawes's services in this respect. Indeed, in his double capacity, as a manufacturer of manures, and as an indefatigable experimentalist on their effects, Mr. Lawes merits recognition as one of the most active promoters of agriculture now living. Nor would it be just, in such a mention, to overlook the large share of service rendered by Dr. Gilbert, the able coadjutor of Mr. Lawes, in the experimental and analytic department of his labors.

Mr. Lawes appears to have made his first essays in the manufacture of superphosphate in 1841–2; and, on the success of these experiments, to have begun his great manufactory at Deptford, in 1843. Many similar works have since sprung up, and the manufacture has grown to enormous magnitude. Mr. Lawes himself produces 18,000 to 20,000 tons of superphosphate annually; and the total yearly production of superphosphate in Great Britain is estimated by him as ranging from 150,000 to 200,000 tons.

Mr. Lawes has favored the Reporter with the following interesting particulars as to the most recent and improved mode of manufacturing superphosphate, its average composition, and its present market price:—

"The phosphatic materials are first ground to a very fine powder by millstones; the powder is then carried up by means of elevators, and discharged continuously into a long iron cylinder, having agitators revolving within it with great velocity. A constant stream of sulphuric acid, of sp. gr. 1·66, enters the cylinder at the same end as the dry powder, and the mixture flows out at the other end in the form of a thick mud, having taken from three to five minutes in passing through the machine. The quantity turned out by such a mixing-machine is about 100 tons daily. The semi-fluid mass runs into covered pits ten to twelve feet deep, each of sufficient size to hold the produce of the day's work. It becomes tolerably solid in a few hours, but retains a high temperature for weeks, and even months, if left undisturbed.

"The composition of a superphosphate, of good quality, made partly from mineral phosphate and partly from ordinary bones, may be stated as follows:

Soluble phosphate	22 to 25 per cent.
Insoluble phosphate	8 " 10 " "
Water	10 " 12 " "
Sulphate of lime	35 " 45 " "
Organic matter	12 " 15 " "

Nitrogen 0·75 to 1·5 per cent.

" If sufficient sulphuric acid were used to decompose the whole of the phosphate of lime, the product would be too wet to be packed in bags, and would require either to be mixed with extraneous substances of a dry and porous nature, or to be artificially dried.

" The price of the best descriptions of superphosphate ranges from 5*l.* 15*s.* to 6*l.* 10*s.* per ton, and of that made from purely mineral phosphate from 4*l.* to 5*l* 5*s.* per ton."

Of the raw materials annually worked up into superphosphate in Great Britain, Mr. Lawes estimates that about half is derived from the deposits of fossil bone-earth, or coprolite, discovered of late years in several parts of England. Bone-ash, chiefly imported from South America, animal charcoal from Germany, and bones from all parts of the world, together supply about forty per cent more of the raw material; while the remaining ten per cent of the total supply is made up by guano (chiefly of the less nitrogenous and more phosphatic kinds), with a little apatite (say 200 to 500 tons per annum), obtained from Spain, Norway, and America.

IMPORTATION OF MANURES INTO GREAT BRITAIN.—These data alone might serve to indicate that the industry of manures, since the impulse it received in 1840, has afforded occupation not only to the inventive and manufacturing, but also to the commercial activity of the English nation. But of this the origin and development of the guano-trade affords direct evidence.

[Here follows an historical sketch of the growth of the trade in guano, from which we learn that the first experiments with this manure in England appear to have been made from 1838 to 1840. Messrs Gibbs & Sons, its principal importers, commenced in 1842 by importing 182 tons of guano. In 1843 they imported 4667 tons, and in 1862 their total supplies (as well for foreign as for British consumption) equalled no less than 435,000 tons. Of this between one-third and one-fourth was retained for use in the United Kingdom. Its price, which has varied from 9*l.* to 15*l.*, is now about 12*l.* the ton.]

The extraordinary success of the Peruvian guano-trade led to voyages of discovery in search of fresh deposits; several of which have been found and extensively worked on the islands of the West African coast and elsewhere. Nor has commercial enterprise confined itself to guano. Nitrate of sodium, formerly valued chiefly as a substitute for saltpetre in the sulphuric-acid manufacture, has of late years come more and more largely into use as a powerful fertilizer; and the vast deposits of this substance successively opened up in several parts of the South American continent are now extensively worked for the supply of the English manure-market. As for bones and bone-ash, they have been imported by thousands of shiploads, not merely from the boundless South American pampas,—feeding-grounds and cemeteries of unnumbered herds, from immemorial time,—but also from populous European countries, whose soil could by no means spare them so well, and whose fertility must have been seriously impaired by their withdrawal.

Good and Evil of the Trade in Manures.—The manure-trade presents itself, therefore, in two aspects; the one advantageous, the other detrimental to mankind. Nothing can be more advantageous than the collection and utilization of fertilizing residua formerly cast away as worthless. The fossil phosphates quarried out of the bosom of the earth, and the guano extracted (by the successive intervention of seaweeds, fishes, and penguins) from the depths of the ocean, are evidently so much treasure fairly won from nature for the legitimate enrichment of mankind.* Even the withdrawal of recent bones and bone-ash, from plains untenanted as yet save by wild cattle, to fertilize the corn-fields of the populous old world, must be accounted a legitimate commerce. But the boundary line is over-passed, and the manure-trade becomes abnormal, when bones are withdrawn from one populous country to enrich the exhausted fields of another.

Nor is the detriment thus occasioned confined to the country whose soil is impoverished. In the closely knit relations of modern commerce, the impoverishment of any one commercial country reacts on the prosperity of all the others, by diminishing the stock of exchangeable wealth in the world. If Germany, for instance, grows less corn, her purchasing power for foreign goods, say

* See, in this connection, a paper by Mr. Sterry Hunt on Fish-Manures (Canadian Naturalist, vol. iv, pp. 13–23), where will be found much information on the theory of manures and on their commercial value.—Editors.

French or British, is proportionally diminished, and commerce suffers *pro tanto*. The gain to France and England is, therefore, but illusory, if either robs a neighbor's soil to fertilize her own.

In a work just published,* Baron Liebig sternly rebukes England for her over-eagerness to buy up, in the form of bones, the phosphatic wealth of countries less advanced than herself in financial and industrial power; and for the apparent recklessness with which she squanders forth these treasures (ill-gotten and ill-spent), down her innumerable sewers to the sea. The great agricultural teacher manifests alarm at the superabundant zeal with which the most diligent of his pupils obeys his lessons; and to other nations he earnestly points out the ruinous consequences that must ensue to them from the exportation of phosphates, drawn from their soil, to stay the exhaustion of the English fields. His cry of warning is couched in terms of almost passionate invective:—

England (he exclaims) is robbing all other countries of the conditions of their fertility. Already, in her eagerness for bones, she has turned up the battle-fields of Leipsic, of Waterloo, and of the Crimea; already from the catacombs of Sicily she has carried away the skeletons of many successive generations. Annually she removes from the shores of other countries to her own, the manurial equivalent of three millions and a half of men; whom she takes from us the means of supporting, and squanders down her sewers to the sea. Like a vampire she hangs upon the neck of Europe, nay of the entire world, and sucks the heart-blood from nations, without a thought of justice towards them, without a shadow of lasting advantage for herself.

It is impossible (he proceeds to say) that such iniquitous interference with the Divine order of the world should escape its rightful punishment; and this may perhaps overtake England even sooner than the countries she robs. Most assuredly a time awaits her, when all her riches of gold, iron, and coal will be inadequate to buy back a thousandth part of the conditions of life, which for centuries she has wantonly squandered away.

It must be admitted that these strictures, though somewhat harsh in tone, are not without a certain degree of truth. It may, however, be urged, on the other hand, that they apply only to one branch, among many, of British manurial industry,—and even to

* "Einletung in die Naturgesetze des Feldbaues." Von Justus von Liebig. Braunschweig, Vieweg und Sohn, 1863.

that branch only partially. For, since the British coprolite-beds have been extensively worked, they have supplied fossil phosphates at a price so low as to supersede, in a great measure, the supply of recent bones, for agricultural purposes, from Continental countries. Nor do the laws of political economy permit us to doubt that undue scarcity, artificially created, gradually raises market price to an extent which becomes at last prohibitory; so that the evil provides its own corrective. Of this, indeed, a very apposite illustration reaches the Reporter while he writes. M. Clemm-Lenniga, manufacturer of Manheim, informs him that English fossil phosphates are being extensively exported to Germany; he himself (M. Clemm-Lennig) receiving considerable supplies of this material from British ports. The balance of trade seems, therefore, to be arriving at a just equilibrum in this matter, as, indeed, it always does, if only it be left to swing freely.

MODERN HISTORICAL EVENTS CONNECTED WITH THE DEVELOPMENT OF THE MANURIAL INDUSTRY.—But were England a more signal offender than she is, or ever has been, against what may be termed the manurial equilibrium of the world, she might plead her justification in the train of modern historical events which have brought her manurial industry into its present remarkable phasis; a phasis purely transitional, and which marks the crisis of a momentous revolution, even now in course of accomplishment.

The events here alluded to, like the revolution in which they are culminating, have their common origin in the memorable invention of the steam-engine by Watt.

The new motive power placed by Watt's genius at the disposal of mankind, after having transformed in succession every other main branch of human industry—the spinning and weaving of raiment, for example; the arts of locomotion, by land and sea; all the various forms of brute drudgery, such as lifting, hewing, pumping, grinding, &c.; all the technical plastic arts, from the shaping of the most stubborn metals to the moulding of the most delicate clay—in a word, after having lightened for mankind all the other forms of toil, is now making its way into the farm, and impressing upon the operations of husbandry an equally signal revolution.

It is important to observe that the transformations which have preceded this final, and most momentous change of all, have not only prepared the way for it, but have, at the same time, rendered its advent an indispensable necessity; as a very brief consideration will show.

It is, in the first place, by the operation of steam-power that the *handicrafts*, formerly pursued by families dispersed in villages over the whole surface of the land, have been replaced by *manufactures*, conducted in colossal factories, determining the agglomeration of enormous populations, in rapidly developed towns and cities, located usually (for the convenience of trade) upon streams and rivers leading to the sea.

Food has naturally followed population; and corn and cattle, vegetables and fruit, are daily poured from the country into the towns, in streams of constantly increasing magnitude. The quantity of fertilizing residua resulting from the consumption of these provisions, and requiring, in fair husbandry, restoration to the distant fields from which they come, undergoes, of course, proportionate augmentation; and the problem of their re-conveyance to the land has been, and still is, one of annually increasing difficulty.

During the earlier development of the factory-system, the old mode of urban defecation, by means of cesspools emptied periodically, was in vogue; and much of the night-soil produced in the great manufacturing towns found its way back from these stagnant receptacles to the land.

But as the populations assembled in these industrial encampments grew vaster and more dense, diseases of the so-called *zymotic* class became more and more rife among them; and though the respective causes of the several forms which zymotic or febrile disease assumes remained unknown, it was gradually established by professional investigations that they had all one common favoring condition in the putrescent effluvia of stagnant filth.

To the few scientific inquirers who traced out this relation, it became apparent that the stagnant cesspool system was radically vicious, and must be rooted out at any cost. They perceived that urban populations could only be preserved from febrile disease by the daily removal of their ejecta before its entry into the state of putrefaction; and for this end a system of house and street drains, kept constantly washed with abundant supplies of water, seemed to afford the readiest means.

Here again the power of steam was on the side of progress.

The public water-supply of towns, no longer led, as of old, in wooden pipes, to public fountains, thence to be fetched in pail and pitcher to the dwellings, was urged by steam-pumps at high pressure, through iron pipes having lateral branches, into the houses themselves, and even up to their highest floors. This permitted the adoption of Bramah's water-closet (a capital invention) with its swift water-rush and trapped exit-drain, instead of the noisome privy, untrapped and waterless, with its stagnant pit of putrescence beneath. And though Bramah's closet itself was a costly piece of mechanism, cheaper contrivances of like kind soon followed, bringing within reach of the poor as well as the rich the inestimable blessing of cleanly defecation.

These ameliorations had, however, gained but little attention, and were but slowly making their way, when, in 1836, the views of their advocates received at once a terrible confirmation and a powerful impulse, by the sudden outburst of the Asiatic cholera. * * * * * * * * * * * * * * * * The consternation it produced was universal; and it gave rise to that remarkable series of researches, conclusions, and practical reforms, known collectively as the modern Sanitary Movement.

Under this new influence the substitution of flowing drains for stagnant cess-pools was carried on with much increased activity; though obstructed by a vehement controversy as to the proper size and form of the drains. Small circular stone-ware tubes were recommended by one party; large brick flat-bottomed sewers by the other. The tubular system happily proved to be the cheapest as well as the best; and its advocates, after a ten years' struggle, finally carried the day. Whole towns are now drained through 12-inch pipes, which would formerly have been deemed of scant dimension for the drainage of a single mansion.

The application of the manurial streams from urban drains to irrigate farm-lands was also warmly advocated by the sanitary reformers, but as warmly declared impracticable by several leading engineers; whose views upon that part of the question prevailed.

The second invasion of Asiatic cholera, in 1849, gave a new impulse to the abolition of cesspools; and the value of tubular drains, of small size and rapid scour, for their replacement, had by that time obtained very general recognition. But the leading engineers of England, while admitting, theoretically, the value of sewage to fertilize land, still denied the soundness and economy of the mechanical arrangements proposed by the Sanitary Reformers for its distribution. On an engineering question, public opinion (not unnaturally) sided at the outset with the engineers. The new system has had, therefore, to encounter a professional opposition, all the more formidable for being thoroughly conscientious. Probably that opposition, with the controversy it has engendered, and, above all, the experiments to which it has given rise, constitutes a wholesome ordeal to test the soundness of the new plan, and to bring about the correction of such weak points as it may present. But in the mean time, the application of town sewage to farm-lands, on an extensive, national scale, has stood, and still stands, adjourned.

Hence the present condition, obviously transitional, of the great manufacturing and commercial towns of England; hence the insufferable pollution of her streams and rivers; hence that prodigious squandering of the elements of human blood, for which she is so bitterly reproached by Liebig.

But the same mighty power of steam which brought about the centralization of the manufacturing population in great towns, with the evils thence ensuing, and the sanitary ameliorations by which those evils were (in part) subdued, came fraught with other principles also, and other events, not less influential in the development of the manurial industry. Among these the most conspicuously important, in their bearing upon this great industry, were the doctrine and practice of Free Trade. The historical affiliation of Free Trade to steam-power is direct and obvious. The millions congregated by steam-power had to be fed. To the working of the new factory-system cheap corn was as necessary as cheap coal. The restriction of bread-supplies, and, the consequent enhancement of their price, by artificial means, to benefit a class, became utterly inadmissable. Protection, always a fallacy, was now also an anachronism; and after a severe struggle, and a long series of transitional expedients, the ports of England were thrown open freely to foreign supplies of food. The cultivators of this cold northern soil were thus exposed to the competition of rival food-growers, tilling, beneath warmer suns, the more prolific corn-fields of the south. Upon this unequal competition the English territorial proprietors entered, as upon a struggle for life or death. Abundant manuring seemed at the outset their main, if not their sole resource; hence the rapid and prodigious development of the guano-trade; hence the multiplication of manurial products from every form of waste, as manifested in the patent records; hence the celebrated "nitrogen theory" and the "high-farming" system, to which allusion will presently be made; hence, lastly, that ransacking of the whole world for bones, so criminal in Liebig's view.

APPLICATION OF STEAM-POWER TO AGRICULTURE.—But steam-power, which has imposed upon the British cultivator this struggle for existence, brings him also the means of issuing victorious from the encounter. Why may not the steam-urged ploughshare pass to and fro through the field, as the steam-driven shuttle passes through the fabric in the loom? If pure water can be pumped by steam-power at an infinitesimal cost into a town for its supply, why may not the very same water, enriched with the *ejecta* of the population, and so converted into a powerful manure, be also pumped out of the town by steam-power, and applied to maintain the fertility of the land? In a word, why may not husbandry rise, in its turn, from the rank of a *handicraft* to that of a *manufacture;* the farm be organized and worked like a factory; and food, like every other commodity, be at length produced by *steam-power?* These questions are now in every mouth; and the agricultural revolution they imply appears to be, at this moment, in course of accomplishment by the English people. Already, on many an English farm, the characteristic tall factory-chimney is seen rising among the trees; the steam-engine is heard panting below; and the rapid threshing-wheel, with its noisy revolutions, supersedes the laborer's tardy flail.

Already, at somewhat fewer points, the farm-locomotive stands smoking in the field, winding to and fro, round the anchored windlass, the slender rope of steel which draws the rapid plough-share through the soil; thus furrowed twice as deep, and thrice as fast, as formerly by man and horse; and thus economically enriched with proportionately-increased supplies of atmospheric plant-food. And lastly, already, at still rarer intervals, the subterranean pipes for sewage-irrigation ramify beneath the fields, precisely as the pipes for water-distribution ramify beneath the streets of the adjacent town; the propelling power being in both cases that of steam.

These innovations are doubtless still experimental; and like all innovations, they are vaunted by some with premature zeal as perfect; while others, with pardonable scepticism, decry them as utterly impracticable. Truth for the present seems to lie between these extremes. The steam-plough, though answering well in large and level fields with favorable soils, still requires adaptation to less easy conditions of tillage. The Tubular Irrigating system is still liable to the sudden influx of storm-waters, over-burdening, and often over-mastering, the steam-pumps, so as seriously to interfere with the economy of the distributive operation. But inventive research and practical experiment are rapidly proceeding side by side, and every year, not to say every month, sees some fresh truth elicited, some previous "impossibility" achieved.

UTILIZATION OF URBAN EJECTA AS MANURE.—The separation of surface-water from sewage is, by a certain number, confidently relied on to solve the problem of sewage utilization, in conformity with Mr. F. O. Ward's formula,—"*the rainfall to the river, the sewage to the soil.*" Others are of opinion that sewage, even when diluted by admixture with rain-swollen brooks, may be economically pumped on the land. A third party believe gravitation to be the only economical distributive power for sewage; and open gutters, contoured along the undulating ground, the only channels suited for its conveyance.

On these mechanical questions the Reporter, as a chemist, has of course no opinion to offer. But that the reckless squandering of town-sewage to the sea, if continued on its present prodigious scale, must, in a few generations, justify the worst forebodings of Liebig, and that the same steam-power which has induced the evil can alone supply the remedy, the Reporter confidently believes.

[Here follows a notice of the systems of urban defecation pursued in Baden and in Japan, with the remarks of Liebig thereon.]

The organization of the so-called "Continuous tubular circulating system," by which, with the aid of steam-power, the healthy and ceaseless interchange of pure water and manurial liquor between town and country is now sought to be achieved, seems destined to constitute the mechanical compliment of the great chemico-physiological truths promulgated by Justus Liebig; from whose powerful genius the promoters of this plan anxiously anticipate not merely its adoption, but its incorporation in his great agricultural edifice, as its crown and pinnacle.

It is not however pretended by the warmest advocates of this system, that it can be accomplished by a single generation. It is admitted, on the contrary, that the complete tubularization of the farms of Europe must be a task as gradual as the complete drain and water pipeage of her towns, or as the universal extension of her railway and electric communications. But as the magnitude of such a project may be, for many minds, the very pivot on which their judgment of it, favorable or adverse, may turn, the Reporter quotes here, from a speech of Mr. F. O. Ward (in 1855), some remarks bearing on this point.

"It is argued," said the speaker, after adverting to the cost of the requisite pipeage,—"it is argued from this vast expenditure, and widely-extended range of distribution, that the plan is impracticable. But I think this resembles the arguments used against gas-lighting at the outset. 'What!' it was said in the old days of oil-lamps, to the daring innovators who proposed gas-lighting, 'do you seriously ask us to tear up all the streets of our towns, and lay down thousands of miles of subterranean arteries, to circulate a subtile vapor through every street and into every house, to do, at the costs of millions upon millions, what our lamps and candles already do sufficiently well?' Such was the language used; and the proposal of gas-lighting was regarded at the outset, by the majority of mankind, as the wildest and most visionary halluncination. But when Murdoch's factory had been illuminated with gas, the whole problem was virtually solved; and when the first line of gaslights burned along Pall Mall, the illumination of all the towns of Europe became a mere question of time. Just so, when the first farm was successively laid down with irrigating tubes for the distribution of liquid manure, there ceased to be any force in the argument about the quality and cost of pipeage for this purpose. * * * Nor should we be deterred from grappling with the sewage problem by contemplating the vast magnitude of the results to which it will lead in the course of time—of generations, perhaps, when the whole subsoil of Europe will probably be piped for the distribution of liquid manure, just as all Flanders is already honeycombed with tanks for its storage."

SUMMARY OF THE MANURE-QUESTION IN ITS HISTORICAL RELATIONS.—If the foregoing views be correct, the present peculiar and provisional condition of the manurial industry in England is due to a series of concatenated influences, springing from the invention of the steam-engine as their common source, and comprising the development, under its influence, of the modern manufacturing system, with its centralized swarms of population,—leading, on the one hand, to increased demand for food, and to the consequent proclamation of Free trade,—leading also, on the other hand, to reiterated invasion of Asiatic pestilence, and to the consequent abandonment of the cesspool-system, in favor of certain tubular arrangements, designed for the continuous removal and utilization of the manurial waters, and now in midway course of organization. Wholesome controversy, the mother of experiment, enlightens, while it retards this revolution; and if, meanwhile, as Liebig alleges, England "sucks, vampire-like, the blood of Europe," it is because she herself (in this sense) bleeds from a thousand wounds. As the closure of these, now her most ardent desire, shall be progressively accomplished, so, in like proportion, will she be absolved from further need of the sanguinary supplies, for which she now pays so dear. To drop metaphor,—as the new circulating mechanism for the utilization of sewage-manure shall be progressively worked out and realized in England, so, in like degree will her importations of manure fall off; till at last, when her manurial circulation shall be complete, the course of the manure-trade may be reversed, and England may be in a condition to send back to the continents which supply her with food, the fertilizing elements therein contained, or their equivalent.

In some degree, no doubt, the development of the human race, accelerated as it assuredly will be by more abundant food-supplies, may tend to prevent these manurial economies, by the absorption, in increasing quantities, of what may be termed man's floating capital of phosphates—to wit, those held in human skeletons and blood. But large reserves of these, and of all other fertilizing materials, are fortunately open to our exploitation, in the as yet unappropriated domains of nature,—the ocean, the atmosphere, and the underlying strata of the earth. To these mineral sources the manufacturer of manures, guided in this respect by the general course of modern industrial history, will doubtless have recourse in an increasing degree. By aid of the steam-engine, as already explained, we are enabled to draw from the air, and to fix in the rapidly and economically comminuted soil, increased supplies of volatile plant-food. The same system will assist to open up, for use (not waste), the phosphatic and alkaline reserves of the soil. To the increasing substitution of fossil for recent bones, as raw material, in the superphosphate manufacture, reference has already been made; and in the section on potash, the new means at our disposal for extracting this fertilizer from the ocean and the primitive rocks, have been set forth at length.*

It is not necessary however to pursue these reasonings further; nor to trace, to a more distant future, the probable influence of foregone and contemporary events on the course of the manurial industry. The Reporter will have accomplished his wish should the attention of governments and individuals throughout the world be directed by these cursory remarks to the double revolution, Sanitary and Agricultural, now taking place in England; and to the signal benefits likely to accrue therefrom to the British nation, and ultimately to the whole human race.

MODERN THEORY OF PLANT-NUTRITION. NATURE AND OPERATION OF MANURES.—Quitting the historical aspect of the question, the Reporter proposes now to offer a few remarks on the nature and *modus operandi* of manures, and on the grand and simple laws which govern their relations to the soil and the crop. For the clear apprehension of these it will be necessary, in the first instance, briefly to direct attention to the nature and functions of plants, and to the modern theory of their alimentation. Growing as they do, with their leaves spread forth in the air, and their roots radiating in the soil, plants necessarily draw from these media the materials of which they consist. As fertile soils are rich in the debris of previous vegetation, such as dead roots, leaves, and the like, crumbled to *mould* or *humus*; and as this humus is slightly soluble in water, which is constantly supplied to the soil in the form of rain and dew; it was formerly and not unnaturally believed, that the aqueous solution of organic matter thus formed

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* Reference is here made by the Reporter to a previous section of this report, pp. 48–52. From this it appears that the process for the economic extraction of potash-salts from sea-water, as described by Mr. Sterry Hunt (Canadian Naturalist, vol. iii, pp. 105–109), has been still further perfected by Mr. Merle, who employs artificial cold to aid the process; and has now established, in the south of France, very extensive works for the purpose of carrying out Mr. Balard's processes with this improvement. As regards the extraction of potash from feldspathic rocks, the late experiments of Ward and Wynants, as noticed in the report, show that by carefully calcining feldspar with proper proportions of lime or chalk and fluor-spar, a frit is obtained from which nearly all the potash may be removed in a caustic state by the action of water.—EDITORS.

was imbibed by the roots plunged therein, and so conveyed as food to the living tissues. According to this view, plants were supposed to live like animals, on organic food, more or less resembling in chemical composition the tissues which it nourished. This was the old *organic* or *humus* theory of plant-nutrition, referred to above as having been attacked and demolished by the great author of the *mineral* theory, now universally accepted. Liebig indeed proved, in the clearest manner, partly by *data* ready to his hand, partly by his own incomparable researches, that it is not possible for plants to obtain their nutriment in the form of *organic* matter. He showed that the Vegetal kingdom of nature is interposed between the Mineral and the Animal Kingdoms, with the special function of elaborating from the former the food of the latter.

Thus, for example, with reference to carbon, the weightest solid constituent of plants, Liebig proved it to be absolutely impossible that a sufficient supply of this element should reach them in the form of dissolved organic matter, or humus. In this demonstration Liebig took as his data, first, the ascertained solubility of humus in rain water; secondly, the known average quantity of rain-water falling annually on an acre of land; and lastly, the quantity of carbon annually yielded by the average crop of that area, whether in the form of hay, timber, or corn and straw. With these elements of calculation, Liebig demonstrated irrefragably that humus, as such, is not soluble enough to serve as plant-food; seeing that the whole annual rainfall, even if completely saturated with humus, and entirely absorbed by the growing wheat-plants, grass, or trees, would not supply a fourth part of the carbon removed from the farm in those crops. Liebig showed further, that the growth of perennial plants (forest trees, for example), so far from exhausting the soil of humus, tends on the contrary, to occasion its accumulation therein; vegetation, in point of fact, being a condition precedent of humus, not humus of vegetation.

Supply of Carbon to Plants.—Pursuing a chain of argument in which the researches of De Saussure, Boussingault, and many others, were, by a masterly and luminous induction, brought to bear in support of his own conceptions, Liebig established the fact, now universally received, that carbon is conveyed to plants, not in any *organic* combination whatever, but as a *mineral* gas, formed by the aid of atmospheric oxygen, and termed carbonic acid.

The steps of research by which our present knowledge of this matter was built up by Liebig, from data partly collected, partly original, cannot be here enumerated, but the received view may be thus briefly summed up: Every 32 lbs. of atmospheric oxygen can take up, without change of volume, 12 lbs. of carbon in the form of carbonic-acid gas. This gas, on the other hand, plants have power to absorb by leaf and root; and by their vital force, coupled with the action of the solar light upon their leaves, to decompose. The carbon they reduce to the solid form, and fix in their growing tissues; the oxygen they restore to the air. The oxygen thus liberated by living organisms takes up fresh carbon from effete organic matter; whether from the debris of vegetables themselves, *e. g.* mouldering humus, slowly oxydized within the soil; or from vegetal fuel (recent or fossil) rapidly oxydized by combustion; or from the residuary materials of animal life, circulating in the blood, and eliminated by oxydation during the respiratory process; or lastly, from the final residuum of animal life, —the *corpse*, which also, during its decay and dissolution, yields carbon in abundance to the oxygen of the air. Thus, by the intervention of atmospheric oxygen as its carrier, carbon, in the form of carbonic-acid gas, is transferred from dead to living organisms, the air constantly receiving from the former as much carbon as it supplies to the latter.

COSMIC EQUILIBRIUM OF THE ATMOSPHERE, HOW FAR DOUBTFUL.—Whether or not the ever-active processes which collectively supply carbon to the air *exactly* balance those which perpetually co-operate to withdraw it, so as to form a perfect and unalterable cosmic equilibrium, we do not know. The assertion is often made, and popular writers are in the habit of extolling the assumed arrangement as an admirable provision of nature. But we are in truth quite ignorant on this subject; no reliable data having come down to us as points of comparison by which to determine any variation that may have taken place, and be still in progress, in the composition of the atmosphere. And here the Reporter cannot but remark in passing, that it is time systematic observations were begun in Europe, to serve as a starting-point, or first term of comparison, by which our successors, if not ourselves, may be enabled to elucidate this question; than which none can be conceived of deeper importance to mankind.

TRUE FUNCTIONS OF HUMUS.—Reverting to the humus in the soil, its true office, as contradistinguished from the imaginary functions assigned it of old, may now be clearly perceived. As living organisms feed on the carbon restored to the air by their defunct predecessors, and as humus is but the debris of previous vegetation in a soil, the carbonic acid developed by its decay must play a proportionate part in nourishing the crop then in course of growth. Hence the necessity of an atmosphere within the soil to oxydize the humus, and thereby to reduce its carbon from the organic to the mineral condition, so as to make it assimilable by plants. The necessity of such an *underground atmosphere* is an established fact; air being as essential as warmth and moisture to the germination of seeds, and to the development of plants. One of the main services rendered by ploughing consists in the loosening of the soil, and the multiplication within it of interstitial air-spaces. Of like kind is (in one of its aspects) the benefit rendered by subsoil-drainage to water-logged soils; whose interstices of course receive air from above, as fast as the redundant water is drained off from below. Lastly, one principal advantage of the porosity of soils, and of their consequent *surface attraction*, consists in their property, thence derived, of condensing and retaining within their pores so much of the underground air. The oxygen thus brought into close contact with humus, attacks it and becomes charged with its carbon; remaining thus charged, within its pores, as carbonic-acid gas,—the appropriate mineral carboniferous plant-food, as already explained. This gas, meeting with the moisture also retained in humus by the surface-action of its pores (termed, with reference to fluids, *capillary attraction*), is therein dissolved, and so presented to the ramifying rootlets in the most favorable manner for imbibition by the so-called *osmotic* action of their membranous spongioles, and the suction-power developed by the evaporation of their sap from the leaves.

In this way do decaying organic bodies replenish the atmosphere, whether above ground or below, with gaseous carbon; which the atmosphere, in its turn, conveys to the plants; whose leaves appear to inhale it as gas, but to whose roots it is supplied in watery solution. The carbon of the plant and the carbon of the soil have but one primal origin, the atmosphere. From this source the carbon constantly flows; to this reservoir it as constantly returns. The humus of the soil, and the tissues of plants, are but successive resting-points for carbon in its circulating course.

It is now easy to understand that forest-trees and other perennial plants, growing slowly but continuously, year after year, and possessing a comparatively vast expanse of foliage and of roots, can thrive in soils less rich in mouldering humus, and therefore in carbonic-acid gas, than is needful for certain annuals,—such as, for instance, the wheat-plant,—whose term of existence is brief, whose foliage scanty, whose roots small (especially during the earlier stages of its development), and whose growing power is of a proportionately delicate quality. In this latter case, art may usefully intervene to concentrate, within narrower limits of time and space, the supply of carbon diffused by nature over a more extended area and a longer term. This explanation justifies, in the case of wheat and similar crops, additional supplies, not only of carbon, but also of other forms of plant-food; and it leads to the consideration of "high farming," its objects, its dangers, and its normal limits,—which may, however, be conveniently reserved for brief elucidation further on.

Supply of Water to Plants.—Meanwhile a few remarks are due to the plant-food next in order of weight to carbon; viz., to hydrogen and oxygen; which are supplied to plants in combination with each other, as water.

The source of this aliment is too familiar to need even indication here. Yet the natural mechanism by which water is distributed to plants, in the form of rain and dew, is too wonderful and beautiful to be passed in silence. Shakespeare, who always arrived at truth through beauty, was struck with the all-pervasive diffusion of rain, and with the admirable tempering of its descent by the atmospheric resistance. Its soft fall upon the unruffled foliage symbolized for him Mercy's sweet grace and "unstrained quality," whereof he says,

> "It droppeth as the gentle rain from heaven
> Upon the plants beneath."*

Shelley too, personifying the Cloud, sings beautifully:

> "I bring fresh showers for the thirsting flowers
> From the seas and the streams."

A volume of prose could scarcely express with more precision and completeness than these four lines the philosophy of the aqueous

* This is commonly printed "upon the *place* beneath." But as *place* cannot be effected by the gentleness of rainfall, and *plants* can, the latter seems the more likely to have been Shakespeare's word.

food-supply of plants,—so finely divided, so delicately dropped, and so grandly replenished by the colossal water-service of the world. As indeed of carbon, so of water, the atmosphere is, for plants, the mighty reservoir and ever-flowing fount. In point of fact, every cubic foot of air upholds between two and three grains of water invisibly dissolved; and as fast as this condenses above to floating clouds and falling rain, so, in annual quantity precisely equal, is it fed below by the evaporation of "the seas and the streams." This process however, like all the other great operations of Nature, is subject to perturbation, in the redress of which human Art finds its appropriate sphere. In temperate climates, the formation, distribution, and condensation of rain-clouds take place, on the whole, with sufficient regularity to insure, in ordinary seasons, enough of this aliment to the crops. It is otherwise in tropical regions. There, superfluous deluges of rain, and long-protracted droughts, succeed each other; so that artificial irrigation becomes the prime condition of tropical husbandry. Irrigation might, indeed, be fairly described as the *high farming* of the tropics; and water as their most precious *manure.*

Water, indeed, is not merely the vehicle of all other aliments for plants, it is also an aliment itself—in the sense that it assumes the solid form in their tissues, entering into their chemical consitution, and contributing largely to their weight. Wood, for example, after having been thoroughly dried, still consists, for nearly half its weight, of the elements of water. Water, moreover, is the chief constituent of the sap of plants; and its rapid evaporation from their surfaces creates the internal vacuum to which they owe the astonishing suction-power of their roots; as Hales first proved by his capital experiments on this subject published in 1717.

Supply of Nitrogen to Plants.—Last in order, because least in quantity, yet by no means on that account lowest in importance stands the nitrógen among the volatile constituents to plants. It is of peculiar interest, as one of the costliest and most eagerly-sought manurial elements, and as that concerning which the principal agricultural controversy of the day is now raging. Nitrogen like carbon, and the elements of water, has in the atmosphere its source and reservoir; flowing thence to living organisms, and thither restored by their decay and dissolut on after death. It is thus diffused, chiefly in combination with hydrogen, as ammonia; a gas in the highest degree diffusible in air, soluble in water, and absorbable by porous bodies such as vegetal mould. It is, therefore, readily washed down from the air by the rain and dew, and as readily imbibed by the soil, and retained within its bosom by the peculiar physico-chemical force, already referred to as "surface-action." All fertile soils contain abundance of ammonia thus availably presented for absorption by the roots of plants. The leaves of plants also absorb ammonia from the air in quantities varying with the different genera and species.

It is not only however in the form of ammonia that atmospheric nitrogen is supplied to plants. Nitrogen combines with atmospheric oxygen to an extent always appreciable, and much augmented under certain circumstances (as, for instance, during lightning-storms), to form nitric acid; which is washed down to the soil by the rain, and assists, certainly by its solvent powers, probably also as aliment itself, in the nutrition of plants. Nitric acid also originates to some extent, as a secondary product of the decay of nitrogenous organic matters; these yielding ammonia, which oxydation converts into nitric acid and water. Furthermore, a nitrogen-compound, containing both hydrogen and oxygen, viz. nitrite of ammonium, has been lately ascertained (by Schönbein) to originate during the slow oxydation of phosphorous; two equivalents of atmospheric nitrogen taking up two equivalents of water to produce it. Nitrite of ammonium is similarly generated (according to Kolbe and Böttger) during the oxydation of hydrogen, and of hydrocarbons generally. Indeed there is fair reason to surmise that the generation of this salt accompanies all processes of slow oxydation; such as, for example, that of humus in the soil. These facts are of the deepest interest; and should the supposed universality of this natural reaction, as a concomitant of slow oxidation, be confirmed, a powerful light will be thrown on the nature and source of the nitrogenous alimentation of plants. It will indeed be a remarkable discovery, as Liebig (who cites these facts in his admirable work above mentioned*) justly observes, should it be found that the very process by which carbon is rendered available as plant-food, operates also to bring atmospheric nitrogen into a form in which it is assimilable by plants.†

* This view of the origin of nitrous acid and ammonia from atmospheric nitrogen does not belong to Schönbien, but was previously enunciated by Mr. Sterry Hunt (Canadian Journal, April, 1861). See also Nickles, Silliman's Journal [2], xxxv, 263–271.

† "The Natural Laws," &c., pp. 326-328, Eng. ed.

Whether *free* atmospheric nitrogen is assimilable by plants is a moot-point. M. G. Ville and others maintain that it is: M. Boussingault, from the results of experiments extending over twenty years, draws the opposite conclusion. Messrs. Lawes, Gilbert, and Pugh, in an elaborate paper lately published,* record the result of a series of valuable experiments on this point; and their conclusions are confirmatory of M. Boussingault's view. This therefore appears to be the opinion supported by the preponderating weight of experimental evidence; a circumstance which renders Schönbein's observation, and the conclusion to which it points, doubly interesting and important.

Atmospheric Derivation of Plants and Humus.—Thus far the atmosphere, and the moisture and gases it contains, supply the food on which plants live; the soil serving merely as a sponge to bring into contact with the roots their share of this air-derived food. Even the carbon-yielding humus, though it immediately surrounds the roots, supplies them not directly, but only through the intervention of what has been above termed the *underground* atmosphere, by which it is slowly burned. Each successive generation of plants leaves its roots and other debris behind it; thus replenishing the soil with a fresh stock of air-derived humus, *eremacausis*, or decay, in its turn. Every shower washes down nitrogen, in its acid or alkaline form, from the air; and the same cloud-supplied water furnishes the crops with their oxygen and hydrogen. It is evident that from centuries of such plant-growth as this no exhaustion of the soil would ensue.

There is certainly no result of modern investigation more calculated to strike the mind with wonder and admiration than this fact,—that the mighty forests which clothe the earth, and all the vast expanse of herbage and waving crops, and all the living animals which feed on these and each other, including man himself, the lord of all, are built up, so far as concerns nineteen-twentieths of their weight, entirely of invisible gases and vapor supplied by the atmosphere.

Thus upheld, and moving with the wind, the carbon and nitrogen compounds chiefly diffused below, the watery clouds suspended above to wash them down, these, the materials of the whole organic kingdom, hover invisible around us; and by a distributive mechanism the most grand and simple that can be conceived, all

* Lawes, Gilbert, and Pugh, "Phil. Trans." vol. cli, p. 431, 1861.

animated nature is wafted, as on wings, to every corner of the habitable earth. No mountain-fastness so remote, no wild so desolate, no ocean rock so lonely and so bare, but thither also float, and there descend, the viewless elements of life dissolved in air. The tiny lichen, that scarce stains the wave-worn cliff, in its wild solitude is not alone. Its food is floated to it day by day; and the same elements, sailing on the same winds, build up the delicate tissues by means of which it lives, and furnish the oxalic acid wherewith it excavates the grave that holds its dust when dead. That dust, be it remembered, is the primitive *humus*, and the earliest form of *soil*. It is derived, like the lichen itself, from the air, and it confirms the saying of Liebeg, that it is not humus which generates plants, but plants which engender humus.

(To be continued.)

ON PISCICULTURE.

The importance of the artificial breeding of fish, which the French have dignified with the name of pisciculture, is such that we have thought well to bring before our readers some of the results obtained in England and in Norway. For this we are indebted in the first place to a lecture recently delivered in London by Frank Buckland, Esq., and published in *The Journal of the Society of Arts*, for March 11, 1864. This lecture we have somewhat abridged. In the second place, we extract a very interesting chapter from Rev. M. R. Barnard's *Sport in Norway*, giving a description of the method of fish-breeding pursued in that country. Lastly, we copy from *The Angler-Naturalist*, an excellent book by H. C. Pennell, lately published by Van Voorst, what the author designates as Proved Facts in the History of the Salmon. —Editors.

On Fish-Hatching: By Frank Buckland.

This is one of the most practical applications of the study of natural history that has been brought to notice of late years. The mode of hatching valuable fish, such as the trout and salmon, by artificial means, is no longer an experiment. It has, I have been pleased to see, been lately gazetted by public consent to the rank of a science, which is every year attracting more attention. I shall not weary you by entering into the history of the art: suffice it to say, that the first discoverers were two poor French fishermen, Gehin and Remi. All honor to their names for the great good they have done to their fellow-creatures.

You will find in books a statement repeated over and over again, —a fault very common in treatises on natural history,—that the Chinese were the first to practice pisciculture. But let me tell you what their pisciculture consists of. They have no idea (I have it from the best authority, viz. of officers in the army who have travelled there) of hatching fish in troughs, such as we see in European establishments, nor have they yet arrived at the practice of impregnating the eggs artificially. What they do is this: They observe the spawn of fish hanging about the bushes, having been placed there by the fish themselves. They collect this spawn, hang it up in tubs and ponds, and let it hatch out of itself. But though they have not the science that we have, yet they are pisciculturists in a most practical manner; for I have it on the authority of an eye-witness, that when the Chinese flood their paddy or rice fields with water, they turn out into those flooded fields large numbers of fish, which feed upon the worms, insects, &c., which they find in the mud, and this without injury but rather benefit to the plants themselves. When the fields have had enough water, the Chinese water-farmer opens the hatchways, catches what fish are fat enough and sends them to market; the others he lets out into another fresh-flooded paddy-field for a pasture. In fact, the Chinese herd their fish, and drive them from one pasture to another, just as a shepherd drives his sheep from one field to another. These fish are, it is said, great coarse things, and appear to be something between a chub and a tench. There are, I believe, no representatives of the Salmonidæ in China.

Leaving the history of the subject at this point, I would now proceed to the practice of the art. There may be some who say, Why not let the fish breed for themselves? Doubtless, if left alone in a perfect natural state, they would multiply themselves to an enormous extent, as is the case, I am told, at Petropaulowski, where the salmon are occasionally left high and dry by the subsiding of the floods, and such numbers of them perish in this way as to cause a plague by the putrefaction of their bodies.

When we consider the vast number of eggs which nature has given to fish, it is a wonder, indeed, that all the world is not fish. The *eggs* of fish are simply the hard roe of fish; and if you examine the next red-herring for breakfast you will find that the hard roe is composed of a large number of little balls, each of which might possibly come to a fish. You will find in books on natural history the number of eggs in fish. Not trusting altogether to these statements, I have been at some considerable pains to count the eggs* of the following fish. To begin with the salmon, these fish carry about 1,000 eggs to a pound of their weight; so if we can get a fish weighing twenty-five pounds, we have no less than 25,000 eggs.

If therefore a female salmon weighing 20 lbs. deposited her eggs in some safe place, and they all eventually became marketable fish, which would be in three or four years' time, we should find that the eggs of this one salmon would yield no less than 178 tons 11 cwt. of salmon fit for food; and supposing we put this down at 2s. per lb., it would be worth £40,000. Even supposing only a quarter of the young fish ever became marketable, still this one fish would yield a value of £10,000, and all without costing any human being a half-penny for food. A trout of one pound weight contains over 1000 eggs, a perch of half a pound 20,592, a smelt of two ounces 36,652, a sole of one pound 134,466, a herring of half a pound 19,840, a mackerel of one pound 86,120, and a cod of twenty pounds not less than 4,872,000 eggs, while an oyster yields about 1,500,000.

It may be asked, therefore, what becomes of all the eggs of the

* The way to count the eggs is this: Make a few cuts with a knife in the membrane which contains the roe, and then plunge it into water which is, at the moment of immersion, positively at the boiling-point. Being composed of albumen, the eggs obey the natural law and coagulate in an instant. Then add a little common salt, and continue to boil the eggs till they all become quite detached from the membrane, and swim about in the water, loose like marbles. If they adhere to the membrane, they should be gently removed by a short brush, or by shaking in the boiling water. I then, when all the eggs are quite loose, draw off the water and pour the eggs into a dish, drying them slowly in the sun, or in an oven, the door of which is left open to prevent their becoming baked into lumps. I then weigh the whole mass of eggs, and put down the total weight on paper. After which I weigh out five grains of the mass, and get them counted over carefully under a magnifying hand-glass, on white paper. This is ladies' work.

salmon, trout, &c.? The same thing that happens to the common fowl happens to the fish. In the case of the fowl, we ourselves eat many thousands of eggs, and we know how good they are for various culinary purposes. And as in the case of the fowl, so also with the fish-eggs: there are enemies innumerable that seek to destroy them; even the water itself is occasionally antagonistic to their well-being.

First of all, then, many of the fish's eggs do not get at all impregnated, or, not becoming properly buried in the gravel, are washed away by the stream. In proof of this I would mention the following: There are no good spawning-places in the Thames; the fish—and the Thames trout are really fine fish—are therefore obliged to deposit their eggs in the rapids in the centre of the stream. Some of the nests where trout had been actually seen to deposit their eggs have lately been carefully examined, and not a single egg could be found: they had all been carried away by the stream, or devoured by insects, of which thousands were found in the nest. A friend, writing from Hampshire, says that he has examined the nests where the salmon have been seen to spawn, but no eggs could be found. Even supposing the eggs have been properly deposited in the nests, down come the floods and overwhelm the place. Thus, my friend Mr. T. Ashworth informs me, that at the beginning of the season over 275,000 eggs were taken from salmon and placed in his hatching-boxes. Immediately after this was done, the waters arose, and of the eggs which had been exposed to their violence hardly one could have survived. Then again, we have the reverse of floods, *i. e.* the droughts, which leave the eggs exposed; or, as it happens in Hampshire, the fish lay their eggs in what is called "the drawings"; the water is let off them, and the eggs of course perish. Fish again are great enemies to their own eggs. I have myself frequently seen two or three small trout hiding behind the nest, and as the female deposited her eggs, swim after and eat them. Trout have also been often observed, with their tails in the air, robbing the nests. Even females will eat their own eggs. What wonder then that trout should be so scarce when both father and mother devour their offspring. I myself have frequently, from the maws of trout, taken eggs which they had stolen from the spawning-beds; and my friend Mr. Ashworth tells me that he has actually hatched out 500 eggs taken from the mouth of one fish-robber.

Supposing the eggs to have been properly laid in their nests, they become the prey of pests innumerable. The larva of the may-fly and the dragon-fly (justly called the river-tiger) act the same part to the fish-eggs in the water as do the hedgehogs and other vermin to the pheasant-eggs on land.

Among birds the fish-eggs have many enemies as well as friends. The chief of the former are common ducks, which, with their spade-like bills, soon get all the eggs out of the nests and devour them. The swans, though very graceful ornaments in a pond, do a deal of mischief to the fish, especially in the Thames. Two birds, the water-ouzel and dab-chick, have been accused as poachers after fish-eggs. I have examined the crops of several of these birds, and have invariably found them to contain the remains of insects, but no fish-eggs. This matter was fully discussed at the Zoological Society, and the verdict first arrived at was "not proven," and on second consideration the water-ousel was fully acquitted from the charge of eating spawn. True it is he is ever feeding upon the spawning-beds; he goes there to eat the insects that are devouring the eggs, but he himself does not touch them at all.

The moor-hens, however, I am pretty sure, will eat the eggs of the fish. A good observer tells me that one morning the moor-hens got to his hatching-boxes and cleared all the eggs out of them. There is another bird which does a good deal of harm to the fish-hatcher. A friend writes to me to say that he has killed several king-fishers under the wires where his fish were confined. Herons also are terribly destructive to the fish in the spawning-beds.

We have seen what becomes of the fish's eggs if they are left to themselves. It is necessary, therefore, for man to interfere, and take the eggs from the fish and keep them under his charge. In all matters of interference with nature, we cannot do better than take nature herself as a guide. We observe that the fish makes her nest of her own accord in a rapid, shallow, and gravelly stream. We therefore must put the eggs in an artificial nest where the following requisites are present: a stream more or less rapid; gravel; darkness; and perfect quiet. This stream must be allowed to run over the eggs perpetually, day and night, until the young fish are hatched out, just as it would do in the brook.

At the piscicultural establishment at Huningue, in France, the eggs are placed upon glass rods, such as I now show you, during the time of incubation. I would however most humbly beg to differ from the great authorities who use the glass bars: for in the first place, the fish do not find glass bars at the bottom of the water on which to deposit their eggs, but they always find gravel; in the second, it is absolutely necessary that the egg should be perfectly motionless for some thirty-five or forty days. If you place a round egg against two glass bars which are also round, the whole being under water, you at once get the best possible conditions for motion of the egg on the glass bar at the slightest touch, and you certainly do not get what you chiefly want,—perfect immobility; for if the water be turned on from a tap a little too fast, or you happen to touch one egg with a camel-hair brush, all the eggs in the box immediately run against each other, and begin to dance and roll about. Again, when the young fish begin to hatch out, their umbilical bags very often get caught between the bars, and then they perish; or if they fall through, they get into water that is much too deep for them, and whence it is very difficult to extract them without disturbing every egg in the box. This is done in the French plan, by taking out a cork and letting the water run off from under the bars.

By placing the eggs *on gravel*, on the contrary, all this difficulty is obviated. The eggs can be placed so that they do not touch one another; so that the dead ones do not contaminate their live neighbors, and may be easily picked out by a pair of forceps; so that the inequalities of the gravel will keep them perfectly steady; so that the young fish when coming out of the egg —like the young snake casting his skin in a furze-bush—may have facilities afforded him to get rid of his shell, and be not like his neighbor on glass bars, who slips about thereon like a clumsy skater upon well-swept ice.

You will observe, of course, when you examine the fish-hatching boxes now in the room, that we do not in one respect adhere to nature; that is, we do not cover the eggs with gravel, as does the parent fish. The only reason why the parent fish buries her eggs is because of the light, which is unfavorable. All roots and seeds of plants, we may observe, are buried in the ground; it would appear, therefore, that at first darkness is absolutely necessary for the development of the first germs of life. Again, if the eggs are exposed to the light, a white fungus immediately appears upon them. All this is obviated in a moment by placing wooden covers on the boxes, for these keep out all the light, and obviate all the inconveniences of bringing the eggs where you cannot see them, and cannot watch their progress.

There are two kinds of hatching-apparatus, which may be used; —one out of doors, for carrying out operations on a large scale; and the other for use on a smaller scale in-doors.

I far prefer the in-door apparatus, which is very simple in construction, more certain of success, cleaner, neater, and at the same time affords the great pleasure to the owner of being able to observe the progress of the eggs. The slate-boxes on the tables are those used by my friend, Mr. Ponder, at Hampton, in which he has hatched so many thousands of fish, paying for the boxes out of his own pocket, and giving his time gratuitously for the Thames Angling Preservation Society. They are three feet long, and three and a half inches deep. They should be placed one above the other, after the manner of the steps of a staircase, and so arranged that the water runs through them all in zigzag manner. Some gravel, about the size of peas, must be obtained from a gravel pit, not from the river-side. It must be well boiled to destroy all the seeds of vegetation, be washed perfectly clean, and then placed in the troughs, so that there should be an inch of gravel, an inch of water, and an inch above the water. Place in the eggs, put on the wooden covers, see that the stream runs properly, and leave them entirely alone in the boxes. Such as these have this year, at Hampton, hatched out, and are still hatching out no less than 124,700 fish and eggs.

All that is requisite is a gentle and incessant flow of water, and what is water enough for one trough is, as a matter of necessity, enough for half-a-dozen or so. In London houses the supply of water is often limited; it is a comfort therefore to know that the same water can be used again twice or three times.

If you wish to hatch your fish in boxes out of doors, you must adopt the same principle as that applied to in-door boxes, recollecting the requisites,—a clear running stream, clean gravel, and darkness. Full details of both in-door and out-door apparatus, and also the proper mode of working them, can be found in my little book.*

The eggs having been placed in the boxes and left totally undisturbed, in course of time the eyes of the young fish will be seen like two black spots in the egg. The time required for this appearance to exhibit itself depends entirely on the temperature.

* Fish-hatching. Tinsley Brothers, Catherine Street, Strand. Price 5s.

The proper temperature of the water, both in and out of doors, ought to range from 40° to 50°. Mr. Ponder's observations tell him that at this temperature it requires thirty-five days for the eyes to appear, and that they hatch out fourteen days afterwards. The same result has been obtained by him for two successive seasons with very little variation. Again, he has observed that when the temperature was 50° (in the spring of the year) the eyes of the fish were visible in twenty-six days, and that he hatched them out in ten days afterwards. Lay it down however for an axiom, that the higher the temperature for the egg the weaker the fish produced from the egg. Anything above 50° is weakening.

The first fish hatched out from a batch are the weakest, the last are the healthiest; when however they once begin to hatch, they will come out all in a mass, two, three, or four thousand of a morning. The proper temperature for trout and salmon eggs is 40° to 50°.

Grayling however appear to be an exception to this rule. Mr. Ponder has obtained a fair supply of the ova of these fish, which the Thames Angling Preservation Society are introducing in the Thames. The quantity obtained amounted to between fifteen and twenty thousand; and though several of these died, for they are most delicate things to carry, the remainder did very well. They are much more delicate than trout-ova, both in appearance and hatching, and seem to die at the least provocation. They are beautifully transparent, and, when viewed in the sun, of a lovely opalescent hue. He has discovered about these a most interesting, and I believe, a novel fact. The body of the fish is perfectly visible in nine days, and the fish will actually hatch out of the egg in fourteen days.

All difficulties and trouble with the eggs having been overcome, we are at length rewarded by seeing the young fish begin to come out of the egg. At this time the tail of the fish may be observed moving from side to side with a rapid vibratory movement inside the egg. The young fish, when hatched, increase in size daily; and the darkening of the transparent substance which would eventually be the body, and the development of the fins, have already proved one fact, and this (as the question has frequently been put to me) I shall venture now to mention. The eggs do not grow—*i. e.*, they do not increase in circumference or in diameter,—but the fish inside the egg most certainly increases in bulk, till at last it becomes so large that the egg-shell suddenly bursts, and out comes the young fish.

In the gradual development of the young salmon and trout we begin with a globule of albumen. We see within it a faint line, and two black spots. Day by day these become larger, till the young fish is born. After this, the umbilical vesicle is absorbed, the color appears on the scales, the long single crests, which one observes at birth running down the upper and lower parts of the body, resolve themselves, as it were by magic, into the various fins distinctive of the adult creature, and we have a perfect fish before us.

It is most interesting to watch an egg at the moment of hatching. You may happen to be gazing on a particular egg, when of a sudden you will see it split in twain, at the part corresponding with the back of the fish; you will then see a tiny head with black eyes and a long tail appear, and you will see the new-born creature give several convulsive shudders in his attempts to free himself from the now useless shell. Poor little fellow! he can't manage to get out: the shell is too tight for him. Take, therefore, a soft hair-pencil, press lightly on the egg-shell,—he seems to know you are his friend,—he gives another vigorous kick or two, and presto! he is free, and has commenced life. If we judge from his motions, he must enjoy it, for away he swims as fast as his tiny and wriggling tail will carry him, round and round in a circle, and then plump down he goes to the bottom of the tank, and reclines on his side, breathing freely with his gills for the first time in his life.

It would appear that it is not possible for the fish to remain long enough in the egg to come out ready to eat food at once, as is the case with the ovo-viviparous creatures. They have therefore attached to their belly a bag, which contains the nourishment that the young fish must absorb before they are able to shift for themselves. The moment the contents of the bag are gone, they begin to feed with the mouth.

In various creatures the progress of development is different. Thus, for instance, in the human baby, the first portion of the body developed is the lower jaw, and this for an obvious reason, because the most material want of the baby is to obtain the mother's milk by suction.

Now, in the case of the fish, nature has kindly packed up all the nourishment that it will want for some six or eight weeks in a neat little bag or parcel, which she has affixed to the body of the fish in such a manner that it can be absorbed into the system; while as the fish does not suck milk like a warm-blooded animal, its lower jaw is not developed.

What is, then, the most important organ to the young fish? He has numerous enemies, and it is his first object to get out of their way. The eyes, therefore, are the organs which first arrive at perfection. The eye is in perfect working order at the moment of birth, though the rest of the body is far from complete.

One of my many visitors to the tanks at the *Field* newspaper office, where I exhibited the process last year, was narrating to me how he once caught an enormous salmon in the Tay, weighing some thirty odd pounds; this put the idea into my head to weigh one of my salmon. He has, poor little fellow, a deal to make up before he arrives at thirty pounds, for at present (four days old) he hardly turns the scale at two grains.

By the kindness of Mr. Ashworth, of Cheadle, near Manchester, I am enabled to show you a drawing of the young fish which weighs about two grains. He has also given me the following observations as regards the increase of weight in the young salmon: The fry at three days old is about two grains in weight. At sixteen months old it has increased to two ounces, or 410 times its first weight. At twenty months old, after the smelt has been in the sea, it has become a grilse of eight and a half pounds: it has increased sixteen times in three or four months. At two years and eight months old it becomes a salmon of twelve to fifteen pounds in weight; after which its increased weight of growth has not been ascertained, but by the time it becomes thirty pounds in weight it has increased to 115,200 times the weight it was at first.

Among the numerous progeny of fishes, it could hardly be expected that all of them would be straight-limbed and healthy; we find, therefore, occasionally, but not very commonly, crippled and deformed fish. Thus I show you, this evening, diagrams and living specimens of a fish of a cork-screw shape, also of a fish with four eyes and one head, also of a salmon and of a charr with two heads and one body. I take the greatest care of these fish, and trust they will live, and should they be caught hereafter by any angler they would astonish him.

As regards the practical treatment of the young fish, and the question as to when they should be turned out into the stream, as well as many other points, I must beg to refer again to my little book on fish-hatching.

Having had now two years' practical experience in hatching fish, I bethought me whether this year I could not somewhat add to the science of the matter, and have therefore instituted several experiments as regarded the duration of the vitality of the milt and ova, whether kept separate in bottles, or taken from dead fish. This, I am convinced, is a most important point, and it may possibly lead to many practical results. The first experiment which I tried was with a fish found dead in the river, having been killed by a heron, and which had probably been dead twenty-four hours. The eggs, which I impregnated with fresh milt, are now in my boxes, and very few of them have died.

I have also tried a series of experiments as regards keeping the milt and ova separate in bottles for times varying from ten minutes up to sixty-eight hours. The results hitherto have been favorable, but I cannot be certain that fish will hatch out of these eggs. Should however the experiment succeed, the important practical bearing of this will at once be perceptible. Thus for instance I impregnated at Worcester some salmon-ova fresh from the fish, with trout-milt which had been sixty-eight hours in a bottle, but very few of these eggs are as yet dead. Again, I brought some salmon-eggs from Worcester and impregnated them with fresh trout-milt at Mr. Samuel Gurney's, Carshalton. The eggs in this case were twenty-nine hours old.

It is generally a difficult matter to get the eggs, whether of trout or salmon, properly operated upon, and then sent from a distance to the hatching-boxes; it therefore occurred to me that if I could possibly get the eggs from dead fish to hatch equally as well as those from live fish, it would save a great deal of time and expense, as well as trouble. Fish therefore have been sent up to me dead, packed in moss, and I have taken the eggs from them after twelve hours, twenty-four hours, and eighty hours. It is almost impossible to tell from any test that I know of, whether these eggs have been properly impregnated. Time alone will prove this. If the experiment succeed, we shall be able to write to our friends in the extreme north of Scotland, or in the furthermost part of Ireland, and ask them to catch the fish and send them to London, where they can be operated upon just as well as though an express messenger had been sent many hundred miles to do it.

Those who have experienced the sad disappointments that I have had with eggs sent even from short distances, and supposed to have been properly operated on, which arrive quite hard, white, and opaque, and, of course dead (the cause of this being generally the shaking of the railway, or bad packing), can appreciate the immense advantage of operating on dead fish. Now if we never unpack the eggs at all, and leave them as nature has herself arranged, then we shall have more chances of success than by the clumsy attempts of human hands to send them in a tin or glass vessel. The only objection to the plan is that the parent fish are of a necessity destroyed, which is not the case when they are treated in the usual manner.

I have often been asked if operating on fish and taking their eggs from them killed them? My answer is that we have this year taken over one hundred thousand trout-eggs, and have not killed, to my knowledge, one single fish, male or female. Those gentlemen, therefore, who have been good enough to allow us to operate on their fish,* whether salmon or trout, need not be in the least fear that any injury has been done to the fish, who, for aught I know to the contrary, may really feel much obliged to us for the trouble we have saved them of making their nests and depositing their eggs.

It has been objected by some that these experiments with dead fish, and with milt and ova taken from fish, and kept separate many hours, have been tried before. In the *Field* of Feb. 27, 1864, "the Chronicler" quotes from M. Coste, the eminent and learned professor of embryology in the Collège de France, a statement that milt will remain alive for twenty-four hours. I have however carried my experiments further on this point, and have ascertained, through the kindness of my friend Mr. H. B. Hancock, that the spermatozoa in the fish would live for so long a period as 141 hours, that is to say, nearly six days. It must however be remarked that both M. Coste and myself have separately come to the same conclusion, viz., that water must not be added to the dead fish till the moment that it is required for use, for it appears

* There is a special clause in the Act of Parliament which does away with the illegality of taking spawning-fish with the net for the *bona fide* purpose of obtaining their eggs for the purposes of pisciculture.

that the spermatozoa assume their peculiar vibratory quick action when water is added to them, otherwise they are quite quiescent. This is a most important point as regards the actual bringing the theory into practice.

I here desire to state, once for all, as I wish every one to remember, that I do not say that my experiment in keeping the milt and ova separate for so long a time will succeed, and that healthy young fish come from the egg, nor again am I at all sure that fish will hatch from eggs taken from the dead fish; but there is however no reason why the experiment should not be tried, for nature has many choice secrets in her laboratory which she has yet withheld from us, and which she will only disclose to us by asking her in the form of experiments varied and repeated in every possible manner.

Thus far I have attempted to show what becomes of the eggs of the fish in their natural state; how they may be taken care of, and what great results may be, with good luck and careful management, obtained. I would venture now to report progress and the result. The first originators and supporters of the important science of fish-hatching for the public good were the French Government, who have, as most of you are aware, erected a magnificent series of buildings, which may be fairly denominated a fish-manufactory, at Huningue, near Basle.

I must now mention what has been done in her Majesty's dominions. The first place established (that I know of) was at Perth, where thousands of salmon are hatched by artificial means annually. In Mr. W. Brown's admirable little book* will be found details as to the number of eggs laid down, &c. One of the consequences of this artificial hatching, Mr. Brown informs us, is as follows: We find that in the year 1828, the year of the passing of Home Drummond's Act, the rental of the salmon-fisheries of the Tay was £14,574. It gradually fell off every year afterwards till 1852, when it reached the minimum, amounting to £7,973. In 1853 the artificial rearing commenced; and in 1858, when the statement was printed, the rental was £11,487; it has now reached what it was in 1828." Mr. Brown has been kind enough to send me the latest news as follows:—

"The number of ova deposited in the boxes at Stormontfield

* The Stormontfield Experiment on the Salmon. Glasgow: Murray and Son. London: Arthur Hall, Virtue and Co. Price 3s.

in November and December 1862 was about 250,000; in 1863 (last spawning) about 80,000. The reason that so few eggs were got during the last spawning-season was the unfavorable state of the river for netting operations."

One of the greatest results in practical fish-hatching has been obtained by my friend Mr. Thomas Ashworth, and his brother, for they have actually peopled with salmon Lochs Mask and Corrib, an area of lakes containing thirty-five acres of water. In 1861, Mr. Ashworth laid down 659,000 salmon-eggs; he being, in his own words, "confident that he could breed salmon much easier than lambs." In December 1862 he deposited no less than 770,000 salmon-eggs, making in the two years 1,429,000. Mr. Ashworth tells me that the total cost of doing this has been exceedingly small.

Fish-Culture in Norway: By Rev. M. R. Barnard.

During the last ten years, the attention of the Norwegian Government has been directed towards the propagation of salmon by artificial means. In a country like the Scandinavian peninsula, which has such an extent of seaboard, and which abounds in rivers large and small, running into fiords which intersect the coast, there are so many natural facilities afforded for the protection of the young fish, that it only requires some additional attention on the part of the inhabitants themselves to make Norway stand at the head of the salmon-producing countries of Europe.

Fully alive to the disadvantages which many parts of the country labor under in an agricultural respect, owing to the rigor of winter and the unfertile nature* of the soil, the government, with a laudable generosity, has endeavored to promote the propagation of fish by rendering pecuniary assistance, and by the appointment of officers to superintend in the management of the operation.

It is somewhat remarkable that the artificial propagation of fish was first discovered in Norway by a simple laboring man in 1848. One harvest-time he had been obliged to keep at home on account of a bad leg. To amuse himself he used to get down to the river-side and watch the trout on their spawn-ground. Being of

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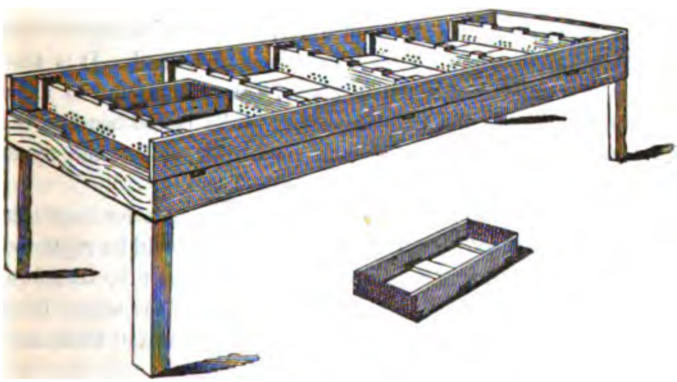
* The whole area of Norway is about 121,800 square miles, of which not more than 1,060 are under cultivation.

an observant nature, he was struck with the manner in which the operation was carried on. He remarked that the male fish placed itself alongside of the female in such a position that its head reached to about the middle of the body of the latter. He further noticed, that whilst the process of discharging the ova was going on, the female turned somewhat on her side with a quivering sort of motion, and that the male emitted his milt simultaneously. It therefore occurred to him that by pressing the spawn out of the female, and the milt from the male at the same time, in water, he would obtain a quantity of fructified eggs, which, by being placed in convenient places in brooks, would in due time bring forth fish. No sooner conceived than executed. He threw out his nets and caught a male and a female fish ready to spawn. His wife took the one, and he the other, and they squeezed their contents out into a bowl of clean water. He then took the eggs and placed them in a sheltered place in a stream where there were previously no trout. The following summer he was rejoiced to see that it swarmed with fish. Convinced, therefore, of the success of his plan, he constructed for himself a breeding-box close to his house; and notwithstanding the jeers and scoffs of his neighbors, who thought it impious, to say the least, in interfering and meddling with things which belonged to Nature alone, continued to breed fish every autumn. Such was the first attempt at hatching ova in Norway!

I will now proceed to give a brief account of the hatching-apparatus generally in vogue in that country, as communicated to me by Professor Rasch.

The case in which the hatching-boxes are placed (and which is under shelter, so that the water does not freeze) is twelve feet long, thirty-four inches wide inside, and five inches deep. The bottom must be perfectly water-tight, and very evenly planed. The sides are formed of single smooth-planed boards, which fit tightly against the bottom, to prevent any leakage ensuing. The uppermost end of the case, into which the water runs from the pipe, is of the same height as the sides. The whole is divided into five compartments, the first of which receives the water from the pipe. This compartment is eighteen inches wide, while the other four are each thirty inches wide. The partition-boards are one inch lower than the sides of the case, and have holes bored in them at a distance of two inches from the bottom, by means of a hot wire. They are bored in two rows (*vide* fig. 1.), four below, and three above. The water can thus run evenly throughout the length of the case.

The hatching-boxes (fig. 2), four of which are placed in each compartment, are constructed as follows: The sides consist of smooth-planed board, two feet long, three inches high, and an inch and a half thick. The bottom is a glass plate, two feet long, and seven inches wide. The ends are of perforated zinc, or brass wire-work, the same height as the sides, which are strengthened by two transverse pieces of wood. All the wood-work should be of well-seasoned material; and those parts which come in contact with the water should be glazed, as any resinous or pitchy substance in the wood would prove injurious to the ova. I should mention that the first compartment into which the water falls should be furnished with a network lid of zinc wire, which forms the bottom of a framework three or four inches high, so as to prevent the water running into the next compartment except through the holes in the zinc lid. Thus the larvæ of destructive insects, worms, &c., will be kept out. The upper end of the case should stand two



inches higher than the lower end. The water which runs out from the last compartment is prevented running out the whole width of the case by means of two pieces of wood, which are fastened to the sides, and reach nearly to the middle, and is carried off by a pipe.

The slimy deposit which comes even from the purest water, and settles on the eggs (it is not detrimental unless there be too much of it), can easily be got rid of by gently moving the boxes, and allowing it to pass through the ends.

After the lapse of about four weeks, it will be well to take the hatching-boxes out of the case to ascertain which eggs are good. The action of the air will render them all transparent; but on replacing them in the water, the unfruitful ones will assume a milky opaque color. These can readily be removed with a pair of fine pincers or long tweezers. The exposure to the air does not hurt the eggs, but care must be taken that they do not become dry on the surface. After repeating this process three or four times, all the bad eggs can be removed. "I am convinced," is the remark of Professor Rasch, "that in a case of the above size I could hatch 10,000 salmon-ova in each box, which would thus give a total of 160,000," there being four hatching-boxes in each of the four compartments. If the fry are to be kept any time in the boxes, care must be taken that they be not overstocked; but 3,000 may well be kept in them from two to three months."

Where water from a spring cannot be directly obtained, the following plan is often adopted. The scale of operations is however necessarily more limited. A large tub, or other wooden vessel, is fitted with a tap. Care must be taken that it shall have previously lain a sufficiently long time in water, so that all the deleterious substances from the wood shall have been extracted. It is then placed on a stand at a sufficient height from the ground to allow the case containing the hatching-boxes to be placed beneath the tap; and they should have a gentle inclination, so that the upper end be about half an inch higher than the lower.

The water, having passed through the boxes, empties itself into another vessel, at least as large as the tub, and should be regulated that it shall run out in twenty-four hours. The tub, therefore, only requires replenishing once in that time. If the water be at all muddy, it is well to place a layer of fine sand mixed with charcoal at the bottom of the tub.

Even in a common tea-saucer a great many ova may be hatched out. The saucer is placed in a deep soup-plate, and a couple of moss-stalks laid over the edge in such a manner that they shall act as syphons. A constant flow of water thus takes place from the saucer into the plate. In about twelve hours half the water from the saucer will have run out, so that it will require filling again morning and evening. When necessary, fresh moss-stalks can be substituted.

It is of course best to procure the male and female fish to be operated upon direct from their breeding-ground, and as short a time as possible before the spawning commences. Where this is impossible, they should be kept in fish-boxes or reservoirs; care however be taken that they be not kept too long in confinement before being used, as this would have an injurious effect both on the ova and the milt. One male fish is sufficient to fructify the ova of a great many females, and can be used from six to eight days in succession.

It is not difficult to ascertain when the female is ready to spawn. Her distended abdomen yields easily to a gentle pressure, and an undulating movement which is perceptible on touching it, shows that the spawn is already disconnected from the ovary. She should then be held by the head in a vertical position, so that the ova will of their own weight fall down towards the vent. When the fish are large, it is best to have three persons to assist. One takes the fish by the head, and the other by the tail, holding it horizontally over a dish, the vent downwards, whilst the third very gently presses along her stomach and sides. When the bottom of the dish has been covered with ova, in layers of two or three deep, the fish can be released into the tub of water from which she was taken. The dish, by the way, must previously have been nearly filled with water. Before operating on the male fish, the water from the fish had better be drained off, and fresh poured in. The male fish is then taken and handled in the same way. A small quantity of milt, just sufficient to discolor the water after being gently stirred with the fingers, is sufficient. It is then put back again into the tub, and while the female is again being brought out, the contents of the dish are to be emptied into another tub half filled with pure water. When all the roe has been pressed out and fructified as before with the milt, and again emptied into this tub, the water is allowed to run out through a hole previously bored in the side about an inch above the bottom. By the motion of the water running out, all the eggs will be brought into contact with the milt. In about five or ten minutes the ova can then be removed into the hatching-boxes.

If the eggs are in a fit state, the very smallest pressure is sufficient to squeeze them out; and it has been found that with due care the female suffers no injury from the manipulation, and will be as fruitful the following year as ever.

The unfruitful eggs, after they have been some time in the hatching-boxes, will be covered with a peculiar parasitical plant, *Leptomitus clavatus*, which gives them the appearance of being wrapped in cotton. These should be removed, as though the other eggs will not be immediately infected, yet the fibres of this vegetable growth will in time get around them, and prevent the water having free access to them, when they too will die. The unfruitful salmon-eggs should be at once removed; but when the ova are very small, as is the case in trout, &c., it is better to wait till the parasitical plant has appeared before removing "the tares from the wheat," as the operation can then be performed more easily. It is therefore much better not to have a layer of small stones at the bottom of the case, as many of the ova will sink between them, and from remaining unperceived may in time cause great damage. It is true that the salmon instinctively makes a hole, and covers her ova with small stones. But she, in all probability, only adopts this precaution in order *to protect them against their numerous foes*, and not that the development of the embryo may be thereby in any way accelerated.

It might not unnaturally be supposed that it is best to transport the ova in the same element as that in which they are deposited in the ordinary course of things, viz., *in water*. But it must at the same time be remembered, that every fertile egg contains a living being, which requires a constant supply of air for its preservation, and that the quantity of air contained in a confined vessel is more rapidly consumed by the ova than fresh air can be absorbed from the surface. The consequence will be that unless fresh water be constantly supplied, or the water in the vessel be by some means aërated, the embryo contained in the egg must die. But not only will the constant replenishing the vessel with fresh water be troublesome, and often impossible, but it will also be attended with great risk to the safety of the ova.

If it is borne in mind that it is not the water, but the air which is therein contained, that is essential to the preservation of the ova, it will be apparent that if they be kept moist, and have a constant supply of fresh air, the necessary conditions will be obtained. The readiest and easiest way is to pack them in damp moss (the marsh moss, *Sphagnum*, which absorbs moisture like a sponge, is the best), through which the air will readily circulate.*

* Professor Rasch told me that he has hatched ova in damp moss, without even immersing them in water at all.

In a common wooden box the moss will retain its dampness so as not to require wetting for several days. And indeed caution is requisite when it is so sprinkled, that the temperature of the fresh water be not lower than that of the moss. Moreover, it is only necessary to sprinkle the topmost layer of the moss, as the moisture will gradually percolate through the contents of the box. Neither should too much water be sprinkled on at one time, lest the ova at the bottom of the box should be immersed. To obviate this contingency, it is best to turn the box over once at least in the course of the day.

In packing the box, the bottom should first be evenly covered with a thick layer of the moss, which should be previously washed quite clean. On this a layer of eggs should be evenly spread, then should come a thinner layer of moss than before, and so on, alternate layers of eggs and moss till the box is nearly full. On the top of all, a layer of moss of the same thickness as the first should be laid; so that when the lid is fastened down, the whole will form a compact mass, and all shifting of the contents be rendered impossible. The elasticity of the moss will prevent the slightest danger from pressure accruing to the ova. If the weather is extremely severe, the box should be protected. It may be remarked, that ova should not be transported till the eyes of the embryo are visible.

A few precautions are necessary on unpacking such a box containing ova. The temperature of the box, and of the water in the hatching-case, must be compared with a thermometer. Supposing that of the former to be the greater, the moss should be gradually sprinkled with water from the latter till they are both equal. Great care must be taken not to hurry this operation.

The contents of the box should then be emptied into a good-sized tub half filled with water of *the same temperature as that in the hatching-case.* By gently moving the hand about among the moss, the ova will sink to the bottom, and the moss remain floating on the surface. The water should now be drained off, and the ova at once deposited in the hatching-boxes.

Should the water in the hatching-boxes, however, be of a higher temperature than the moss in which the ova were conveyed, these can be at once removed into the hatching-cases after they have been detached from the moss as above described.

The greatest care must be taken to prevent the entrance of insects and larvæ into the hatching-apparatus. The most dangerous enemy to the ova and the young fish, is, perhaps, the water-newt (*Sorex fodiens*). If the apparatus cannot be raised to a sufficient height above the ground, it should be protected with a perforated tin or zinc lid.

A curious instance occurred at the hatching-establishment at Greffsen, a water-cure establishment near Christiania, a few years ago. The apparatus was raised two feet above the ground, and was not, therefore, protected with such a lid. A large quantity of eggs had been hatched out, when, one fine morning, the young fry had nearly all disappeared! A number of traps were accordingly set on the floor of the house, and the following morning the intruder was captured. It turned out to be a water-rail, which had found ingress through the mouth of the drain.

The *Dytisci*, *Hydrophili*, and their larvæ, and the larvæ of the *Libellula* and *Agrion*, are also very dangerous enemies. The *Libellula depressa* is especially a deadly foe, and will even devour the fish of two to three months old. It is extremely tenacious of life; and has been known, after having been kept a whole day in spirits, to recover when placed in water where there were young fish, and in a very short time to commence attacking them as if nothing had happened.

Proved Facts in the History of the Salmon: By H. C. Pennell.

1. Salmon and Grilse invariably spawn in fresh water if possible; both the eggs, and the young fry whilst in the Parr state, being destroyed by contact with salt water.

2. The eggs are usually deposited on gravelly shallows, where they hatch in from 80 to 140 days, according to the temperature of the water. Eggs remaining unhatched beyond the latter period will seldom hatch at all, possibly from having been destroyed by the low temperature.

3 The eggs deposited by the female will not hatch under any circumstances unless vivified, after exclusion, by the milt of the male; and—at least up to the period of migration—there is no difference whatever in fry bred between Salmon only, between Grilse only, between Salmon and Grilse, between Salmon and Parr, or between Grilse and Parr.

[The female Parr cannot spawn; but the male Parr possesses, and constantly exercises, the power of vivifying Salmon and Grilse eggs.]

4. The fry remain one, two, and, in some cases, three years in the rivers as Parr before going down to the sea; about half taking their departure at one year, nearly all the others at two years, and the remainder (which are exceptional) at three years old.

5. All young Salmon-fry are marked with bluish bars on their sides until shortly before their migration, up to which period they are Parrs; they then invariably assume a more or less complete coating of silvery scales and become Smolts,—the bars, or Parr-marks, however, being still clearly discernible on rubbing off the new scales.

6. The young of all the species here included in the genus *Salmo* have at some period of their existence these bluish bars; and consequently such marks are not by themselves proofs that fry bearing them are the young of the true Salmon (*Salmo salar*).

7. Unless the young fish put on their Smolt-dress in May or early in June, and thereupon go down to the sea, they remain as Parrs another year; and without Smolt-scales they will not migrate, and cannot exist in salt water.

8. The length of the Parr at six weeks old is about an inch and a half or two inches; and the weight of the Smolt before reaching the salt water from one to two ounces.

9. In at least many cases, Smolts thus migrating to the sea in May and June return as Grilse, sometimes within five, generally within ten weeks, the increase in weight during that period varying from two to ten lbs., the average being from four to six lbs.; and these Grilse spawn about November or December, go back to the sea, and in many cases re-ascend the rivers the next spring as Salmon, with a further increase of from four to twelve lbs. Thus, a fish hatched in April 1854, and marked as migrating in May 1855, was caught as a Salmon of twenty-two lbs. weight in March 1856.

10. It appears certain however that Smolts do not always return during the same year as Grilse, but frequently remain nine or ten months in the sea, returning in the following spring as small-sized Salmon.

[It will thus be seen that the fry of the Salmon are called *Parrs* until they put on their migratory dress, when they become *Smolts* and go down to the salt water; *Grilse* if they return from the sea during the first year of their migration; and at all other periods *Salmon.*]

11. It has also been clearly proved that, in general, Salmon and Grilse find their way back to spawn to the rivers in which they were bred, sometimes to the identical spots,—spawn about November or December,—and go down again to the sea as "spent fish," or "Kelts," in February or March,—returning, in at least many cases, during the following four or five months, as "clean fish," and with an increase in weight of from seven to ten lbs.

[Shortly before spawning, and whilst returning to the sea as Kelts, or spent fish, Salmon are unfit for food, and their capture is then illegal. "Foul fish," *before* spawning, are, if males, termed Red fish, from the orange-colored stripes with which their cheeks are marked, and the golden-orange tint of the body; the females are darker in color, and are called Black fish. *After* spawning, the males are called Kippers, and the females Shedders or Baggits.]

This, in a condensed form, is the present state of our positive knowledge as regards the leading facts in the history of the Salmon as it occurs in British waters.

REVIEW.

Comparisons of American Languages with those of the Old World.*

Under the title noted below, "N.O.," a writer in the Lower Canada Journal of Education attacks some rather bold statements respecting the American languages, made by M. Renan in his work on the Primitive Languages. In an ethnological point of view the subject is of interest, and we are glad that any one acquainted with our native languages is disposed to take it up. The American languages have usually been regarded as altogether distinct from those of other parts of the world, and as very dissimilar among themselves. Yet the most superficial examination shows that similarities of grammatical forms and of root-words exist over wide areas of the American continent, and among tribes per-

* "Jugement erroné de M. Ernest Renan sur les Langues Sauvages," (par N. O. Pamphlet reprinted from the Journal d'Instruction Publique.)

fectly separated from each other. There have also not been wanting students of the subject, who supposed they could discover links of connection with the languages of the old world. Still the subject has been pursued only in a desultory manner, and it presents a rich and comparatively unexplored field. It is more especially important in connection with the bold theory of Retzius, based on cranial conformation, that the "long-headed" Indian races of Eastern America may have been of North African or South European origin. This would make America the meeting ground of the opposite extremes of human migration to the East and the West, as it seems certain that the Indians of Western America are related to the races of Northern Asia. To us this theory receives strong confirmation, not only from the similar physical conformation of the Guanches of the Canaries, and some of the North African races, but also from the facts which have been ascertained as to the form, habits, and rites of the earliest aborigines of Europe. In the further solution of such questions, the study of the languages is most important, and we need a careful and thorough comparison of all the Eastern American tongues, more especially with a view to the question of their possibly having originated from colonists landing on the West-India Islands from some part of the shores of the Mediterranean, and this at a remote period, when the languages of Europe were in their most primitive state. The task is a difficult one, requiring the combination of the learning of many men and laborious investigation; but if any reliable positive results could be obtained, the labor would not be in vain. In the meantime we give a few extracts from the pamphlet of "N. O.," in illustration of his protest against the dictum of M. Renan, that the idea of the primitive unity of language is a chimera:—

"Mr. Renan will be perhaps surprised to learn that that Iroquois tongue which he had considered so barbarous has, nevertheless certain very curious analogies with the learned languages. Thus those Hebrew and Indo-Germanic quadriliteral and quinquiliteral roots, of which M. Renan makes such a show in his book of comparative philology, are also found in the Iroquois tongue; and certainly the words raonraon, kitkit, 8iion8iion, taraktarak, sarasara, teriteri, k8isk8is, herhar, tsiskoko, k8itok8ito, iekonienk, 8irok8iro, and others may very well be compared with *gargar*, *tsiftsêf*, *tsiltsêl*, GARGARISER, GARGARIZEIN, pipivit, PIPI-

ZEIN, tintinnavit, klingeln, and other like words given in the list of Mr. Renan. Let us then conclude that for onomatopœia the American languages are second to none, and that among them the Iroquois is distinguished by its tendency to take the quadriliteral form. But there are other analogies.

"Such will be the analogy which exists between the Algonquin profixes and the Hebrew affixes.

SabaktaNI,	thou hast forgotten me,	NI, me,	Heb. aff.
JadeKA,	thy hand,	KA, of thee,	
RagheLO,	his foot,	O, of him,	
NInaganik,	he forgets me,	NI, me,	Alg. pref.
KIninḍj,	thy hand,	KA, of thee,	
O,	his foot,	O, of him or of her,	

"This is an example which might be considered as an argument in favor of the homogeneity of languages, and which demonstrates, moreover, that the savage tongues have not a character exclusively sensuous, in the sense that Mr. Renan gives to that word, but that they are, at least as psychological as the Indo-Germanic languages.

"The Algonquin root ENIM serves to express all the intellectual operations, all the dispositions of the soul, all the emotions of the heart, all the acts either of the mind or the will. Thus it will be said: ni *minsenimdam*, I am contented; ni *gackenindam*, I am sad; ni *minsenima*, I am satisfied with somebody; ni *cinge nima*, I am not satisfied with it; ni *sakenima*, I am heartily attached to him; *nindapitenima*, I esteem him: ni *nickenima*, I trouble his mind, I make him angry; ni *pagosenima*, I make my supplications to him in my heart, I pray to him inwardly; ni *kitsit8a8enima*, I venerate him, I think him worthy of honor; ni *kikenima*, I know him; ni *k8aiak8enima*, I know him perfectly; ni *piziskenima*, I can remember him; ni *mika8enima*, I remember him; ni *mitonenima*, I think of him; ni *nib8aka8enima*, I believe him wise; ni *tat8enima*, I understand it, I conceive it, I seize it with the mind; *ninol obtiteienima*, I reach him with my thought, my mind reaches up to him; ni *tanenima*, I believe him present; ni *panenima*, he escapes my thought, my mind cannot reach him; ni *8anenima*, I forget it, I lose the remembrance of it; ni *tangenima*, I touch it (him) with my mind, it seems to me that I touch it (him).

"Is not the importance of this root ENIM a thing truly worthy to be remarked, as it is without contradiction a hundred times more productive than its congeners *anime* and *animus*?

"The Latin *animus* has been compared to the Greek *anemos*. We can with as much, nay with more reason, compare our root *enim* to this last one. In fact it is found in the form *anim*, with the Greek meaning, in the impersonal verbs *animat*, the wind blows; *pitanimat*, the wind blows this way; *ondanimat*, the wind comes from that direction, etc., etc.

"But here is another peculiarity which comes to our mind which cannot fail to draw the attention of an Oriental scholar:

"In Hebrew, the third person masculine singular of the first tense of the indicative serves to form all the other persons and all the other tenses of the verb.

"In Algonquin, the third person singular common gender of the present of the indicative serves to form all the other tenses and persons of the verb.

"Thus it is said in Hebrew: qâthal, he has killed; qâhaltâ; thou hast killed; qâthalti, I have killed. In the same way it will be said in Algonquin: nicise, he kills, ki nici8e, thou killest, ni nici8e, I kill.

"In both languages, the third person does not take any characteristic for itself, whilst the two others are accompanied or preceded by the signs which distinguish them, ta, ti, ki, ni.

"The third person is then the root of the verb. Therefore that is the reason why the Algonquin dictionary gives first that person, in imitation of the Hebrew.

"We have said that the syntax of our two savage languages is *pretty complicated*. It is too much so to allow us to enter, in a review like the present one, into the details which would be necessary to give a correct idea of it. For the same reason we will not give the list of the conjugations either Iroquois or Algonquin; we shall only say that they are divided into copulative, disjunctive, suppositive, concessive, causal, temporal, adversative, optative, and expletive.

"We have affirmed that these two languages are very clear, very precise, expressing with facility not only the exterior of ideas, but still more their metaphysical relations. In fact, the Algonquin has not less than eight moods, whose names are: indicative, conditional, imperative, subjunctive, simultaneous, participle, contingent, and gerund. With the exception of this last one, all these moods have several tenses. The total number of them is twenty-nine. The verbs in Iroquois have twenty-one tenses, divided into three moods, indicative, imperative, and subjunctive.

" Nouns are scarcely less marvellous; they are conjugated rather than declined. It will be said in Iroquois: kasitake, at my feet; sasitake, at thy feet; rasitake, at his feet: and in Algonquin: nisit, my foot; kisit, thy foot; osit, his foot: as it is said: ktahahtos, ni 8*ab*, I see; satkahtos, *ki8ab*, thou seest; rathkatos, 8*abi*, he sees. The prefixes of nouns are almost the same as those of the verbs. There are in Iroquois, as well in the conjugation of nouns as in theconjugation of verbs, fifteen persons, of which four are in the sing, five in the dual, five in the plural, and an indeterminate one. The Algonquins have only seven persons; but their nouns possess, nevertheless, a prodigious number of inflexions on account of the accidents to which they are liable, the list of which is: the diminutive, the deteriorative, the ultra-deteriorative, the investigative, the dubitative, the near preterite, the remote preterite, the locative, the obviative, the superobviative, the possessive, the sociative, and the modificative."

A multitude of questions and objections might be raised even on the few points stated above. The following, for example, have been suggested to us by an eminent hebraist:

The first of the three words cited as examples of the Hebrew (sabaktani) is not Hebrew, but belongs to another, though cognate language. In this first example, therefore, we think M. Renan will be disposed to deny the analogy. The reviewer through inadvertence has here given his opponent an advantage. Then again without objecting that in the one language the *ni* is prefixed, and in the other post-fixed, we must recollect that in Hebrew, *ni*, which is only the objective case of the pronoun when immediately joined to a verb, is used but very seldom, especially when compared with the fuller prevalence of the form *i*, and that in verbs the *n* for the first person is *never* used in the past tenses, and in the future tenses the *n* and the *i* are *both* omitted, and the letter *a*, the other fragment of the absolute form of the pronouns, is employed. It is only right to keep these points in view, in establishing the analogy sought to be set up. In the second example cited, Iadeka (more properly yadecha), the *a* is changed into *i* in the Iroquois, and the *o* of the third person is not used in the verb, e. g., (p. 20,) nici8e, he kills. The reviewer however informs us of very interesting facts respecting the composition of the tenses of the verbs, as compared with the Hebrew forms, and it is more of these interesting facts that we would desire.

Again, while N. O. is quite right on scientific grounds to condemn M. Renan's unphilosophical reference of certain analogies to chance, it may not be quite right to object as he does, to what M. Renan has to say on the subject of onomatopœia, and in which he but coincides with such eminent modern critics as Gesenius, Fürst, etc. N. O. is doubtless acquainted with the original Hebrew text of the Scriptures. Can he, then, ignore the remarkable prevalence of Onomatopœia, more especially in the early books of the Sacred Volume? And need we remind him that this prevalence of onomatopœia in the early history of the language is of no small value in discussing the question of the primitive language —"unité primordiale du langage" which, says N. O., is treated by M. Renan as "ridicule chimère, et mythe le plus bizarre." We are not quite clear as to whether the reviewer holds the Hebrew to be the primitive language of man; but for his Algonquin "kokoc, kokoko, kackacipinesi, kakaki, makaki, etc.," how many examples could we cite, not only in the Hebrew, but in the later Latin family of languages. Here are a few: Hebrew לקק, lackack, English, he licked; Italian leccare; French lécher: so in Greek λεχεῖν, German lecken. Next Hebrew קרא, kara; English, he cried; Italian, gridare; Fr. crier; Ger. schreien. Our limited space, however, compels us to leave this topic here. Scarcely more satisfied are we with the meagre list of quadriliteral and quinquiliteral Iroquois roots which N. O. opposes to a yet shorter list of Hebrew and other similar roots, as an offset to those "dont M. Renan fait un si pompeux étalage." We shall wait for the more elaborate effort which we desire to see from the reviewer before we fully give in our adhesion to the following important claims: "Concluons donc qu'en matière d'onomatopées, les langues américaines ne le cèdent à aucune, et que parmi elles, l'iroquois se distingue par des tendances à revêtir la forme quadrilitère."

Similar objections may be raised to comparisons of Algonquin with Greek and Latin, as 'enim,' above referred to, or the root "tang" in the verb to touch, or another which has been suggested as a parallel,—the prevalence of the root "ouk," or "oik," in the sense of house or dwelling. More especially would such objections be strengthened by the fact stated by N. O., that perhaps the root "sit," foot, is the only one common to the neighboring Iroquois and Algonquin languages; unless, indeed, it should appear that these two languages have been derived the one from the east, the other from the west, and have met in Canada. To give force to these comparisons of roots, it would be necessary to show that they occur also in the Carib, or other languages of that region, and in the extinct Guanche of the Canaries, or in some of the ancient languages of Northern Africa or Southwestern Europe. At one time there was a strong tendency to get up fanciful resemblances between languages. The tide has turned, and the prejudices of scholars are all the other way. For this very reason we thank N. O. for his effort, and would encourage, in the interests of ethnology, all the honest cultivators of the comparative philology of even those primitive tongues, unjustly neglected as barbarous and uncultivated; though for that very reason, like the habits and rites of the people who speak them, they may, as Dr. Wilson has well shown, be of inestimable value in interpreting the primitive relations of men, and their condition in "pre-historic times."

MEETING OF BRITISH ASSOCIATION.

Geography and Ethnology.

In this section, after some opening observations on the progress made between 1838 and 1863 in the vast centre of industry on the Tyne, the President remarked: "I will first call your attention to some of the leading geographical results in British Geography which have been brought about since we last met here. At that time four years had elapsed since (at our first meeting in Scotland) I directed the attention of this Association to the untoward condition of the Topographical Survey of the British Isles, by showing that no map of any country north of the Trent was in existence; in short, that all the North of England and the whole of Scotland were in that lamentable state; whilst the survey of France, and of nearly all the little states of Germany, had been completed. Having roused public sentiment to this neglected state of the national map,—so neglected, indeed, that one of the great headlands (Cape Wrath) was known to have been laid down some miles out of its proper place in all maps and charts,—deputations to the government followed, in the first of which I pleaded the cause of geography; but with little or no effect as regarded the North of England, and my native country, Scotland. In the twenty-nine years which have elapsed between the period when the question was first agitated at Edinburgh, considerable progress has, doubtless, been made; but it is surely a reproach to a powerful country like Britain that in thirty years we have only just seen the region between the Trent and the Tyne delineated and laid down on a real map,—*i. e.*, on the one-inch scale,—whilst even yet the maps of the northernmost English counties are unfinished. With the extension of the survey to the North of England and Scotland, not only has the six-inch scale been adopted, but much larger cadastral plans, on the 25¼-inch scale, have been and are in execution. While these plans are, I grant, most valuable to individual proprietors, they are beside the purposes of the geographer—inasmuch as they exhibit no attempt whatever at the delineation of physical features. Hence I regret that their execution should have been preferred to the completion, in the first instance, of an intelligible and useful map of the British Isles, which, if made to depend on the *previous* completion of the large-scale plans, will still involve, I fear, the lapse of another very long period before the whole country will possess what geographers consider a map. The most powerful cause which has retarded the progress of good cartography has been the frequently-recurring cold fits of indifference and consequent cutting off of the supplies by which our legislature has been periodically affected, and which have necessarily occasioned a collapse and stagnation in the works of this important survey. As respects my own special department, or the "Geological Survey," I deprecate still more strongly the delay of the construction of the one-inch map, seeing that no geologist can labor in the Highlands of Scotland, and accurately delineate their interesting rock-formations, by coloring any of the defective country-maps of that region. Let us now cast a rapid glance over the progress of discovery in distant lands, and particularly where our countrymen have signalized themselves. At former meetings of this Association, we have dwelt on the early discoveries of new lands in the interior of Australia, in which the names of Mitchell, Eyre, Sturt, Leichhardt, and others have been always mentioned with honor and respect. The latter journeys of the brothers Augustus and Frank Gregory have earned for these good surveyors the highest honors of the Royal Geographical

Society, for their extensive researches and determinations of longitude and latitude in Northern, Eastern, and Western Australia. Whilst more recently, the bold expedition of Burk and Wills cost these noble fellows their lives, the latest researches of their successors stand out as indeed most singularly successful. M'Douall Stuart, after various previous triumphs, in one of which he reached the watershed of North Australia, has actually passed from Adelaide, in South Australia, to Van Dieman Bay on the north coast, in latitude 15 deg. S. Contemporaneously with this last expedition, M'Kinlay, proceeding also from Adelaide, reached the Gulf of Carpentaria, and thence travelled to the eastern shore; and Landsborough, realizing all the value of the discoveries of Burk and Wills, and penetrating from the Gulf of Carpentaria, traversed the continent southward until he regained the noble colony of Victoria, in which the expedition was organized. The rapid rise of the different colonies in Australia is truly marvellous; and whilst we have successfully occupied all the available ports and lands along the eastern, southern, and western sides of this great continent, we are, I rejoice to say, now beginning to extend our settlements to the north coast, the occupation of which I have advocated for many a year, on political as well as on commercial and colonial grounds A few years only of practical researches have dispelled our ignorance respecting the interior of this vast mass of land; in which, though there are wild desert tracks, there are also many rich and well-watered oases of fine pasture-grounds, through which the colonists may open out communications across the continent from the south and east to the northern shores. A short time only, I venture to predict, will elapse before towns arise at the head of the Gulf of Carpentaria, as well as at the mouth of the Victoria River of the north; from whence, as well as from the new settlement of Cape York, Australia will have a direct communication with our great Indian Empire."

Referring to the discovery of the sources of the Nile, the President remarked upon the fact that "traveller after traveller, from the days of the Egyptian priests and of the Roman emperors down to modern periods, had endeavored to ascend the Nile to its source, and all had failed"; and that it was by reversing the process, and by proceeding from the east coast of Africa, near Zanzibar, to the central plateau land between North and South Africa, that Captains Speke and Grant had solved the problem.

The President, after stating the subjects of greatest interest to be discussed in this section, remarked: "In the commencement of this address, I spoke of the comparatively few means we possessed in 1838 of reaching rapidly this flourishing town; and now I need not remind you that we are surrounded by a network of railroads, which wind along valleys, or are driven under your hills. Still less at our former meeting here had the genius and sagaciousness of Wheatstone overspread the country with the electric telegraph, enabling men rapidly to transact important affairs in our largest cities, whether separated by a few miles or by hundreds of miles from their correspondents. At the last Manchester meeting, indeed, we interchanged questions and answers with the philosophers of St Petersburgh during an evening assembly; and since then great advances have been made in transmitting telegrams round the world. In this way a vast stride will be made in the ensuing winter by the extension of the telegraph from Constantinople through Asia Minor; and thence, *via* the Persian Gulf, to the country of Mekran, at the head of the Indian Ocean, and so to the British possessions in India. At the same time, other efforts are in progress to carry a system of telegraphs from Russia through Siberia, and thence across the Desert of Gobi to Pekin. The great desideratum, however, of connecting Europe with America by a submarine telegraph remains to be accomplished. With a view to that desirable end, the Council of the Royal Geographical Society warmly supported a proposal by Dr. Wallich to effect a complete survey of the sea bottom, as a precursor to the actual laying down of a cable upon the vast unknown irregularities of the submarine surface. We naturally supported an effort like this, which was certain to throw much light on Natural History and Physical Geography; and we rejoiced in the preliminary researches which had been made towards the establishment of an electric line overland to British India; because they, for the first time, laid open to European knowledge countries which, though unknown to the moderns, were seats of power when Alexander the Great and his lieutenants invaded India. The soundings which ascertain the nature of the bottom of the ocean, not only give us the outlines and characters of various sunken rocks, sands, and mud-banks, and of vast and deep cavities, but inform us where the under-currents prevail, and where at vast depths the surface is tranquil and unruffled in some places, whilst in others submarine volcanoes disturb the sea-bottom. Nay, more, these submarine operations have taught us that animals cannot only live, but flourish, preserving even their colors, at the enormous depth of one mile and a half. We thus see how the efforts of the nautical surveyors and the engineers to spread the electric telegraph are not merely destined to be useful to mankind, but also to elicit great and important truths in Natural History, the development of which is specially connected with the pursuits of the geographer and the ethnologist."

The address concluded by a reference to the appointment of so skilful and philosophical a naturalist as Mr. John Lubbock to the chair of President of the Ethnological Society, and to the appointment of Mr. F. Galton as Secretary, under whose auspices an increased activity was being already shewn.

MISCELLANEOUS.

The Earthquake of April, 1864.

In the *Canadian Naturalist*, Vol. v., p. 379, will be found a list of all the earthquakes observed in Canada up to that of October, 1860. Since that time, with the exception of a few slight and local shocks, chiefly in the vicinity of Murray Bay and the Saguenay, which appear to be points of special intensity for the seismic agency of this country, there have been no earthquakes felt until Wednesday, April 20th, 1864, when a shock of no great intensity was felt throughout a great part of Lower Canada. Like other Canadian earthquakes it was felt almost simultaneously over a wide extent of country, indicating perhaps that its source was deep-seated, and the vibrations propagated almost vertically to the surface. At Quebec the shock was felt between 1.10 and 1.15 p.m.;* and at L'Islet, Danville, Montreal, and other places, in so far as can be ascertained, the hour was nearly the same, except in the case of Father Point, where a shock is said to have been felt at 11 o'clock. Unless there is some mistake in the statement this must have been a shock not felt elsewhere. In so far as reported, the shock seems to have been most violent at Quebec, where, as well as at several other places, two distinct vibrations

* Or according to other statements at 1.20 P. M.

were noted by some observers. The reports do not give much information as to the direction of the vibration, but it was probably, as in the earthquake of 1860, from east to west, or from southeast to northwest.

The only remarkable point in relation to this earthquake is its occurrence at a season when seismic energy in this region seems, from past experience, to manifest itself less frequently than at most other times. Only four out of eighty-three recorded earthquakes in Canada and its vicinity have occurred in April; the autumn and winter being the seasons of greatest seismic activity.

The following extracts from Quebec newspapers give some details of interest:—

The *Mercury* says:—"The earth trembled violently; every house was shaken as if an explosion of gas or gunpowder, or an *eboulement* of the rock had taken place—only no noise was heard. Some fancied that a heavy weight had fallen upon the floors above them, and, indeed, that was our own sensation. The walls of the house rocked; the windows rattled; and we rocked ourselves. To make sure that the power-press had not fallen to pieces, we examined the press-room, but found all right there. The inmates of the rooms above us, horror-stricken, came down stairs to enquire what the matter was; people from the street came tumbling in to ask us if we had felt any unusual sensation: the people over the way felt it; the cruet stands were overset, plates broken, and the whole dinner-table service at Russell's set in motion; the soldiers rushed out of their bomb-proofs on the citadel, where the shock was, we are informed, the most severe; in St. John street without, people ran from their houses, and hosts of people besieged the gates of the gas-works. In the streets, however, the shock was not sensibly felt, and by some persons not felt at all. It is fully believed that the concussory effect upon the houses was greater than when the laboratory blew up. A gentleman informs us that at Mount Pleasant the shock appeared to come from the southwest with a gradually increasing rumbling noise, and ended with a report as of a distant explosion. At the house of Mr. Mainguy, in Scott street, near the Lewis Road, the earth has opened in two places in a passage leading to the yard, and a quantity of earth was thrown down from the siding of the cellar.

The *Chronicle* states:—"About ten minutes or a quarter past one, yesterday afternoon, the city was "frightened from its propriety" by a shock of an earthquake—of brief duration and unattended by any serious results, but sufficiently violent to give an idea of the destruction which would have been caused had the convulsion of the earth lasted as many minutes as it did seconds. The shock was of a peculiar nature. It was not of the swaying or vibratory species—it was a shaking of the ground precisely similar in effect with that caused on a bridge by the passing of a heavy train at a considerable speed. In the houses it was felt to a much greater extent than by persons in the streets—this fact being of course easily explained by the motion communicated to floors, the rattling of windows, doors, furniture, glass-ware, and loose fixtures. Several persons appear not to have felt the quivering motion of the ground out of doors, and were therefore surprised to see persons rushing into the streets, anxiously enquiring what had occurred. In the houses the rumbling or jarring sound was however, positively alarming. In some instances ornaments and ill-secured panes of glass fell from windows. The shock lasted, as nearly as can be determined, five or six seconds. Of course, on such an occasion, few persons could be found with sufficient presence of mind to count at the moment the duration of the convulsion, and it can therefore only be estimated by the recollection of the event.

"In the upper portions of the city—on the Cape, in the Citadel, and in St. Lewis suburbs—the shock seems to have been most severe. In the Lower Town and St. Roch's, however, it was felt with sufficient force to send thousands of persons into the streets to enquire if another explosion had taken place, if the gas works at Orleans wharf, Palais, had blown up, or if a portion of Cape Diamond had given way and crushed the houses in Champlain street. All these surmises were indulged in at the moment. That with regard to the gas works, however, grew into a rumor that spread like wildfire, and hundreds ran or drove towards the Palais to find that it was unfounded. This rumor was doubtless strengthened by the fact that many persons fancied that they perceived a gaseous smell immediately after the shock. But the absence of anything like the loud report which characterizes an explosion seems to have led most people to attribute it at once to its true cause.

"There were none of the signs of the elements which usually herald the coming of earthquakes in southern latitudes. The sky was cloudless at the time, the weather clear and agreeable, with what mariners would call a "stiff breeze." The wind prevented the effect of the earthquake from being noticeable on the river, although some observant persons say that the surface of the water appeared darker than its ordinary color while the concussion lasted."

The *News* adds the following:—"The shock was so sudden that to those who were within doors it appeared as if the chimney-wall or roof of their own or their neighbor's house had given way and was tumbling down. At the Artillery Barracks, the men ran from their rooms into the square and up towards the magazine, fully convinced that another explosion had taken place. On the citadel, too, where we are told the shock was most violent, the men ran in terror from their bomb-proof rooms into the square, and crowded the ramparts to see where the explosion had occurred.

"We learn that in the ship-yards at St. Roch's, the ships on the stocks waved to and fro. Some persons say they distinctly saw the river rise in some parts to a height of nearly ten feet, and that it receded almost immediately."

Mr. Herbert Williams writes to the Quebec *Chronicle* as follows, from Harvey Hill Mines, under the date of Thursday April 21: "At 1.15 p.m., yesterday, a smart shock of an earthquake was felt in this district, lasting from ten to fifteen seconds. It was also perceived by some of our miners, who were at the time working at a depth of 180 feet below the surface. The undulation at this place, as nearly as I could judge, seemed to travel from southwest to northeast, the wind blowing at the time from the northeast. At 6.40 p.m., we had a brilliant flash of lightning without its usual accompaniment of thunder; the sky at the time was perfectly clear, the wind blowing strong from the northeast. As yuo will, I doubt not, receive many communications from different parts of the Province, it may be interesting to learn the time of its appearance at different places. Hence I send you the above facts of its occurrence here."

On Organic Remains in the Laurentian Rocks of Canada. (Letter from Sir W. E. Logan to the Editors of "Silliman's Journal.")

"In August, 1859, I exhibited to the American Association at Springfield, Mass., specimens of what was regarded by me as an organic form externally resembling *Stromatocerium*, and found in the Laurentian limestone of the Ottawa. These were described by me in the *Canadian Naturalist* for that year (vol. iv, p. 300), and afterwards figured in the *Geology of Canada*, p. 49. In 1863, similar forms were detected by the Geological Survey, in the serpentine-limestone of Grenville, sections of which we have prepared and submitted for microscopic examination to Dr. J. W. Dawson. He finds that the serpentine, which was supposed to replace the organic form, really fills the interspaces of the calcareous fossil. ' This exhibits in some parts a well-preserved organic structure, which Dr. Dawson describes as that of a Foraminifer ' growing in large sessile patches after the manner of *Carpenteria*, but of much greater dimensions, and presenting minute points which reveal a structure resembling that of other foraminiferous forms, as for example *Calcarina* and *Nummulites*.' Figures and descriptions will soon be published by the Geological Survey.

" Large portions of the Laurentian limestones appear to be made up of fragments of these organisms, mixed with other fragments which suggest comparisons with crinoids and other calcareous fossils, but cannot be distinctly determined. Some of the limestones are more or less colored by carbonaceous matter, which Dr. Dawson has found to exhibit under the microscope evidences of organic structure, probably vegetable.

" In this connection, it may be noticed that Mr. Sterry Hunt, in a paper presented to the Geological Society of London in 1858, (see also Silliman's Journal, [2], xxxvi, 296,) insisted upon the presence of beds of iron-ore, metallic sulphurets, and graphite in the Laurentian series as " affording evidence of the existence of organic life at the time of the deposition of these old crystalline rocks."

Dr. Dawson has proposed for this fossil the name of *Eozoön Canadense*, under which it will shortly be fully described.

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THE

CANADIAN NATURALIST.

SECOND SERIES.

CONTRIBUTIONS TO LITHOLOGY.*

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III. On Some Eruptive Rocks.†

In Silliman's Journal for March 1860 (2nd, xxix, 282) there is a short note, pointing out the existence, in the vicinity of Montreal, of several interesting classes of eruptive rocks, including quartziferous porphyries, trachytes, phonolite, dolerites, and diorites. It is proposed in the third part of the present paper to describe the results of some chemical and mineralogical examinations of these rocks, and to give by way of preface a description of their geographical distribution and geological relations. They may be considered geographically as belonging to two groups; of which the first and more important for the number and variety of its rocks may be conveniently described as the Montreal group. It consists of a succession of intrusive masses along a belt running nearly transverse to the undulations of the Notre Dame Mountains, which are the prolongation of the Appalachians into eastern Canada. Commencing at Shefford Mountain, an isolated trachytic mass not far removed from the western base of the Notre Dame range, we find, going westward, the detached hills known as Yamaska, Rougemont, Rouville or Belœil, Montarville or Boucherville, Mount Royal or Montreal, and Rigaud Mountains; the last being distant about ninety miles from Shefford. Brome Mountain, which

* Concluded from page 36.
† From *Silliman's Journal*, vol. xxxviii.

occupies a large area to the south of Shefford, approaches within two miles of it. In like manner, a few miles to the south of Belœil is another intrusive mass known as Mount Johnson or Monnoir; making in all nine hills of eruptive rock belonging to the Montreal group. Besides these, numerous smaller intrusive masses in the form of dykes are met with around and between the hills. From Mount Royal to Rigaud Mountain, a distance of about thirty miles, a gentle undulation of the strata is observed, which increases to the westward of Rigaud, and finally gives place to a considerable fault. This disturbance has been traced to the Laurentide hills on the Lac des Chats, 140 miles west of Montreal; but to the eastward the strata exhibit no evidence of this transverse undulation, unless the appearance of the intrusive rocks already mentioned be supposed to indicate the prolongation of a fracture without sensible dislocation.

The whole of these eruptive rocks rise through unaltered paleozoic strata, which however, in the immediate vicinity of the intrusive rocks, exhibit a local metamorphism. The hills of Shefford, Brome, and Yamaska break through the strata of the Quebec group, and lie a little to the east of the great line of dislocation which, in this region, brings up the lower members of the paleozoic series against the superior portion of the Lower Silurian, and divides into two districts the great paleozoic basin. (Geology of Canada, pp. 234, 597.) The other hills all belong to the western division of this basin, and break through various members of the Lower Silurian series from the Potsdam to the Hudson River formation. Among the numerous dykes which traverse not only the sedimentary strata but the intrusive masses, there are some which intersect the conglomerates of St. Helen's Island. These are of uncertain age, but repose unconformably on the Lower Silurian series, and enclose pebbles and masses of Upper Silurian limestone characterized by fossils of the Lower Helderberg period. (Ibid., p. 356.)

This group of intrusive rocks offers very great varieties in composition; thus Shefford and Brome consist of what we shall describe as a granitoid trachyte, while the succeeding mountain, Yamaska, and the most western, Rigaud, both consist in part of a kind of trachyte, and in part of diorite. Monnoir and Belœil also consist of diorites, which however differ from the last two, and from each other; while Rougemont, Montarville, and Mount Royal consist in great part of dolerites, presenting however many varieties in composition, and sometimes passing into pyroxenite. The dolerites of Rougemont and Mount Royal are cut by dykes of trachyte. Similar dykes also traverse the diorite of Yamaska, and may perhaps be connected with the trachytic portion of this mountain. It is probable, judging from some specimens from Rougemont, that the dolerite is there intersected by veins of diorite, some of which resemble that of Belœil, and others that of Monnoir. Dykes both of trachyte, phonolite, and dolerite are also found traversing the Lower Silurian strata in the vicinity of the great eruptive masses; and the conglomerate of St. Helen's mentioned above is traversed by dykes of dolerite, which in their turn are cut by others of trachyte.

A second and smaller group of intrusive rocks occurs to the northwest of Montreal, chiefly in the county of Grenville, where they traverse the gneiss and limestones of the Laurentian system. The principal undulations of these rocks have, like those of the Appalachians, a north and south direction; but there is apparent also a second series of undulations, affecting in a less degree the geographical distribution of the strata, and having, like the Montreal and Rigaud undulation, an east and west direction. Coincident with the latter system of folds is a series of doleritic dykes, which nowhere attain a great breath, but have in some cases been traced more than fifty miles in a nearly east and west direction. These dykes are interrupted by a great mass of reddish syenite, passing in some parts into granite, and occupying an area of about thirty-six square miles in the townships of Grenville, Chatham, and Wentworth. Dykes of this syenite extend from the central mass, and traverse the surrounding gneiss and limestone. Numerous dykes of quartziferous porphyry intersect both this syenite and the surrounding gneiss, and are seen in one case to proceed from a considerable nucleus of porphyry, which rises into a small mountain; rendering it probable that numerous other porphyry dykes of the region radiate in like manner from other nuclei of the same rock. Some parts of this porphyry enclose fragments of syenite, dolerite, and gneiss, which vary in size from small grains to several feet in diameter, and often give to the rock the character of a breccia. In one instance a bed of gneiss, upwards of a hundred yards in length, is completely surrounded by the porphyry.

ORTHOPHYRE AND SYENITE.

ORTHOCLASE-PORPHYRY OR ORTHOPHYRE.—Under this head may be noticed a rock which has for its base a compact petrosilex, or intimate mixture of orthoclase and quartz, rendered porphyritic by the presence of grains or crystals of orthoclase, of quartz, or of both of these minerals together. The occurrence of this rock at Grenville, where it forms dykes in the syenite of that region, has just been noticed. The fine-grained petrosilicious base of this rock varies in color from dark green to various shades of red, purple, and black; these differences probably depending upon the degree of oxydation of the contained iron. Throughout this paste are disseminated well-defined crystals of a rose-red or flesh-red feldspar apparently orthoclase, sometimes very abundant; and less frequently small grains of nearly colorless translucent quartz. An analysis was made of a characteristic variety of the rock, the base of which was greenish-black, jasper-like, conchoidal in fracture, and feebly translucent on the edges, with a somewhat waxy lustre. The hardness was nearly equal to that of quartz, and the specific gravity 2.62. A few distinct crystals of red orthoclase, and some grains of quartz, were present. The base, freed as much as possible from these, gave as follows:

	I
Silica	72.20
Alumina	12.50
Peroxyd of iron	3.70
Lime	.90
Potash	3.88
Soda	5.30
Volatile	.60
	99.08

The oxygen ratio of the alkalies and alumina is 2.02: 5.84, or nearly 1:3. The alumina requires 43.80 parts of silica to form with the alkalies 65.48 parts of a feldspar having the ratios 1:3:12, which are those of orthoclase and albite. There will then remain 28.4 parts of silica. This, with the exception of a small amount which is probably united with the oxyd of iron and lime, may be regarded as uncombined. The porphyries of this region receive a high polish, and are sometimes very beautiful.

SYENITE.—The syenite of this region consists of orthoclase, usually flesh-red in color, and grayish vitreous quartz, with a small portion of blackish-green hornblende, which is sometimes almost or altogether wanting, and is occasionally accompanied with a little mica. The orthoclase is often nearly compact, but more gen-rally distinctly crystalline and cleavable, and so far as observed, is not associated with any triclinic feldspar. The hornblende is apparently subject to decomposition, becoming soft, earthy, and ferruginous in its aspect, while the feldspar retains its brilliancy. The partial analysis of such a specimen of the syenite gave only 0.56 of lime, and traces of magnesia, with 3.75 per cent. of peroxyd of iron, and of alkalies, potash 4.43, soda 4.35. This large proportion of soda is also to be remarked in the orthophyre just described, and in the red orthoclase-gneiss of this region, a portion of which gave 3.86 per cent of potash and 3.70 of soda; while the red orthoclase from the rocks of this Laurentian series, named perthite by Dr. Thompson, gives in like manner 6.37 of potash to 5.56 of soda. A nearly pure potash-orthoclase, generally white in color, is however found in some of the stratified Laurentian rocks. (Geology of Canada, page 474.)

This syenite of Grenville has in some portions undergone a peculiar decomposition, which has reduced it to a soft greenish matter having the aspect of serpentine, or rather of pyrallolite. This change has been remarked only in the vicinity of some remarkable veins of chert which are here found cutting the syenite, and as described by Sir W. E. Logan, is more or less complete for a distance of two hundred yards on each side of them. In specimens of this altered rock, the quartz remains unchanged; while the feldspar, still preserving its cleavages, has a hardness no greater than carbonate of lime. It is somewhat unctuous to the touch, with a feeble waxy lustre, and its color is occasionally reddish, but more often of a pale green. Such a specimen was selected for analysis and gave of silica 80.65, alumina 12.60, lime 0.60, soda and a little potash 2.65, volatile 2.10, magnesia and oxyd of iron, traces; = 98.60. From this result it appears that the feldspar of the syenite has lost nearly two thirds of its alkali; the iron and other bases having also for the most part disappeared. This removal of the protoxyd bases would appear from the character of the resulting mineral to be different from that which takes place during the kaolinization of feldspar. The nature of the process requires further investigation, but it was not improbably connected with the deposition of the adjacent chert or hornstone. This substance, according to Sir W. E. Logan, forms two large veins which cut the syenite vertically, and have a breadth of from four to seven feet. It is generally arranged in bands or layers parallel to the walls of the veins, and varying in color from white to yellowish and flesh-red. The mineral has the chemical characters of flint or buhrstone, and like the latter presents numerous irregular cells, the walls of which are sometimes incrusted with crystals of quartz, and in other cases bear the impression of small cubes, perhaps of crystals of fluor-spar, which have themselves disappeared. The relations of these singular veins of silex show that it cannot be of sedimentary origin, and it can scarcely be doubted that it is an aqueous deposit, and results from a similar process to that which on a lesser scale gives rise to agate and chalcedony in various rocks. (Geology of Canada, page 41.)

TRACHYTES.

Under this head we shall describe a class of rocks which are very abundant in Eastern Canada, and present a great variety of aspects. There are many dykes in the vicinity of Montreal which resemble some of the typical trachytic rocks of Auvergne and of the Rhine; while the rocks of the mountains of Brome and Shefford consist almost entirely of distinctly crystalline feldspar. These will be described as granitoid trachytes, under which head may also be included a somewhat similar rock from Yamaska Mountain.

BROME AND SHEFFORD MOUNTAINS.—The trachytes of Brome and Shefford occupy two considerable areas near to each other, and, as already stated, are the easternmost of the eruptive masses now under description. The larger area covers about twenty square miles in Brome and the western part of the township of Shefford. It consists of several rounded hills, of which the principal are named Brome and Shefford Mountains, and rise boldly about 1,000 feet above the surrounding plain. The rock shows divisional planes, giving it an aspect of stratification, and separates by other joints into rectangular blocks. The second area includes about nine square miles in the township of Shefford, to the northwest of the last, and at the nearest point is only about two miles removed from it. This is known as Shefford Mountain.

The rocks of these two mountainous areas present but very slight differences; being, so far as examined, everywhere made up in great part of a crystalline feldspar, with small portions of brownish-black mica, or of black hornblende, which are sometimes associated. The proportion of these two minerals is never above a few hundredths, and is often less than one hundredth. The other mineral species are small brilliant crystals of yellowish sphene, and others of magnetic iron, amounting together probably to one thousandth of the mass. In some finer-grained varieties a few rare crystals of sodalite and of nepheline are met with. But for the uniform absence of quartz, these rocks might be taken for varieties of granite and syenite. They are very friable, and subject to disintegration, so that the soil for some distance around these mountains is almost entirely made up of the separated crystals of feldspar; which however show but little tendency to decomposition, and retain their lustre. The rock is sometimes rather finely granular in its texture; but is often composed of cleavable masses of orthoclase, which are from one fifth to one half of an inch in breadth, and sometimes nearly an inch in length. The lustre is vitreous, and in the more opaque varieties, pearly; but the crystals never exhibit the eminently glassy lustre nor the fissured appearance that characterizes the feldspars of many European trachytes which are similar to them in composition. The color of the feldspar of these rocks is white, passing into reddish on the one hand, and into pearl-gray or lavender-gray on the other.

Specimens of the rock of Brome Mountain were taken from the side near to the village of West Shefford. It was coarsely crystalline, lavender-gray in color, and contained a little brown mica, sphene, and magnetic iron, but no hornblende. The density of fragments of the rock was found to be 2.632–2.638. Selected grains of the feldspar had a specific gravity of 2.575, and gave by analysis the result II. The analysis of a second specimen from another portion of the hill, is given under III.

The rock from the south side of Shefford Mountain was next examined. In one part it consisted of a coarse-grained grayish-white feldspar with a little black mica, and closely resembled the rock just described from the adjacent mountain. A little lower down the hill however was a variety which, though completely crystalline, was more coherent and finer-grained than that of Brome, the feldspar rarely exhibiting cleavage-planes more than a fourth of an inch in length. Brilliant crystalline grains of black hornblende about the size of grains of rice were sparingly disseminated through the mass, together with very small portions of magnetite and yellowish sphene. Fragments of the rock had a density of 2.607–2.657. The feldspar was yellowish-white and sub-translucent, with a somewhat pearly lustre. By crushing and washing the mass, the grains of feldspar were separated from the heavier minerals, and found to have a specific gravity of 2.561. The result of its analysis, which scarcely differs from that of Brome, is given under IV.

	II.	III.	IV.
Silica	65.70	65.30	65.15
Alumina	20.80	20.70	20.55
Lime	.84	.84	.73
Potash	6.43	....	6.39
Soda	6·52	....	6.67
Volatile	.50	....	.50
	100.79		99.99

YAMASKA MOUNTAIN.—About twelve miles to the north of west from Shefford Mountain rises the hill of intrusive rock known as Yamaska Mountain, which has an area of about four square miles, and breaks through the strata of the Quebec group, near the line of the great dislocation which brings these up against the limestones of the Trenton group. The southeastern part of this hill consists of a granitoid diorite hereafter to be noticed; but the greater portion of the mass may be described as a granitoid trachyte, differing in aspect from that of Brome and Shefford, in being somewhat more micaceous and more fissile. The mica, which is dark brown, is in elongated flakes, and there is neither hornblende nor quartz in the specimens collected, which however hold small portions of magnetite, and minute crystals of amber-yellow sphene. These seem to be contained in veins of segregation, which are of a lighter color than the mass. The cleavable feldspar grains, which make up by far the greater part of the rock, are brilliant, with a vitreous lustre, and are often yellowish or reddish-gray in color. A portion of this feldspar separated by washing from the crushed mass of the rock, had a specific gravity of 2·563, and gave by analysis the result V. Another portion of selected grains of the feldspar gave VI. Both specimens were however somewhat impure.

	V.	VI.
Silica	61.10	58.60
Alumina	20.10	21.60
Peroxyd of iron	2.90	2.88
Lime	3.65	5.40
Magnesia	.79	1.84
Potash	3.54	3.08
Soda	5.93	5.51
Volatile	.40	.80
	98.41	99.71

Besides these great trachytic hills, numerous smaller masses of different varieties of trachyte, in the form of dykes and beds, are found along the line of country between Rigaud and Yamaska Mountains. The diorite of the latter is cut into dykes of a white or brownish-gray trachyte, which is often porphyritic, and may be connected the great mass just described.

CHAMBLY.—At Chambly a mass of porphyritic trachyte is intruded in the form of a bed among the strata of the Hudson River formation; and about midway in the Chambly canal a similar trachyte is met with, which contains in drusy cavities, crystals of quartz, calcite, analcime, and chabazite. The base of this rock is of a pale fawn color, and appears at first sight to be micaceous; but on closer examination it is seen to be almost entirely feldspathic. Minute portions of pyrites, and grains of magnetic iron, are rarely met with, and small scales of a dark green micaceous mineral are very sparsely disseminated. The crystals of orthoclase, which are very abundant, are sometimes an inch in length, and one-fourth of an inch in thickness: they are more or less modified, and terminated at both ends. They are easily detached from the rock, and are yellowish and opaque on the exterior, but the inner portions of the large crystals are transparent and vitreous. The composition of the crystals is given under VII. The paste of this porphyry, when carefully freed from crystals, lost by ignition 2.1 per cent. When pulverized and digested with dilute nitric acid, it effervesced slightly, giving off carbonic acid, together with red fumes, arising in part from the oxydation of the pyrites. The portion thus dissolved equalled carbonate of lime 1.76, carbonate of magnesia 0.98, peroxyd of iron with a trace of alumina 2.12 per cent. The residue, dried at 300° F., gave the result VIII.

	VII.	VIII.
Silica	66.15	67.60
Alumina	19.75	18.30
Peroxyd of iron	....	1.40
Lime	.95	.45
Potash	7.53	5.10
Soda	5.19	5.85
Volatile	.55	.25
	100.12	99.85

The paste of this trachyte thus differs but little from the crystals in composition. It contains only a slight excess of silica, and seems to be made up of lamellæ of orthoclase, mingled with small portions of carbonates of lime and magnesia. A part of the iron also is probably present as carbonate, which, by its decomposition, gives rise to the rusty red color of the weathered surface of the trachyte.

MONTREAL.—The island of Montreal offers a great variety of trachytic rocks, which traverse both the Lower Silurian strata, and the dolerite of Mount Royal. Some of these dykes are finely granular, occasionally crumbling to sand, and frequently are earthy in texture. In some cases they assume a concretionary structure, and they are often porphyritic from the presence of feldspar or hornblende. One variety exhibits large feldspar crystals in a compact purplish or lavender-gray base, with a waxy lustre. This effervesces with acids, from an admixture of earthy carbonates, and closely resembles in its aspect certain trachytes from the Siebengebirge on the Rhine. Other varieties can scarcely be distinguished from the so-called domite, the trachyte of the Puy de Dôme, and exhibit small drusy cavities. The presence of carbonates in trachytic rocks has generally been overlooked; Deville however found seven per cent of carbonate of lime in a trachytic rock from Hungary, and it occurs disseminated in some of the trachytes of the Siebengebirge. Some of the trachytes about to be described contain moreover carbonates of magnesia and protoxyd of iron, and weather to some depth of a reddish-brown color from the peroxydation of the latter, like the trachyte from Chambly just noticed. Acids remove from many of these rocks, in addition to the carbonates, portions of alumina and alkalies. These are derived from a soluble silicate, which in the trachytes of Brome appears only as rare crystals of nepheline, and in Chambly as analcime and chabazite. In some of the compact and earthy varieties about Montreal, however, this soluble silicate exists to a large extent, and has the composition of natrolite. By this admixture of a zeolite the trachytes pass into phonolite.

The first of these trachytes which will be noticed forms a dyke near McGill College. The rock is divided by joints into irregular fragments, whose surfaces are often coated with thin-bladed crystals of an aluminous mineral, apparently zeolitic. Small brilliant crystals of cubic iron-pyrites, often highly modified, are disseminated through the mass. The rock has the hardness of feldspar, and a specific gravity of from 2.617 to 2.632. Its color is white, passing into bluish and grayish-white; it has a feebly shining lustre, and is slightly translucent on the edges, with a compact or finely granular texture, and an uneven sub-conchoidal fracture. Before the blow-pipe it fuses with intumescence into a white enamel. The rock in powder, is attacked even by acetic acid, which removes 0.8 per cent of carbonate of lime, besides 1.5 per cent of alumina and oxyd of iron; the latter apparently derived from a carbonate. Nitric acid dissolves a little more lime, oxydizes the pyrites, and takes up, besides alumina and alkalies, a considerable portion of manganese. This apparently exists in the form of sulphuret, since, while it is soluble in dilute nitric acid, the white portions of the rock afford no trace of manganese before the blow-pipe; although minute dark-colored grains, associated with the pyrites, were found to give an intense manganese reaction. From the residue after the action of the nitric acid, a solution of carbonate of soda removed a portion of silica; and the remainder, dried at 300° F., was free from iron and from manganese. Its analysis is given under IX; while that of the matters dissolved by nitric acid and carbonate of soda from 100 parts of the rock, will be found under IX A.

A dyke of trachyte near to the last, and very similar to it in appearance, was submitted to the action of nitric acid, but the insoluble residue was not treated by carbonate of soda. Its analysis is given under X, while that of the soluble matters is to be found under X A. A white trachyte from a dyke at Lachine, resembled the preceding, but was somewhat earthy in its aspect, and effervesced with nitric acid, which removed a portion of lime equal to 7.40 per cent of carbonate. On boiling the pulverized rock with nitrate of ammonia, an amount of lime equal to 5.33 per cent of carbonate was dissolved. An accident prevented the complete determination of the alkalies in the feldspathic residue of this trachyte; and the soluble silica was not removed previous to the analysis, whose result is given under XI. The proportion of the potash to the soda was however found to be, by weight, nearly as two to three. The matters dissolved by nitric acid will be found under XI A.

Another dyke of trachyte from Lachine was concretionary, and stained by infiltration; the interior of the concretions was white and earthy. The substances removed from 100 parts of the rock by nitric acid and carbonate of soda, are given under B. A partial analysis of the insoluble residue showed it to be a feldspar allied to those of the preceding trachytes: the quantities of potash and soda were however nearly in the ratio of four to three.

A large dyke of trachyte in the limestone quarries at the Mile End, near Montreal, is remarkable for the amount of carbonates which it contains. It is grayish-white, with dark grey spots, granular, sub-vitreous in lustre, and holds a few crystals of hornblende. By ignition it loses 11.0 per cent. of its weight. In powder it effervesces freely with nitric acid, disengaging carbonic acid, and when heat is applied, red fumes from the peroxydation of the iron. 100 parts of the rock yielded in this way the soluble matters given under XII A. The composition of the residue, from which the soluble silica was not removed, is given under XII.

	IX.	X.	XI.	XII.
Silica,	63.25	62.90	58.50	61.62
Alumina,	22.12	23.10	24.90	21.00
Lime	.56	.45	.45	2.69
Potash,	5.92	2.43	....	4.66
Soda	6.29	8.69	....	5.35
Volatile	.93	1.40	2.10	2.37
	99.07	98.97		97.69

A second determination of the alkalies in a portion of the trachyte IX, which had not previously been treated by acid, gave potash 5.40 and soda 6.49. A second analysis of X gave potash 2.28, and soda 7·95.

	IX A.	X A.	XI A.	B.	XII A.
Silica,	1.43	....	....	5.00	....
Alumina	2.43	....	1.27	1.32	4.84
Peroxyd of iron	2.40	2.84	1.47	2.51	2.63
Lime	.60	1.86	4.14	3.50	6.49
Magnesia	....	....	1.34	1.35	1.70
Potash,	.40	.25	undet.	undet.	undet
Soda	.98	.21	"	"	"
Red oxyd of manganese,	1.31	.87	....	....	....

Of the matters soluble in nitric acid in the last-described trachyte, XII, the lime in the form of carbonate would equal not less than 11.60 per cent, the magnesia 3.58, and the iron 3.82 per cent of carbonates, in which condition by far the greater part of these bases are probably present.

PHONOLITE.

Associated with the numerous trachytic dykes at Lachine is one of the phonolite already referred to. It is brittle and somewhat schistose, breaking into angular fragments, and appears to consist of a reddish fawn-colored base, in which are disseminated greenish-white rounded masses, often grouped, and apparently concretionary in their structure. These greenish portions are sometimes half an inch or more in diameter, and cover from one third to one half of the surfaces. They are not very distinctly seen unless the rock is moistened. The hardness of the different portions does not greatly vary, and is nearly that of apatite. The specific gravity is very low, being only 2·414. The mass contains small cavities filled with carbonate of lime, which is rarely stained purple: it is also found in small films in the joints. The rock is granular in its fracture, without lustre, and is feebly translucent at the edges. When pulverized, and treated with nitric acid of specific gravity 1.25, a slight effervescence ensues, with abundant red fumes. The mass grows warm, and gelatinizes; and on washing out the acid solution, and treating the insoluble portion with a solution of caustic soda, a white granular residue remains. These reactions are obtained both with the fawn-colored and the greenish portions, but the amount of insoluble matter is greater from the last. The rock is but slightly hygroscopic: a portion of it in powder lost only 0.2 per cent by a prolonged exposure to 212° F., but 7.10 per cent at a red heat.

For the quantitative analysis, the method already indicated was followed. It was found that while a dilute solution of caustic soda removed all of the gelatinous silica separated by the acid, it took up only a trace of alumina; leaving a feldspathic residue which was no longer attacked by nitric acid. The silica was separated from the alkaline liquid, and the acid solution was found to contain, besides alumina and soda, a little potash, some lime, magnesia, and iron, and traces of manganese. The greater part of the lime is evidently present as carbonate; for when a portion of the pulverized phonolite, which gave to nitric acid lime equal to 4.36 per cent of carbonate, was boiled with a solution of nitrate of ammonia, there were dissolved 3.87 per cent of carbonate of lime; besides which there was a separation of a considerable amount of oxyd from the decomposed carbonate of iron. From this reaction, and from the entire absence of sulphur, which was carefully sought for, it is probable that the whole of the iron, except the small portion of peroxyd which colors the rock, exists in the state of carbonate. In the following analyses, therefore, the lime and the iron, as well as a little magnesia, are calculated as carbonates. XIII is the result obtained with four grams of the reddish portion of the phonolite, as free as possible from the green; and XIV was obtained with two and a half grams of a mixture of the two colors.

	XIII.	XIV.
Soluble silicate, zeolite (A), by difference.	46.57	36.16
Insoluble silicate, feldspar (B)...........	45.75	55.40
Carbonate of lime.....................	3.63	4.36
" iron.....................	3.52	3.72
" magnesia................	.53	.36
	100.00	100.00

In order to fix the composition of the soluble silicate, the amounts of the insoluble residue and of the separated silica, alumina, and alkalies, having been carefully determined, and the lime, magnesia, and oxyd of iron calculated as carbonates, the water was estimated by the loss. In this way were obtained the results given under XIII A, and XIV A; while the analyses of the insoluble silicate, which is a potash feldspar, are given under XIII B, and XIV B.

	XIII A.	XIV A.	Natrolite.	Analcime.
Silica................	51.96	51.66	47.40	54.06
Alumina............	24.42	24.88	26.09	23.20
Soda................	12.93	13.05	16.02	14.10
Potash..............	1.15	1.28	....	....
Water..............	9.54	9.13	9.05	8.10
	100.00	100.00	100.00	100.00

The composition of this zeolitic mineral is intermediate between analcime and natrolite; but the readiness with which it gelatinizes with acids, leads to the conclusion that it belongs, in great part at least, to natrolite. The theoretical composition of these two zeolites is for the sake of comparison, placed alongside of the two analyses of the soluble portion of the phonolite.

	XIII B.	XIV B.
Silica..................................	59.70	60.90
Alumina..............................	23.25	24.45
Lime..................................	.99	.45
Potash................................	9.16	undet.
Soda...................................	2.97	"
Volatile...............................	2.23	2.10
	98.30	....

The feldspars of the above trachytes and phonolite offer some considerable variations in their composition, especially in the proportions of the alkalies. In IX the proportions of potash and soda are nearly the same as in the trachytes of Brome, Shefford, and Chambly; and the same is true of XII. These are doubtless to be regarded as varieties of orthoclase with a large amount of soda, while in the feldspar from the phonolite the proportion of soda is very small. In X, on the contrary, the large predominance of soda indicates a composition approaching that of albite. It is further apparent, from a comparison of the feldspars of the other trachytes whose complete analyses are not given, that the proportions of the alkalies are liable to considerable variation, even in adjacent and apparently similar dykes. All of the above feldspars are probably to be referred to orthoclase, or to albite; but these, in the earthy trachytes, have undergone a commencement of decomposition; which consists in the loss of a portion of silica and alkali, and the combination of water, resulting in a formation of kaolin. An admixture of this substance will explain the increased amount of alumina, the deficiency of silica, and the presence of water in the feldspars of the more earthy of these trachytes.

These trachytic dykes are not confined to the vicinity of Montreal. To the southward, on the shores of Lake Champlain, there is found in and about Burlington, Vermont, a vast number of dykes of intrusive rock; some of which appear to intersect the strata of the Quebec group, and others those of the Trenton group. Some of these are described as being of greenstone; and others, as a white or yellowish-white feldspathic rock, often porphyritic from the presence of feldspar crystals. The base of a yellowish-gray porphyritic dyke from Shelburne, having a rough fracture, and a specific gravity of 2.60, gave to Prof. G. F. Barker, silica 67.30, alumina and peroxyd of iron 19.10, lime 0.79, magnesia, traces, potash 4.74, soda 6·04, volatile 1.70,= 99.67. It contained a little intermingled quartz; and the mass resulting from the fusion of the rock with an alkaline carbonate, afforded traces of a sulphuret. (Geology of Vermont, pages 579–707.)

Somewhat to the south of Burlington, on the west side of Lake Champlain, and near to Essex, there is a great mass of intrusive rock, found in the slates of the Hudson River formation. As described by Emmons, it is interstratified in an irregular manner among the layers of the unaltered sedimentary rocks, and has a fissile and schistose structure, which gives, at first sight, the aspect of stratification to what is undoubtedly an intrusive rock. When exposed to the action of the waves on the lake-shore, its structure appears to be columnar, and sometimes concretionary. This rock is described as composed of a reddish or pale leek-green compact feldspar, holding crystals of the same mineral. (Geology of New York, vol ii, page 84.) These intrusive feldspathic rocks on Lake Champlain resemble closely the trachytes of Montreal and Chambly,—with the latter of which, the trachyte of Shelburne, the only one of them which has been chemically examined, closely agrees in composition.

Dolerites.

The anorthosites, which yet remain to be described, may be divided into two groups,—those composed of anorthic feldspars with augite, constituting the dolerites, and those in which similar feldspars are associated with hornblende. The general geognostical relations of these two groups of rocks in the districts under discussion have already been indicated.

Grenville.—It has already been stated on page 163 that the oldest known intrusive masses which traverse the Laurentian series are of dolerite, and that the dykes of this rocks are intersected by the syenite, which was succeeded by the orthophyre or quartziferous porphyry, Nothing corresponding to the syenite or the orthophyre is met with among the adjacent Lower Silurian strata, which are seen to repose upon the worn surfaces of these intrusive rocks. A fourth series of dykes of a porphyritic dolerite is however found to cut all of the preceding rocks, and is perhaps identical with some of the dolerites which intersect the Silurian rocks of the island of Montreal. In the other parts of the Laurentian series, so far as yet examined, intrusive rocks have been but seldom met with. Much of what has been called syenite and granite in various parts of the Laurentian region, seems, like the hypersthenite and other anorthosites of the Labrador series, to be indigenous.

The dykes of this most ancient dolerite or greenstone in Grenville, have a well-marked columnar structure at right angles to the plane of the dyke. They are fine grained, dark greenish-gray in color, and weather greyish-white. Under a lens, the rock is seen to consist of a greenish-white feldspar with a scaly fracture, mingled with grains of pyroxene, occasional plates of mica, and grains of pyrites. It contains no carbonates. Two analyses of portions of the dolerite, from dykes differing a little in texture, gave as follows under XV and XVI:

	XV.	XVI.	XVII.
Silica	50.35	50.25	52.20
Alumina	17.35	32.10	18.50
Peroxyd of iron	12.50		*10.00
Lime	10.19	9.63	7.34
Magnesia	4.93	5.04	4.17
Potash	.69	.58	2.14
Soda	2.28	2.12	2.41
Volatile	.75	1.00	2.50
	99.04	100.72	99.26

The iron in these analyses, although given above as peroxyd, exists in the form of protoxyd, and in the second specimen, in part as a sulphuret. These rocks, which appear to have the composition of mixtures of a basic feldspar with pyroxene, do not differ from ordinary dolerite.

The newer dolerite, which cuts the three other classes of eruptive rocks in the Laurentian region, has a grayish-black, very fine-grained base, earthy and sub-conchoidal in fracture, and resembling somewhat the preceding. It contains small brilliant black grains of ilmenite, with others of sphene, and small scales of mica. Occasional masses of black cleavable augite, sometimes half an inch in diameter, give to the rock a porphyritic character. It contains besides, small cleavable masses of white carbonate of lime, with which the whole rock seems penetrated, When in powder, it effervesces freely in the cold with dilute nitric acid, and the solution evolves red fumes on heating. In this way there were dissolved, lime, equal to 8.70 per cent of carbonate, 0.50 of magnesia, and 6.50 of alumina and oxyd of iron = 15.70 per cent. The residue dried at 211° F, equalled 83.80 per cent. A portion of aluminous silicate had evidently been attacked by the acid. The dried residue gave on analysis the results which will be found above under XVII.

The dolerites of the Montreal district, besides forming numerous dykes, constitute the chief portions of the mountains of Mon-

* With some titanic acid.

tarville, Rougemont, and Mount Royal. In all of these however great diversities of composition are met with, which will be successively noticed.

MONTARVILLE.—The greater part of Montarville is composed of a coarse-grained granitoid dolerite, in which black cleavable augite predominates,—sometimes almost to the exclusion of any other mineral. Small portions of white feldspar, and scales of brown mica, are sparsely scattered through the rock, with grains of carbonate of lime. The removal of these by solution from the weathered surface often gives to it a pitted aspect. In other portions, the feldspathic element predominates, and the rock becomes porphyritic from the presence of large crystals of augite. The worn surfaces of the dolerite sometimes show alternations of this variety with another which is finer-grained and whiter. The two are arranged in bands, whose varying thickness and curving lines suggest the notion that they have been produced by the flow and the partial commingling of two semi-fluid masses.

Another and remarkable variety of dolerite, found at Montarville, appears to be confined to a hill on the shore of the little lake about half a mile northward from the manor-house. The whole of this hill, with the exception of some adherent portions of indurated shale, seems to be composed of a granitoid dolerite, containing a large proportion of olivine. This mineral occurs in rounded crystalline masses or imperfect crystals from one tenth to one half an inch in diameter, associated with a white or greenish-white crystalline feldspar, black augite, a little brown mica, and magnetite.

The proportion of olivine is very variable, but in some parts it is the predominant mineral. Its color is olive-green, passing into amber-yellow. The grains, which are translucent, are much fissured and very brittle. The pulverized olivine gelatinizes with chlorhydric acid in the cold, and is almost instantly decomposed when warmed with sulphuric acid diluted with its volume of water, the silica separating chiefly in a flocculent form, and enclosing small grains of the undecomposed mineral, which are left when the ignited silica is dissolved by a solution of soda. A little silica is however retained in solution, and is precipitated by ammonia with the oxyd of iron. Two analyses of different portions of the olivine made in this way gave, after deducting the undecomposed mineral, the following results:

Silica	37.13	37.17 = Oxygen	19.82
Magnesia	39.36	39.68 = "	15.87
Protoxyd of iron	22.57	22.54 = "	5.10
	99.06	99.39	

The augite of this olivinitic dolerite appears in the form of small crystalline grains, and also in short thick and terminated prisms, which are readily detached from their matrix. They are often an inch in length by half an inch in diameter, and are sometimes partially coated by a film of brown mica. These crystals cleave readily, presenting brilliant surfaces, and are black in color, with an ash-gray streak. Their hardness is 6.0, and their specific gravity 3.34. Analysis gave as follows:

Silica	49.40
Alumina	6.70
Lime	21.88
Magnesia	13.06
Protoxyd of iron	7.83
Soda and traces of potash	.74
Volatile	.50
	100.11

The augite which abounds in the non-olivinitic dolerite that forms the greater part of Montarville, does not appear to differ from that just described.

An average specimen of this olivinitic dolerite, or peridotite, was reduced to powder: it did not effervesce with nitric acid, and when ignited lost only 0.5 per cent. When gently warmed with sulphuric acid, the olivine was readily decomposed, with the separation of flocculent silica; and by the subsequent use of a dilute solution of soda, followed by chlorhydric acid, and a second treatment with the alkaline ley, 55.0 per cent of the whole were dissolved. This portion consisted of silica 37.30, magnesia 33.50, protoxyd of iron 26.20, alumina 3.00 = 100.00: being equal to 18.4 of magnesia for the entire mass. In another experiment, 18.0 per cent were obtained. Taking the mean of the two analyses of olivine above referred to, which gives 39.5 per cent of magnesia, 18.0 parts of this base correspond to 45.5 parts of olivine. The remaining 9.5 parts of dissolved matter represent alumina and silica from the feldspar, and oxyd of iron from the magnetite; both of which were somewhat attacked by the acids. The undissolved portion of the rock equalled 44.7 per cent., and appeared to consist of a feldspar, with pyroxene, some mica, and a little magnetite. Its analysis afforded silica 49.35, alumina 18.92, protoxyd of iron 4.51, lime 18.36, magnesia 6.36, loss (alkalies?) 2.50; = 100.00.

In some portions of the dolerite of Montarville, the feldspar is more abundant, and appears in slender crystals with augite, and with a smaller proportion of olivine than the last. A specimen of this variety, being crushed and washed, gave 3·9 per cent. of magnetite, and 10.0 per cent of a mixture of ilmenite with o ivine. The feldspar was obtained nearly pure, in yellowish vitreous grains, having a specific gravity of 2.73—2.74, and nearly the composition of labradorite. The results of its analysis are seen under XVIII.

	XVIII.	XIX.
Silica	53.10	53.60
Alumina	26.80	24.40
Peroxyd of iron	1.35	4.60
Lime	11.48	8.62
Magnesia	.72	.86
Potash	.71	undet.
Soda	4.24	"
Volatile	.60	.80
	99.00	....

The dolerite of Montarville is traversed by veins belonging to several different periods. In one instance, the black and highly augitic mass is cut by a dyke of a fine-grained greyish-white dolerite. This is intersected by a dyke of a fine-grained greenish rock, which, in its turn, is cut off by another small dyke which is grayish-white lik the first.

ROUGEMONT.—The rocks of Rougemont offer a general resemblance to those of Montarville. Some portions are a coarse-grained dolerite, in which augite greatly predominates, with grains of feldspar, and a little disseminated carbonate of lime. In some parts, the augite crystals are an inch or more in diameter, with brilliant cleavages; and grains of pyrites are abundant, with calcite in the interstices. This rock resembles the highly augitic dolerite of Montarville. Olivine is very abundant in two varieties of dolerite from Rougemont. One of these has a grayish white finely granular feldspathic base, in which are disseminated black augite and amber-colored olivine, the latter sometimes in distinct crystals. The proportions of these elements sometimes vary in the same specimen; the feldspar forming more than half the mass in one part, while in another the augite and olivine predominate. By the action of the weather, the feldspar acquires an opaque white surface, upon which the black shining augite and the rusty-red decomposing olivine appear in strong contrast.

The dolerite of this mountain is traversed by numerous dykes, some of which are diorites like those of Monnoir and Belœil, about to be described. A dyke of compact dolerite holding crystals of feldspar and grains of olivine, is found intersecting the strata of the Hudson River formation at St. Hyacinthe.

MOUNT ROYAL.—This hill which rises immediately in the rear of Montreal, consists for the most part of a mass of highly augitic dolerite. In some parts large crystals of augite, like those of Montarville, are disseminated through a fine-grained base, which is dark ash-gray in color; and often effervesces freely with acids, from the presence of a portion of intermingled carbonate of lime. At other times this is wanting, and the rock is a mass of black crystalline augite, constituting a veritable pyroxenite, from which feldspar is absent. Mixtures of augite with feldspar are also met with, constituting a granitoid dolerite, in parts of which the feldspar predominates, giving rise to a light grayish rock. Portions of this are sometimes found limited on either side by bands of nearly pure black pyroxenite, giving at first sight an aspect of stratification. The bands of these two varieties are found curiously contorted and interupted, and as at Montarville, seem to have resulted from movements in a heterogeneous pasty mass, which have effected a partial blending of an augitic magma with another more feldspathic in its nature.

The more augitic parts of Mount Royal contain, like the similar varieties from Rougemont and Montarville, considerable portions of magnetite, and some ilmenite. At the east end of the mountain a variety of dolerite, containing olivine, occurs. It consists of a base of grayish-white granular feldspar, which in the specimen examined constitutes about one half of the mass, and encloses crystals of brilliant black augite, and of semi-transparent amber-yellow olivine. This rock closely resembles the feldspathic peridotite of Rougemont, described above; but the imbedded crystals are somewhat larger, although less than those in the dolerite of Montarville. A portion of the feldspar, freed as much as possible from augite, furnished by analysis the result already given under XIX; which shows that it approaches labradorite in composition.

DIORITES.

YAMASKA.—It now remains to describe the diorites which have already been noticed as forming several important masses among the intrusive rocks of the Montreal group. In the first place may be considered that of Yamaska. The greater part of this mountain consists, as already described, of a micaceous granitoid trachyte; but the southeastern portion is entirely different, being a diorite made up of a pearly white crystalline translucent feldspar, with black brilliant hornblende, ilmenite, and magnetic iron. This rock is sometimes rather fine-grained, though the elements are always very distinct to the naked eye. In other parts are seen large cleavage-surfaces of feldspar half an inch in breadth, which exhibit in a very beautiful manner the striæ characteristic of the polysynthetic macles of the triclinic feldspars. The associated crystals of hornblende are always much smaller and less distinct, forming with grains of feldspar, a base, to which the larger feldspar crystals give a porphyritic aspect. Finer-grained bands, in which magnetite and ilmenite predominate, traverse the coarser portions, often reticulating; and the whole mass is also occasionally cut by dykes of a whitish or brownish-gray trachytic rock, which are often porphyritic, and may perhaps be branches from the trachytic part of the mountain.

A portion of the coarse-grained diorite selected for examination, contained, besides the minerals already enumerated, small portions of blackish mica, with grains of pyrites, and a little disseminated carbonate of lime, which caused the mass to effervesce slightly with nitric acid. The macled feldspar crystals, sometimes half an inch in length, were so much penetrated by hornblende that they were not fit for analysis; but by crushing and washing the rock, a portion of the feldspar was obtained, which did not effervesce with nitric acid, and contained no visible impurity, except a few scales of mica; its specific gravity was 2.756—2.763. It was decomposed by hydrochloric acid, with separation of pulverulent silica; and its analysis, which is given under XX and XXI, shows it to be near to anorthite, and identical in composition with the feldspar of a diorite from Bogoslowsk, in the Ural Mountains. This is associated with a greenish-black hornblende containing some titanic acid, with a little mica, and some quartz. (R. H. Scott, L. E. and D. Philos. Magazine [4], xv, 518.)

MONNOIR.—Monnoir or Mount Johnson is composed of a diorite, which, in its general aspect, greatly resembles that of Yamaska just described, except that it is rather more feldspathic. The finer-grained varieties are grayish in color, and exhibit a mixture of grains and small crystals of feldspar, with hornblende, brown mica, and magnetite. Frequently however the rock is much coarser-grained, consisting of feldspar grains, with slender prisms of black hornblende, often half an inch long and tenth of an inch broad, and numerous small crystals of amber-colored sphene. In this aggregate there are imbedded cleavable masses of the feldspar, sometimes an inch long by half an inch in breadth. At the southern foot of the mountain, large blocks of the coarse-grained diorite are found in a state of disintegration, affording detached crystals of feldspar with rounded angles, and weathered externally to an opaque white, from a partial decomposition. Near to the base of the mountain, a coarse-grained variety of the diorite encloses small but distinct crystals of brown mica; and a fine-grained micaceous variety, containing sphene, occurs near the summit.

The feldspar, in all the specimens examined from this mountain, appears to be uniform in character. Its color is white, rarely greenish or grayish; it has a vitreous lustre, inclining to pearly, and it is somewhat translucent. The cleavages of this feldspar resemble those of oligoclase, with which species it also agrees in specific gravity and chemical composition. The macled forms, so common in the crystals of triclinic feldspars, have not however been detected in the specimens from this locality. A fragment of a crystal gave a density of 2.631, and another portion in powder, 2.659. The results of its analysis are given under XXII and XXIII.

	XX.	XXI.	XXII.	XXIII.	XXIV.
Silica	46.90	47.00	62.05	62.10	58.30
Alumina	31.10	32.65	22.60	....	24.72
Peroxyd of iron	1.35		.75	....	
Lime	16.07	15.90	3.96	3.69	5.42
Magnesia	.65	....	....	....	.91
Potash	.58	....	1.80	....	2.74
Soda	1.77	....	7.95	....	6.73
Volatile	1.00	....	.80	....	.50
	99.42	....	99.91	....	99.32

BELŒIL.—The specimens which have been examined from this mountain consist of a kind of micaceous diorite. The feldspar, which so far predominates as to give a light gray color to the mass, is in white translucent vitreous cleavable grains; associated with small distinct prisms of black hornblende, scales of copper-colored mica, and grains of magnetite. The analysis of the feldspar, extracted by washing a portion of the crushed rock, and still containing a little mica, is given above under XXIV. This result approaches to those obtained from the micaceous feldspar rock of Yamaska, V and VI; which has been described as a kind of trachyte, and with the rock of Belœil seems to constitute a passage between the trachytes and diorites.

RIGAUD.—A portion of Rigaud Mountain consists of a rather coarse-grained diorite, which is made up of a crystalline feldspar, white or greenish in color, with small prisms of brilliant black hornblende, and crystals of black mica. In some specimens the feldspar, and in others the hornblende predominates. This rock resembles the diorites of Belœil and Monnoir.

The granitoid dolerites of the Montreal group, containing coarsely crystalline augite and olivine, break through the Lower Silurian strata; and portions of these two minerals, probably derived from these intrusive rocks, are found in the dolomitic conglomerates near Montreal, which in some cases include masses of Upper Silurian limestone, and are cut by dykes of a fine grained dolerite. These, which perhaps correspond to the newer dykes of the same rock at Grenville, show that there were at least three distinct eruptions of dolerite,—one during the Silurian period, one before it, and another after it. The trachytes of Montreal and Chambly appear to be still more recent than these, and to traverse the newest dolerites.

The trachytes of Brome and Shefford seem to constitute a group apart; but the diorites of Yamaska and Mount Johnson, although similar in aspect, differ widely in chemical composition. Facts are still wanting to establish the geological age of these intrusive masses. The different dolerites, which are related in mineral composition, belong as we have seen to different geological periods; and it would not be safe to affirm that the different diorites or the different trachytes of this vicinity are contemporaneous. Nor, on the other hand, should even great discordances in chemical or mineralogical constitution be necessarily regarded as establishing a difference in the age of eruptive rocks. Evidence to the contrary of this is seen in the contiguous and intermingled masses of black pyroxenite and grey feldspathic dolerite in Mount Royal and

Montarville; and it is not improbable that the olivinitic dolerite which is associated with these, may be contemporaneous. If, as has been maintained in the first part of this paper, the various intrusive rocks are only dis laced sediments of deeply-buried and probably unconformable strata, it will readily be conceived that plastic masses of very unlike characters may be ejected simultaneously along a line of disruption.

The various intrusive masses of the Montreal group which have been here described, appear, from their compact and crystalline structure, to have been displaced and consolidated under the pressure of a considerable mass of superincumbent strata. The fact that even their summits, which are in some cases more than 1000 feet above the present level of the plain, appear equally solid and crystalline with their bases, implies the removal by denudation, since the eruption of these masses, of a thickness of s diment ry strata much exceeding their present height This denudation must however have taken place before the eruption of the later trachytes and dolerites; since the dolomitic conglomerates, which enclose the fragments of the olivinitic dolerite and of Lower and Upper Silurian rocks, repose unconformably upon the Laurentian and the various Lower Silurian strata, in such a manner as to show that these offered nearly their present distribution at the epoch of the deposition of the conglomerates. If then, as is probable, the exposure by denudation of the whole of the eight hills which have been described, took place at one e och, these are all shown to have a greater antiquity than the trachytes and the dolerites, which traverse the conglomerates. The fine-grained and earthy trachytes of Montreal are consequently far more recent than the crystalline ones of Brome and Shefford; with which however, some of them agree in chemical composition.

The general absence of granite from among these intrusive masses is a fact worthy of notice. Quartz has not yet been detected in the feldspathic rocks of Brome and Shefford; although, as above mentioned, the base of the feldspathic porphyries of Chambly, and Shelburne, contains a slight excess of silica. The granitic rocks of Shipton, and of St. Joseph on the Chaudière appear to be indig nous masses, belonging to the strata of the Quebec group; but the higher fossiliferous formations to the east of the Notre Dame Mountains, are traversed in various places by veins and great masses of intrusive granite, as in Stanstead, Barford, and many other places to the northeast, and along the frontier of Canada. It is worthy of note, that the intrusive masses on the two sides of the mountain range are, so far as yet observed, entirely distinct in character; and that eruptive rocks are generally wanting among the Notre Dame Mountains, which consist chiefly of stratified rocks. It is also to be remarked, that the intrusive granites at their eastern base, are not unlike, in mineralogical characters, to the indigenous granites of the mountains; thus suggesting the view that these are possibly the source of the intrusive granites which break through the Devonian strata. A similar relation has been pointed out by Durocher, in Scandinavia, where the palæozoic strata are broken by intrusive masses of granite, orthophyre, zircon-syenite, and diorite. These rocks, according to him, are specifically analogous to those of the underlying primitive gniess, but petrographically distinct. (Bull. Soc. Géol. de France, [2], vi 33.) These facts are in accordance with the theory of eruptive rocks developed at the commencement of this paper; and it would be easy to extend the comparison to the intrusive diorites and dolerites about Montreal, and to show their resemblance with the stratified feldspathic rocks of the Labrador series. (Silliman's Journal [2], xxix, 283, and xxxi, 414.)

IV. Local Metamorphism.

In the second part of this paper I have asserted that the silicated minerals of crystalline rocks have a two-fold origin. In the first place they may result from the molecular change of silicated sediments. These are either derived from the mechanical disintegration and partial decomposition of pre-existing silicates, or have been generated by chemical processes in waters at the earth's surface. In this way steatite, serpentine, pyroxene, hornblende, chlorite, and in many cases garnet, epidote, and other silicates, are formed by a crystallization and molecular re-arrangement of chemically formed silicates, in a manner analogous to that in which mechanically derived clays are converted into crystalline species. I have however pointed out that in the second place many of these silicated minerals may be generated by chemical reactions which take place among the mechanically mixed elements of sediments under the influence of heat aided by alkaline solutions. Both of these methods are involved in rock-metamorphism; and in the case of the local alteration of rocks by igneous masses, it is easy by comparative examinations to trace the chemical changes involved in the production of silicated minerals by the second method. In this way Delesse has shown that in several cases where the chalk of Ireland has been altered by the proximity of intrusive traps, the sand and clay which the former contain have been converted into calcareous silicates. (Ann. des Mines [5], xii, pp. 189, 208, 212.)

An instructive example of this process is furnished at Montreal, where the bluish fossiliferous limestone of the Trenton group is traversed by dykes of dolerite, which are subordinate to the great intrusive mass of Mount Royal. The limestone for a distance of a foot or two, is hardened, but retains its bluish tint. Within a few inches, it is changed to a greenish-white color, which is seen to be due to a granular mineral disseminated in the white carbonate of lime. The unaltered limestones from the vicinity contain variable amounts of insoluble argillaceous matters. A specimen treated with dilute hydrochloric acid, left a residue of about twelve per cent of a fine clayey substance, colored by a small amount of carbonaceous matter, and mixed with a little pyrites, which was removed by dilute nitric acid. This residue, after ignition, gave to a solution of carbonate of soda, 9 5 per cent of its weight of soluble silica; and the insoluble portion, being submitted to analysis, gave the result I. A portion of the limestone which was near to the intrusive rock, and had become hardened and partially altered, was subjected to the action of dilute nitric acid, and gave an insoluble residue with the composition II. The more thoroughly altered greenish limestone was also treated with dilute nitric acid, which dissolved the carbonate of lime, and left a residue, the analyses of which, from two different portions of the rock, are given under III and IV.

	I.	II.	III.	IV.
Silica,	73.02	54.00	42.60	40.20
Alumina,	18.31	14.00	13.70	9.30
Lime,	.93	16.24	31.69	36.40
Magnesia,	.87	5.27	4.17	3.70
Protoxyd of iron,	traces	3.60	4.68	5.22
Potash,	5.55	3.14	undet.	undet.
Soda,	.89	1.22	"	"
Volatile,	....	.90	1.20	1.20
	99.57	98.77	98.04	95.02

The residue from the unaltered limestone, including the silica soluble in alkalies, contains nearly 75.5 hundredths of silica, and

16.5 of alumina. These, in the vicinity of the dolerite, have become saturated with protoxyd bases, including the small portions of magnesia and of oxyd of iron which the limestone contains. This process evidently involves a decomposition of the carbonate of lime, and the expulsion of the carbonic acid. It is worthy of remark that while the unaltered limestone contains a little carbonate of magnesia, the rock from which III was obtained yielded to dilute nitric acid not a trace of magnesia. II marks an intermediate stage in the process, and shows moreover that the alkalies are still retained in combination with the alumonius silicate. These granular silicates, which have been formed by local metamorphism, might, under favorable circumstances, have crystallized in the forms of feldspar, scapolite, garnet, pyroxene, or some other of the silicious minerals which so often occur in metamorphic limestones. The agent in producing these silicates of protoxyds at the expense of the carbonates of the limestone, was probably a portion of alkaline salt, either derived from the feldspathic matter of the limestone, or possibly infiltrated from the contiguous feldspathic rock; whose elevated temperature produced the reaction which has resulted in thus altering this limestone.

Similar examples of local alteration are met with in several other places near to the intrusive rocks of the Montreal group. The schists of the Utica formation in contact with a dyke of intrusive rock at Point St. Charles, and also near a mass of trachyte on a small island opposite the city of Montreal, occasionally exhibit small crystals of pyroxene, and in some cases prisms of hornblende. Among similarly altered shales at Rougemont are beds which consist of a highly ferriferous crystalline dolomite intermingled with dark-green cleavable hornblende, which forms thin layers, or in other cases encloses small rounded masses of the dolomite. (See for a description and analyses of this rock the Geology of Canada, page 634.)

At Montarville the shales of the Hudson River formation are altered in the vicinity of the dolerite which forms the mass of the mountain. Some portions of the strata are very fine-grained, reddish-brown, and have an earthy sub-conchoidal fracture, with occasional cleavage joints. The hardness of this rock is not great, and it is apparently a kind of argillite; but between two beds of it is one of a harder coarse-grained rock, greenish-gray in color, and mottled with a lighter hue. This appears to be feldspathic in composition, and is penetrated in various directions by numerous slender prisms of black cleavable pyroxene, sometimes half an inch in length. The layers of sedimentation are distinctly marked in this bed, as well as in the finer-grained strata which enclose it; and the whole affords an interesting example of the different effects of the same agency upon beds of unlike composition; although it would be impossible without comparative chemical analyses to determine whether the silicate which has here crystallized in the form of pyroxene existed in the unaltered sediment, or whether, as in the case of the uncrystallized silicate from the altered limestone at Montreal, it has been generated under the influence of the intrusive rock. In by far the greater number of cases, the only apparent effect of the igneous rocks in the region under description upon the palæozoic limestones and shales, has been a very local induration. The appearance of crystals in these circumstances is a comparatively rare occurence, and seems to depend upon conditions which are exceptional, showing, as I have elsewhere remarked, that heat and moisture are not the only condition of metamorphism. (Silliman's Journal [2], xxxvi, 219.)

With these few examples of local metamorphism I conclude the present paper; proposing however to give in a subsequent one the results of some investigations of certain indigenous crystalline rocks.

Montreal, March 15, 1864.

CHEMISTRY OF MANURES.*

CINEREAL† CONSTITUENTS OF PLANTS.—It is not however exclusively by carbon, nitrogen, and the elements of water that

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* Continued from page 124.

† This term *cinereal*, from *cineres*, ashes, may prove convenient to indicate, without periphrasis, the ash-constituents of plants in contradistinction from their volatile elements. Some writers fall into the error of employing the epithet "mineral" to denote the ash-ingredients; an error in nomenclature probably arising from some con used impression that, because of its earthy derivation, the ash of plants is more mineral in character than the volatile or gaseous elements which air supplies and fire dissipates. The illustrious author of the min ral-theory seems, in some of his earlier writings, himself to have countenanced this error. Nevertheless, its simple indication suffices for its refutation. Carbon and

plants are nourished; nor is it solely in quest of food, such as the leaves also can assimilate from the air, that the roots spread forth their manifold ramifications amidst the earth.

Liebeg first set forth, in all their peculiar interest and importance, the fixed ingredients of plants; that is the compounds which appear as ash, when the volatilizable air-derived elements of plants are burned off. These ash-ingredients constitute, as he explained, the special (though not the sole) food of the roots; and they are the only kind of nutriment which has its primary and exclusive source in the soil.

These essential ash-ingredients, so far as we yet know them. are the two fixed alkalies, potash and soda; two earthy bases, lime and magnesia; one heavy metallic base, oxide of iron; three acids, phosphoric, silicic, and sulphuric; and lastly, chlorine, which, though a gas, is always taken up by plants in fixed combinations (as for example in common salt), so as to remain in the ash or incineration.

Small as are the proportions of these fixed ingredients assimilated by plants during their growth, they are yet as necessary to the plant's development as the carbon and water which make up its main bulk. So again, as between the fixed ingredients themselves, although some of them are needed in larger, and some in smaller proportions, each species of plant having in this respect, its special requirements; although, for example, one ingredient may form more than one half the total ash of a given plant, and another less than a tenth part thereof; yet are they all equally essential to its development, which languishes as much for want of the minutest as of the bulkiest cinereal supply, Soils wholly deficient in any one of the ash ingredients of a particular plant, cannot produce that plant, howsoever abundantly every other of its elements, volatile and fixed, may be supplied. Partial deficiency of either of the normal ingredients of plant-food, whether fixed or volatile, involves a proportionately scanty crop; and no heaping of other

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carbonic acid, nitrogen, ammonia, and nitric acid, oxygen, hydrogen, and water, all appertain to the mineral kingdom, in every sense as fully as silica, potash, the phosphates, &c. The epithet "mineral" applies therefore equally to all the elements, both volatile and fixed, of plant-food; it is for the separate designation of the fixed or ash constituents, that the epithet *cinereal* is proposed. In this sense (to test its convenience) it will be employed in the remainder of this section.

manures on the soil can have the slightest effect, so long as the one ingredient, wholly or partly deficient, remains unsupplied.

Nor does the mere presence of the cinereal plant-food in the soil suffice: it must be availably present. That is, besides any portion, however large, of cinereal element, that may be held in mechanical isolation within the substance of the stones or clods, beyond the reach of the roots; or that may be locked up in chemical combination, too refractory for the solvent agencies present to subdue; besides any isolated or locked-up portion which may, in truth, be regarded as absent for all immediate purposes of nutrition; there must be a sufficiency of ash-constituents, held lightly, either by the surface-action of the moist and porous earth, or (according to another view) by the chemical attraction of the aluminous silicates, in such manner as to be, both physically and chemically, accessible to the roots. No doubt the locked-up materials of one season, may, and do become, in due course of tillage and fallowing, the accessible food of the next; and, indeed, it is to such gradually-decomposing reserves that the prolonged fertility of certain soils, worked by tillage and fallowing only, without manure, is due. But for all immediate purposes, a soil is exhausted, when, rich as it may be in the conditions of future fertility, it lacks an adequate present supply of the ash-constituents of plants, in free accessible diffusion.

HIGH FARMING: HOW FAR JUSTIFIABLE: AT WHAT POINT EXHAUSTIVE.—And here it becomes opportune to resume the question of high farming, which in a previous page was reserved for subsequent elucidation.

High farming, as already pointed out, is justifiable in so far as it serves to concentrate, within limits adapted to the assimilative powers and circumstances of annual and biennial plants, the food-supplies diffused by nature over a much wider expanse of time and space, to suit vegetation of perennial growth. But it is of the deepest importance to observe, that the more abundant crops, and apparently increased fertility usually induced by high farming, are in too many cases but the premonitory symtoms of an accelerated process of exhaustion. The semblance of prosperous husbandry thus created is as factitious as the spendthrift's ruinous magnificence maintained by squandering his capital; and "high farming," even when coupled with "high manuring," and the keeping of many cattle for their dung, is often, for the unwary husbandman, only a flowery road to destruction.

For it is to be remembered that a soil may, by the excessive use of lime, common salt, nitrates, and other solvent or disintegrant manures, as also by diligent ploughing, scarifying, crushing, and other processes of mechanical comminution, be made to yield its reserves in accessible form, at an unduly accelerated rate. The same result may ensue, if the volatile forms of plant-food, which nature supplies only in moderate annual proportion, be added in pr fusion to the soil, without due care to conjoin therewith proportionate supplies of ash-constituents, or cinereal food.

Rotation of Crops often Exhaustive.—Even the vaunted system of rotation—*i. e.*, the growth of fodder-crops alternately with cereals, these latter receiving as manure the dung of the cattle fed on the former—is but too often so carried on as to be in truth a spoliatory operation; a sort of artifice, serving only to disguise and retard the period of final exhaustion; which so far from averting, it does but make more profound. For the powerful, deeply-penetrating roots of the fodder-crops extract from the subsoil its ash-constituents; which, after passing through the bodies of the cattle, are deposited in their dung on the surface, thence to sink into the upper layers of the soil, and so to find their way to the fibres of the young, slender-rooted cereal plants; in whose grain they are finally exported from the farm.

Lois-Weedon System; its Spoliatory Character.—The so-called Lois-Weedon system of cultivation is open to similar objection. This system, as is well known, consists in the growing, year after year, upon soil which is never manured, of corn-plants thinly sown in rows, separated by wide intervals; the intervals being each year stirred and fallowed, to become the next year's growing spaces; and so on in annual alternation. This system of husbandry, which may be regarded as an extreme exemplification of Jethro Tull's doctrine, is stated to have elicited from the fields in which it is pursued, a series of full grain-crops for many years in succession. This result is in the highest degree probable. And this apparent prosperity may be kept up for a series of years, longer or shorter for each soil, as this may happen to have been originally more or less richly endowed by nature with cinereal plant-food. But the end of this method also is exhaustion,—inevitable foredoomed exhaustion,—exhaustion of which each "prosperous" crop is but an advancing stage, and whose rate the chemist measures, with stern precision, in the annually lessening weight of a little dust in the pan of a balance. Unless the weight of that dust (the available ash-constituents of the soil) remain year after year a constant quantity, the husbandman, howsoever prosperous he may seem to be, pursues a downward road; and he is fatally preparing for himself or his posterity, impoverishment and final ruin.

Disproportionate Manuring.—Nay more: the weight of ash in the balance may even be annually increased, by a profuse manuring of the soil, and yet exhaustion and ruin may impend. This will be the result, if one of the fixed aliments—phosphoric acid for example—be added to the soil in superabundance, without proportionate supplies of other cinereal constituents,—say for example, silica or potash. So, again, if manures which, like guano, are at once nitrogenous and phosphatic, but not proportionately rich in all the cinereal elements of plant-food, be employed in excess, the farming will be higher still, the crops more luxuriant, the "prosperity" more brilliant than ever, and the catastrophe proportionately nearer the more disastrous.

The practice of multiplying cattle on a farm, and of fattening them with the oil of purchased oil-cake, in order that the ash of the cake, after passing through their bodies, may become available for the cinereal replenishment of the soil, is another form of high farming, at present very much in fashion. But, broadly viewed, with reference not to individual but to collective interests, this system also will be found to originate in an oversight, and to end in an illusion. The facts overlooked are, that oil-cake purchased, is also, of necessity, oil-cake sold; that all oil-cake is the produce of land; and that, consequently, what one farm gains, another loses, when oil-cake changes hands. The ash of oil-cake, together with the fertility, immediate or prospective, which that ash represents, is a fixed quantity, which commerce may serve to distribute, but cannot possibly increase. The distributive operation may be more or less useful to vary the apportionment of fertility in space and time. But cake-fed cattle are not, as they are frequently supposed to be, a *source* of cineral manure; and the practice which grows out of this illusory belief is but one more, and not the least dangerous in its tendency, of the fashionable agricultural abuses decorated with the name of high farming.

Should high farming, in either or all of these spurious forms unhappily become prevalent among civilized nations, so as to bring about the exhaustion of extensive tracts of the earth's surface, at about the same period of time,—say, for instance, in the third or fourth generation hence; in such case the demand for cinereal manures, arising simultaneously over whole continents, would necessarily exceed all possible supplies, and incalculable misery, in the form of famine and pestilence, must ensue.

The exhaustion consequent on scanty manuring has been the theme of many exhortations; but the danger of similar evil from injudicious or excessive manuring has not been sufficiently insisted on.

One more example of this danger is all for which space can be afforded here.

The growth of the wheat-plant may be divided, like that of the biennial turnip, into three main periods;—the first, during which the growing power of the plant is chiefly employed in developing its earliest leaves and its root; the second, during which its vital force is directed to increasing its foliage and shooting forth its stalk; the third, during which flowering and fruition take place, and the grain fills with nitrogenous and amylaceous compounds,—the main objects of its culture. Now, injudicious manuring, with excess of nitrogenous compounds and of the special ash-constituents of straw, may cause such a development of stalk and leaf, and so undue a consumption, by these, of food and force required to form the grain, that, when this comes in its turn to the ripening period, the conditions of its evolution fall short, and the result is a crop of magnificent straw, with only half-filled ears.

All these dangers and disasters disappear, all perplexity ceases, and the course of the farmer becomes clear and safe, if he takes for his guidance the natural laws of husbandry,—prominent among which is that which enjoins the scrupulous restitution to the soil of the ash-ingredients removed in the crop.

Social and Political Aspects of the Question.—By ignorance or neglect of these laws, ancient families, possessed of vast estates, have been brought to ruin; distress, the perturber of dynasties, has befallen great nations; and mighty empires have fallen to decay.

It is a remarkable fact, and well worthy of the meditation of statesmen, that the line which indicates, by its rise and fall, the fluctuating price of corn in France, from year to year, during the first half of the present century, rises, at two points of time, to sudden and conspicuous eminence. Those significant pinnacles bear date 1829 and 1847. The political catastrophes which followed these two seasons of distress respectively, do not require indication. How far the precursory distress depended on inclement seasons, how far on erroneous husbandry, the reporter is not aware. But he believes that no institutions strike root deeply in a country that is badly farmed.

EMPIRICAL MANURES.—From these cursory remarks it will be apparent that manures can only be used with success, when they are applied with judgment and moderation, and with due reference, as well to the nature and condition of the soil to be amended, as to the particular description of the crop to be raised. Empirical mixtures, vaunted as suiting special crops, are likely (even when honestly composed) as often to fail as to succeed, because they are commonly employed, in blind confidence, on all kinds and conditions of soils. So extensively does haphazard prevail, as yet, in this matter, that costly ammoniacal salts or composts are often applied, without avail, to fields which a cheap dressing (say with lime or silica) would have fitted to bear a good crop. Nay, in some cases a manure may chance to be efficient by the very ingredient employed for its adulteration ; as, for instance, sand-mixed guano by its silica.

LIEBIG'S MANURES.—The history of Liebig's mineral manure —a mixture of ash-ingredients patented by the illustrious philosopher in April 1845,* as the practical embodiment of his theory published five years previously—is too remarkable to be passed in silence here. This manure is stated in the specification of the patent, to be composed of substances "containing the elements of the ashes of the plants to be grown," ground up, and "occasionally mixed with gypsum, calcined bones, silicate of potash, magnesian and ammoniacal phosphates, and common salt." Here appeared, indeed, to be the elements of a restorative, well adapted to renew, in conformity with theory, the fertility of ash-exhausted soils. Nevertheless this manure, which excited the highest anticipations, and was eagerly tried on fields innumerable, occasioned universal disappointment; and was everywhere abandoned as a failure.

* This patent (No. 10,616, April 15, 1845) is granted to J. Muspratt, as "for a communication from Justus Liebig."

Many, indeed, in the excess of their disappointment, were led to repudiate the "mineral theory" itself, and to impugn all scientific husbandry as a dangerous delusion.

It is now easy, and also in the highest degree instructive, to trace this error of the illustrious philosopher to its source in the then state of science. The special discovery, which has rendered impossible the recurrence of such an error, may also now be pointed out; and this is, in itself, of so much interest and importance that it deserves our most careful attention.

Early View of the Ingestion of Cinereal Aliment.—At the date of Liebig's patent it was universally believed that the ash-constituents of plants were supplied to the roots in moving aqueous solution; *i. e.*, in solutions permeating the soil unchanged, and meeting in its passage rootlet after rootlet, so that the tender spongioles, being immersed therein, could drink. According to this view, it was not the roots which travelled to the ash-constituents, but the ash-constituents which were carried, in solution, to the roots. This belief led Liebig to fear that the more soluble alkaline ingredients of his manure would, by the rain falling on the land, be washed away from the other ingredients, and thus separated therefrom. He therefore directed his mixture to be treated "in such a manner that the character of the alkaline matters may be changed, and the same rendered less soluble"; and he indicated, as the best mode of effecting this object, *the fusion of the materials in a reverberatory furnace.* The danger feared by Liebig was, we now know, illusory; and the treatment he adopted to avert the supposed evil was such as to render his mixture comparatively inert. It was reserved for an English chemist, John Thomas Way, to make, some five years later, the important investigation which led to the abandonment of the above-stated opinion as to the conveyance of liquid plant-food to the roots, and introduced in its stead an entirely new view of the distributive mechanism of the soil.

Absorptive Power of Soils.—Way's observation, briefly stated, was that soils possess an absorptive power, in virtue of which they withdraw from aqueous solutions of saline plant-food filtered through them, sometimes the whole, sometimes the base only, of the dissolved salt. He found that, in the latter case, the acid of the salt from which the soil had thus withdrawn the base, passed through the soil in combination with lime. By a well-devised and extensively-varied series of experiments, he determined the comparative amount of this absorptive power possessed by several varieties of soil, whether natural, or artificially composed. These he tried, both in their raw state, and burned, as also under ordinary and extraordinary conditions of compression, comminution, &c., testing each with solutions of the alkalies and alkaline earths, sometimes caustic, sometimes carbonated, sometimes in combination with the strong mineral acids. By these experiments he confirmed and extended partial observations of like kind recorded long ago by Lord Bacon and Dr. Hales, as also a number of analogous facts, experimentally ascertained by Berzelius and Matteucci abroad, and by Mr. Huxtable and Mr. H. S. Thompson in this country. Referring the reader for details to Way's * original papers on the subject, the reporter may simply state here that Way attributes this power to the peculiar properties of the aluminiferous double silicates, which he states to be more abundant in soils in proportion as these possess higher absorptive power. This interpretation of the observed phenomanon has not met with universal acceptance; many, with Liebig at their head, denying the proportionality alleged by Way, and seeing in the absorptive power of soils for salts dissolved in water, only another aspect of the physico-chemical surface-action due to their porosity, and enabling them to absorb gases and vapors from their diffusion or solution in the atmosphere. The reporter, for his own part, rather inclines to the latter view.

But the facts investigated by Way, independently of their physical conditions and theoretical interpretation, possess an importance and a generality which entitle them to rank among the most conspicuous contributions to modern agricultural science. They prove, among other things, that the plant-food arrested by the soil can be delivered only to the spongioles in immediate contact therewith: and that, consequently, these can obtain fresh food only under one of two conditions;—(*a*) when, by the growing of the rootlets, they are pushed forward into contact with fresh portions of the mould; (*b*) when the descent of rain through the soil effects the solution of fresh saline matter, and calls again into play the surface-attraction of the pores, so as to replenish those previously exhausted by the contiguous spongioles. Showers

* Royal Agric. Soc. Journ. 1850-52-55.

therefore are, in a double sense, "genial"; firstly, as liberating within the soil a fresh supply of surface-held plant-food, available for the rootlets to touch and take; secondly, as promoting the growth of the rootlets, and so moving forward thousands of spongioles simultaneously into contact with fresh food-holding surfaces.

These beautiful relations of the soil, the food, and the roots, now that they are discovered, are perceived to be so indispensable, that one almost wonders they were not arrived at by *à priori* reasoning. For, had soils been undefended by this absorptive property, the rainfall of centuries passing through them must have, ages ago, washed away every trace of their soluble salts. Subsoil drainage, so far from tending, as it does, to fertilize land, would but have exposed its sandy remnants to a lixiviating process more rapid and exhausting than even that of the natural filtration.

Distributive Mechanism of Soils.—It does not of course fall within the scope of the present rapid sketch, to trace this newly-discovered property of soils, to all its important consequences. As one example, perhaps the most striking, of these, the reporter would single out the admirable distributive influence of the absorptive power; which (counteracting in this respect the force of gravitation) tends to maintain the nutritive ingredients where they are most needed, *i. e.*, in the upper layers of the soil, leaving the surplus only to be deposited, as in a reservoir, in the layers beneath. Each layer, in fact, when saturated itself, lets pass unchanged the surplus solution, to saturate the layer next below; and so on, in progression, through the whole depth of the cultivable soil.

Reverting, with this property of soils before us, to Liebig's patented manure, we see clearly the cause of its failure. In aiming at its improvement by the reduction of its solubility, the illustrious inventor inadvertently placed himself in opposition to a law of nature. How nobly he retrieved this error will presently appear.

Distributive Mechanism of Farm-yard Dung.—Meanwhile, it is a point worth notice, that an error, similar to Liebig's, is apt to vitiate experimental comparisons between the immediate fertilizing effect of farm-yard dung, and that of the ash obtained by its incineration. The inferiority of the ash to the dung itself, as an immediate fertilizer, is commonly ascribed solely to the dissipation by fire of the volatile constituents of dung, and particularly of its ammonia; and much prominence has been given to the results of such trials, as evidence of the alleged inefficacy of cinereal supplies to corn. Among the objections to this line of argument it may be mentioned that the observed difference probably depends, in a considerable degree, on the modification by fire of the ash-constituents themselves. In the unburnt dung, composed, to a large extent, of decaying straw, the cinereal elements are diffused throughout the organic tissues, in a state of infinitesimal molecular subdivision. By the decay of the dung in the soil, the organic molecules are gradually converted into carbonic acid and water, the proper solvents of cinereal food. Thus considered, a decaying straw containing (say) five per cent. of ash-ingredients, constitutes as perfect a piece of distributive mechanism as can easily be conceived, for spreading throughout the soil the needful cinereal restoratives, along with the liquid and the gas requisite for their solution and final delivery to the roots. But this is not all. The straw acts with equal efficacy as a distributive vehicle of the urine with which it is soaked, and of the cinereal and volatile plant-food dissolved therein. Before decay, its fibrous tissues constitute a sponge, to absorb and retain, as also widely to expand, the nutrient solution; and when the sponge has brought this solution into contiguity with an extensive surface of soil it silently disappears; its solid tissues dissolve,—their capillarity, having done its office, ceases to exist,—the capillarity of the soil comes into play, and its pores delicately take up the ailment which he straw, in the act of its dissolution, as delicately deposited. Hoffmann, in one of his *Phantasiestücke*, describes a mysterious hand, which, moving in palpable substance through the air, carries a cup of food to one of the personages of his tale, and having set it down before him, vanishes into thin air. Each fragment of straw in dung acts as such a hand to the soil. The substantive, palpable vehicle melts into gas and water when its work is done. Nor is the space left empty by its disappearance without a special use: it forms a channel for the tender rootlet to travel along,—a channel which the decay of the straw at once hollows out, and warms, and lines with aliment; with aliment, as we have seen, finely divided, surface-held, and provided with its appropriate solvent.

All this delicate adjustment of means to a special end is utterly destroyed by fire, which dissipates the hydro-carbonaceous matter of straw, so that its ash-ingredients, no longer separated by intervening molecules, collapse into dust. In this form they do not occupy a hundredth part of the volume through which they were previously spread; and they are, moreover, very apt to be further compacted by actual fusion during the agitation. Farm-dung ash is particularly liable to vitrification, because its straw contains both the alkaline and silicious elements of glass. The vitreous or semi-vitreous ash thus produced by incineration is but slightly soluble. In a word, the effect of incineration on farm-dung closely resembles that produced by Liebig's furnace-treatment on his Mineral Manure.

These considerations should be attentively borne in mind, in estimating the value of experiments adduced to prove the inefficacy of the *cineral* constituents of farm-dung, as contradistinguished from its *ammoniacal* ingredients.*

THE NITROGEN THEORY, AND THE DOCTRINE OF SPECIFIC MANURES.—It is not however to be inferred from the foregoing remarks that cineral plant-food, such as Liebig's manure (or as the ash of incinerated dung), even if supplied in a perfectly soluble form, would be indiscriminately applicable to increase in an equal degree the immediate productive power of all conditions of soil, for every kind of crop. It was against this undue pretension, which was supposed to follow from some of the statements put forth in Liebig's earlier works, that the advocates of the so-called "Nitrogen theory" (who also support the doctrine of "Specific manures") originally raised their flag. It may be doubted whether the illustrious author of the mineral theory, even in his earliest

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* In pointing out the valuable distributive properties of farm-dung the reporter would not be supposed to overlook the still wider diffusion of fertilizing matters obtainable by liquid manuring. This system, indeed, has been already indicated as the principal distributive mechanism of the future. It enables the farmer to direct, from a central point radiating streams of plant-food to his remotest fields; and by the mere turning of a tap, to adopt the supply with the utmost nicety to the requirements of every plot. The cartage-cost, and manual labor incurred in spreading dung upon the soil, may thus to a great extent be replaced by steam-power; or even, in favorable cases, by the still cheaper force of gravitation. To soils requiring a carbonaceous supply such as the cattle-litter in dung affords, this material (cut up) might perhaps be economically conveyed in suspension in the liquid manure-streams. For clay, and other insoluble matters capable of suspension in water, this mode of distribution has been found available.

and crudest enunciations of that doctrine, ever committed himself to the fallacy imputed to him by the upholders of the rival system. If he did, he has long since abjured his error; or rather it has fallen, like a deciduous leaf, in the gradual ripening of his opinions during more than twenty years of experiment and research. The reporter believes that, upon this point, there exists at the present time but little real difference between the views of the contending parties; *i. e.*, between those who affirm that the ashes removed in the crop do, and those who maintain that they do not, represent the return to be made to the soil, to keep up its fertility. No two opinions, certainly, can seem more diametrically opposed than these; and at the outset of the controversy, the opposition was not only apparent but real. But for many years past, the disputants have been gradually approaching each other, by approaching the great central truths which lay between them. By the dropping, on both sides, of some earlier crudities, often perhaps rather of phrase than thought, and by the discussion, by common consent, of *matured* opinions only, many of these truths will, the reporter is convinced, be found expressible in terms acceptable to both.

With reference, for example, to the effect of cinereal manuring, both parties will certainly admit that, whether soils be rich or poor, they derive (*cæteris paribus*) from equal increments of their cinereal stock, equal absolute benefit; to be manifested, sooner or later. in equally increased production. It will also be allowed on all hands that soils, already containing enough cinereal food, in the surface-held soluble state, to supply a series of maximum crops, cannot immediately make manifest, and return, in the form of augmented produce, the value of the additional supply received. Such immediate return, it will be agreed, is to be looked for only from soils already exhausted of one or more of their cinereal ingredients; or if not absolutely exhausted thereof, at least deficient of the requisite supplies in the unlocked soluble condition, which alone renders them available for immediate assimilation by plants. Even in this case, moreover, both parties will admit that assimilation cannot take place, and there can consequently be no immediate return, except in so far as all the other conditions (ponderable and imponderable) of plant-growth are simultaneously supplied,—nitrogen among the rest. In mentioning nitrogen, we touch the very centre and throbbing heart of controversy; one party looking to Nature, the other to Art, for sufficient agricultural supplies of this element, in the form of ammonia. Yet both sides must and do admit that each acre of soil receives from nature an annual quantity of ammonia, greater or less as the seasons are more or less propitious; part being supplied by the air, in the manner already explained, part (as we may now fairly presume) being generated within the soil itself, by some reaction analogous to that observed by Schönbein.

Thus much agreed on, both parties would probably be prepared to admit, as a perfect or typical soil, for the growth of any given rotation of maximum crops, one containing a duly proportioned and available supply of all the cinereals requisite during such rotation; and on the other hand, receiving from nature, during the same period, a quantity of volatile plant-food, nitrogenous, carbonaceous, and aquatic, precisely corresponding to this cinereal supply. Assuming, of course, the mechanical and physical conditions of such a soil to be also typically perfect; and assuming it, further, to be worked during a series of typical seasons; it would evidently require only typical manuring; *i. e.*, the exact restitution, during each rotation, of the *cinereals* withdrawn by the crops. This is a proposition to which no one, at the present time, will demur. But in reality, as we all know, these various classes of typical conditions, mechanical, physical, chemical, and climatic, are never simultaneously fulfilled. Each deviation from one or more of them involves a corresponding deviation from typical manuring. Hence arises a series of special agricultural cases, as manifold as the changes on a set of bells; and an accurate knowledge of every condition, in each of any number of cases selected for comparison, is necessary for their correct interpretation. It is in the midst of these complications that oversights take place, and differences creep in. Many of these are wholly irrespective of the nature of the soil. Take for example, two experiments, otherwise (by hypothesis) equal, but made in two different counties or districts, one happening to enjoy, during the growth of the crop, a larger number of hours of unintercepted sunshine than the other; it is obvious that, notwithstanding the assumed equality on all other points, the results must differ more or less, and may differ very notably, in the two cases. Again, assume, for argument's sake, absolute equality in all the external conditions of plant-growth, but a difference in the quality of the seed employed in two trials;

evidently there will be a disparity in the results, which will appear inexplicable, or which will perhaps be attributed, by the advocates of rival theories, to this or that property of the manure employed.

But it is not necessary to go beyond the soil itself in search of such declensions from type. Defects of the soil occur, grade below grade, through all the possible varieties of poverty, down to absolute barrenness; and the characters and causes of defective fertility differ fully as much as do its innumerable degrees. One soil, for instance, will contain but a poor supply of one or more of the essential cinereal ingredients of the plants to be grown, or will even be totally deficient thereof. Another, well endowed with cinereals, duly apportioned to supply the desired rotation of crops, will be deficient of carboniferous material, or non-retentive of moisture, or not porous enough to hold a sufficient supply of air. A third, perfect perhaps in those respects, will fall short as to the peculiar physico-chemical properties necessary for the absorption, or generation, or retention therein, of ammoniacal supplies, in proper proportion to the air and water, to the carbon, and to the cinereals. All parties must assuredly admit, with respect to such soils, that their natural deficiencies, whether cinereal or ammoniacal, aerial, hygroscopic, or carbonaceous, may with propriety be artificially made good,—so far as such amendment be economically possible; and, in each such case, some particular kind of manure will of course prove specially beneficial for the growth of crops. Thus much will be conceded by those who, with Baron Liebig, most strenuously oppose the doctrine of "specific" manures. In some cases, for example, nitrogen will be "specific" for corn; though only in the same sense, and in the same degree, that lime will, in other cases, "specifically" benefit the same crop.

Again, that leguminous crops rapidly assimilate atmospheric ammonia by means of their widely-spread leafage, whereas the cereals, with their scanty foliage, are much more dependent on their roots for ammoniacal supplies,—these are facts which no one will dispute. The use of fodder-crops and cattle-feeding, as means of artificially accumulating the ammonia-supplies naturally diffused over the whole period of rotation, and bringing this concentrated provision to bear on the cereals, which could not else absorb ammonia at a sufficiently rapid rate to keep their nitrogenous on a par with their cinereal, carbonaceous, and aquatic alimentation,—this also will certainly be admitted by all.

This accumulative and distributive agency of a normal rotation of crops, growing (by hypothesis) on a typical soil, most strikingly reflects, in what may be termed the physiological mechanism of agriculture, the regulative influence exercised in mechanics by the fl -wheel; which, in like manner, during each rotation, stores up the momentum gained at the period of maximum impulsion, to give it out as work at the period of maximum resistance. Thus much being admitted by all with reference to the supposed typical soil, there will only remain for consideration the case of soils falling so far short of this hypothetical perfection, with respect to their natural ammoniferous endowments, that the total supply, including that collected by the leguminosæ, proves inadequate to meet the demand of the cereals. The utility, in such cases, of nitrogenous manures, and the propriety of the husbandman's intervention, thus artificially to make good the defect of the natural ammonia-supply, will not by any one be contested.

Thus, point by point, the main ground of difference (the alleged preponderating value of nitrogen) seems reducible to a mere statistical question;—how many European corn-fields are relatively poor in this or that cinereal? how many are deficient of humus, or water, or air? how many fall short as to their natural ammoniferous properties? Whichever element, fixed or volatile, might be indicated by the result of this inquiry, as deficient in the largest number of cases, might be described as the element of *preponderating*" importance, without violence to the opinions of either party.

This method of settling the great nitrogen-controversy would, however, still leave open for discussion a grave question concerning this element of plant-food,—a question which the intellectual forces, heretofore expended in conflict, might be usefully combined to set at rest. This question is, how much ammonia is it possible, in the present state of our industrial resources, to provide for soils not naturally well supplied therewith? If high farming is to become universal, and to be carried out on second and third class soils, at as high a pitch above their natural ammoniferous endowments, as is now aimed at in many English farms, the demand for ammonia seems likely to exceed all the means at our disposal for its supply.

The saving of urban ejecta, and the consequent return to the soil of the enormous masses of cinereals now wasted, appears likely to increase the relative demand for ammonia; especially as poor lands, of naturally low ammoniferous endowments, will probably be those selected (so far as local circumstances permit) for irrigation with town sewage. For, though sewage is rich, as well in the nitrogenous as in the cinereal constituents of the food consumed in towns, it is not proportionately so rich in the former as in the latter ingredients; the reason being that part of the ammonia of food is dissipated during the processes of animal life,* whereas all the fixed cinereal constituents that are taken into the system of adults reappear undiminished in their ejecta. Moreover, no waste necessarily attends the transit of the cinereals in solution, along the subterranean conduits, from the houses in which they are produced to the fields in which they are consumed; whereas the ammonia of sewage is liable to undergo a considerable amount of waste during its passage from town to country in the ordinary conduits; a circumstance which (it may be parenthetically mentioned) has led Mr. F. O. Ward to the belief that, in the future progress of urban organization, it will be found economical to provide separate urinary and fæcal systems; bringing thus, by a further refinement, the collective organism into closer correspondence with the individual. The probability of this ulterior improvement will, perhaps, be the more readily recognized, when it is considered that three fourths and upwards of the value of human ejecta are comprised in the urine,—only the fractional remainder in the fæces. But, as even the separation of sewage from rainfall is not yet officially admitted, it would be a premature and therefore a hopeless crusade to press, at present, for further niceties of organization. These will come in due time, when the residua of towns, now officially described as "a nuisance to be got rid of," shall be regarded in their just light as "a property to be administered,"—nay more, as the property on whose sound administration depends, in a greater degree than on any other single condition, the lasting prosperity of nations.

Reverting to the nitrogen question, should it prove true that a dissipation of ammonia takes place, as some experimentalists maintain, during the growth of cereal plants; and should this waste

* This point has been made the subject of direct experiments by Boussingault, Barral, Regnault, Reiset, and Lawes, and it may be taken as a fair average estimate, that, of the nitrogen consumed in the food, only about four fifths are recoverable in the ejecta.

be found to exceed the ammonia-accumulating power of the leguminosæ, when grown, in due proportion, in rotation with cereals; under such hypothetical conditions the drain of ammonia will doubtless, in a still larger number of cases, exceed the natural supply, and compel recourse to ammoniacal manures.

Liebig's view of the sufficiency of natural ammonia-supplies, even for the purposes of high farming, when fairly and skilfully conducted on suitable soils, is not incompatible with the opinion that artificial ammonia-supplies may become in an increasing degree the husbandman's principal requirement hereafter, under the modified agricultural conditions rapidly sketched above.

How far it may be wise to encourage the development of such a system, is a serious question. For, unless some cheap source of ammonia should be in the meantime discovered, the exhaustion of the guano-deposits (relatively a limited quantity) must, under such circumstances, bring ruinous disaster in its train. The collapse of the foundation would of necessity involve that of the edifice reared thereon; and large populations, called into existence by these factitious means, would find themselves deprived, more or less suddenly, of their accustomed food-supplies.

Considered from this point of view, the great "nitrogen question" merits the gravest consideration, not only of agriculturists, but also of statists and politicians.

Thus far the matters in dispute seem capable of settlement in terms admissible by both the contending parties; but the questions at issue comprise points, or rather perhaps are presented in forms, on which the divergences of opinion appear too wide to afford any prospect of harmonization.

Thus, for example, it is affirmed on one side, and denied, point blank, on the other, that potash acts "specifically" (*i. e.*, otherwise than in conformity with Liebig's law) in promoting the growth of the leguminous plants, such as beans and peas. Those who maintain this view allege, as their reason, that the leguminosæ, though characteristically rich in nitrogen, require potassic, not ammoniacal manures. The fallacy of this reasoning becomes apparent when it is considered, first, that the leguminous plants, absorbing as they do ammonia in abundance by their leaves, can naturally dispense with a supply of this aliment to their roots; secondly, that of all the ingredients in the ash of the leguminosæ, lime and potash are the two most prominent; so that for soils abounding in lime (as cultivated soils for the most part do) potash remains, *conformably with Liebig's law*, the characteristic manure for the leguminosæ.

The root-crops, however, and particularly turnips, are brought forward as contradictory to Liebig's law, and confirmatory of the theory of manurial "specifics"; because, though the ash of the turnip contains more potash than phosphoric acid, this plant is nevertheless found to benefit, conversely, more by artificial supplies of phosphoric acid than of potash.

"It must be admitted," say the principal champions of the doctrine specific, "that the extraordinary effect of superphosphate of lime cannot be accounted for by the idea of merely supplying it in the actual constituents of the crop, but that it is due to *some special agency in developing the assimilative processes of the plant.*"* And again they say, "It is at any rate certain that phosphoric acid, though it forms so small a proportion of the ash of the turnip, has a very striking effect on its growth when applied as manure."†

On these statements it is first to be remarked that the experimental results on which they are founded, and which were obtained at Rothamstead, are at variance with those obtained on other soils by other equally trustworthy observers. According to the best analyses of the ash of turnips (swedes), these plants may be taken to contain about 0·1 per cent. of phosphoric acid. On the other hand, ordinary superphosphate of lime contains about 16 per cent. of this ingredient in the soluble form of combination; so that three cwt. of this manure contain between fifty-three and fifty-four lbs. of immediately-available phosphoric acid. Mr. J. Russell ‡ divided a turnip-field into plots: upon one plot he applied three cwt. of superphosphate; upon two others five cwt.; upon two others seven cwt. and ten cwt. respectively. On comparing the crops yielded by the two plots equally manured, a difference of 38 cwt. was observed between their respective weights. The figure fixes the limit of variation fairly attributable in this case, to causes other than the quantity of manure employed. The plot manured with three cwt. of superphosphate yielded to Mr. Russell 480 cwt. of swedes. These would

* On Agricultural Chemistry, especially in Relation to the Mineral Theory of Baron Liebig. Journ. Roy. Ag. Soc. of England, vol. xii, part i, 1851.

† Ibid.

‡ Journ. Roy. Ag. Soc., vol. xxii, p. 86.

contain in their ash, at the above-stated proportion of 0·1 per cent., just 53·76 lbs. of phosphoric acid; a result in curiously-close correspondence with the quantity of phosphoric acid contained in the superphosphate used. The mean yield of the two plots manured with five cwt. of superphosphate each did not differ from the yield of the plot manured with only three cwt. so much as the respective products of those two plots differed from each other. Hence it appears that the addition to the soil of a larger proportion of soluble phosphoric acid than the turnip-plants could consume had no "specific" influence in promoting their growth in this case. As for the crop of the plot manured with seven cwt. of superphosphate, it not only did not exceed, but fell short by a few cwt. of the mean yield of the plots manured with five cwt. each. A still further deficit, of a few cwts., was observed in the yield of the plot manured with ten cwt. of superphosphate. Both these deficiencies, however, were less than the difference of yield by the two plots equally manured. So that in this case, the yield of the plot which received in the manure the exact quantity of phosphoric acid removed in the crop was (within the limits of experimental error) equal to the yield of plots respectively supplied with quantities 66 per cent, 133 per cent, and 233 per cent greater. Two plots which were left unmanured, on this occasion, for comparison's sake, gave a mean yield of only 330 cwt. of turnips per acre: being about one third less than the yield of the manured plots.

Hence it would appear that the turnip-plant benefits by an artificial supply of soluble superphosphate up to, but not beyond, the limit of its assimilating powers. And if it be admitted that the phosphates of the soil are in a less soluble state than the artificial superphosphate (a probable supposition), this case would seem to argue that the roots of the turnip, when simultaneously presented with different forms of phosphatic food soluble in different degrees, prefer the most soluble, and imbibe this first.

These results, in the reporter's judgment, stand in strong opposition to those obtained at Rothamstead, and tend to negative the view that phosphoric acid benefits turnips by some "specific agency," other than that due to it as a constituent of their ash.

The advocates of the "specific" doctrine, however, take up another ground. It is, they say, a universally recognized fact among farmers, that, in the ordinary course of husbandry, super phosphate—not potash—is the manure for turnips, though potash predominates over phosphoric acid in their ash. To quote their own language on this point, as given in the paper already referred to: "Common practice has," they say, "definitely determined in favor of phosphoric acid rather than of the alkalis, as the *special* manure to be provided for the turnip from sources external to the farm itself."

Admitting this case to be a very frequent one (it is certainly not universal), it appears to the reporter susceptible of an explanation, by which it falls, quite simple and readily, within the scope of Liebig's law.

For, in the ordinary course of rotation, cereals and root-crop follow each other, and alternately feed on the soil. Now the cereals, as every one knows, are greedy consumers of silica, partly for the coating of their grain, but principally for that of their straw. The cereals also assimilate phosphoric acid, and divide it in like manner between their grain and straw; this time however depositing it mostly in the grain. The silica and phosphates of the grain are, be it remembered, exported from the land. Of potash, the cereals are far less greedy than of phosphoric acid; and of the potash they do assimilate, the larger proportion is deposited in their straw, and returns in the dung to the soil. Keeping these facts in view, and considering also the original composition of fair arable soils, containing ordinary proportions of potassic silicates in course of gradual disintegration, it appears to the reporter that the cereals tend to withdraw the acid-ingredient of these silicates, leaving their alkaline bases as a bequest (so to speak) to the following generation of plants. Thus, when the root-crop enters into possession of the field, it meets with a soi recently drained of available phosphates, but not by any means exhausted of potash. What more natural, under such circumstances,—what more strictly conformable with Liebig's law,—than that soluble phosphates, not potash, should be the cinereal supply required?

Upon the whole, therefore, the reporter is constrained to believe that phosphoric acid is no more a "specific" (in any peculiar or mysterious sense) for the root-crops, than potash is for beans and peas, or nitrogen for corn. The more attentively, indeed, the facts are examined, the more strongly do they appear to confirm the grand and simple rule laid down by Justus Liebig, as the prime condition of sound and durable success in husbandry, viz., *the* *faithful restitution to the soil of the ash-constituents removed in the crops.*

Twelve years ago indeed, the leaders of the "nitrogen" school carried their doctrine so far as to declare ammonia a sufficient "substitute" for cinereal manures. "Even supposing," said they (writing in 1851)—"even supposing a mineral manure, founded on a knowledge of the ashes of plants, to be still the great desideratum, the farmer may rest contented meanwhile that he has in *ammonia*, supplied to him by Peruvian guano, by ammoniacal salts, and by other sources, SO GOOD A SUBSTITUTE."* The reporter does not hesitate to condemn the doctrine set up in this passage as one of unjustifiable spoliation.

Nine years later (in 1861)† the same writers tell the farmer that an ordinary corn-growing soil, taken as one foot deep, cultivated in the usual way, and annually exporting its whole produce of corn and meat, *without restitution of their cinereal constituents*, contains enough phosphoric acid to support this drain for 1000 years, enough potash to meet the demand for 2000 years, and enough silica to last for no less than 6000 years.

The evident tendency of these stupendous figures is to produce the impression that "restitution" to such a reservoir as this would be a mere absurdity. If the available cinereal treasures, lying within twelve inches under the soles of our feet, be really of this dazzling description, a proportionate supply of ammonia, to bring them as fast as possible into activity, may well be put forward as our chief agricultural requirement.

We are thus brought back to the nitrogen question; which, in the light of this doctrine of inexhaustibility, acquires a new and incommensurable importance. For, if we can only match our "inexhaustible" cinereals with a similar supply of ammonia, the lamp of Aladdin (so to speak) is at the disposal of mankind, and the language of Scheherzade is scarcely gorgeous enough to paint the golden future of our happy race.

To the momentous question thus raised, the prophets of cinereal plenty afford us, by their new mode of computation, the means of

* 'On Agricultural Chemistry, especially,' &c., see the preceding note.

† 'On Some Points in Connection with the Exhaustion of Soils.' 'Report of the Brit. Assoc. for the Advancement of Science' for 1861.

making a most satisfactory reply. We know, from the results of numberless analyses of soils, that wheresoever we plunge a spade ten inches deep into an average arable soil, we intersect a layer of nitrogenous plant-food, held as "availably" as the cinereal stores, and sufficient in quantity to nourish good wheat-crops, year after year, *for upwards of seven centuries.*

To this magnificent nitrogenous reserve large-handed Nature liberally adds, out of our plenteous atmospheric stores, at least two thirds of the quantity annually required, even when this is calculated at the most liberal rate of farming; so that it will take 2100 years to exhaust our underground stock of nitrogen. If therefore we have, as we are assured, phosphates for 1000 years, our ammoniacal wealth (computed by the same rule) is fully twice as great; and these figures, be it observed, do not take into account (on either side) so much as a third of the depth really explored by the absorbent roots.

Why, then, do these annual wheat-crops refuse to grow? With all this ammonia lying amongst their roots, and with cinereal supplies in similar profusion, why are these corn-plants (to use the husbandman's metaphor) so "shy?" We turn naturally to the propounders of the "inexhaustible" theory for an explanation. Alas! we find that they studiously refrain from pressing the ammoniacal half of their argument. They place at our disposal phosphates for 1000 years, potash for twenty centuries, and silica for a threefold cycle of time; but of ammonia, by the same rule similarly abundant, they will not grant us one poor century's supply, *nor, indeed, a single year's.*

They supply us, instead, with the curious fact, that an artificial saline dressing, calculated to supply to a cornfield "100 lbs. of ammonia per acre," and "only increasing the percentage of ammonia in the soil by 0·0007,"—a chemically inappreciable addition,—will give "*a produce at least double that of the unmanured land.*"* Thus, with the ammonia of *centuries* crowded into a span-deep layer beneath our feet, we have still to go, money in hand, year by year, to the gas-works or the guano-stores for each succeeding crop's supply.

One consolation remains. Though ammonia, the "good substitute" for cinereals, is withheld, and the application of the "in-

* 'On Agricultural Chemistry,' &c., loc. prec.

exhaustible" theory to this, "the most precious" of plant-foods, is forbidden, we have still our grant of cinereal treasures to fall back on. To these, at least, the "inexhaustible" theory does apply; for are not its magnificent conclusions before us, stated in figures by its creators themselves?

There is in this much comfort. For, of the ammonia we need, Nature supplies, after all, the major part; whereas, of the cinereals, every ounce exported from the fields by man, must be by man, at his own cost, restored.

But this comfort also is snatched from us! Our gravely demonstrated cinereal wealth,—our "inexhaustible" treasure of silica, potash, and the phosphates, turns out to be as impalpable as the ammonia itself. Like conjurers' money, this treasure also vanishes out of our hands, even while we are trying to count it.

Who then deprives us of this, the remaining moiety of our agricultural fortune? Can it be that the theorists who gave it us, themselves also take it away? It is even so. The promulgators of the grand doctrine of cinereal affluence, caution us *not to act on it.* They tell us that they do not adopt it "in practice" for their own guidance; and we learn with sorrow, from their own pre-cited paper, the disastrous issue of an attempt, continued during eighteen years to carry it into effect:—

"They [the authors of the paper] had grown wheat for eighteen years consecutively on the same land, respectively without manure, with farm-yard manure, and with different constituents of manure, and they had determined the amounts of the different mineral constituents taken off in the crop from the respective plots. Numerous tables of the results were exhibited. * *

"Turning," they add, "to the bearing of the results on the main subject of inquiry, it appeared that when ammonia-salts were used alone, year after year, on the same land, the composition of the ash, both of the grain and straw, showed *an appreciable decline in the amount of phosphoric acid*, and that of the straw *a considerable reduction in the percentage of silica.*" Further on in the same paper, the farmer is told that the experimentalists "do not recommend such exhaustive practice as that quoted from their own experiments." Ten years previously (in 1851) the "inexhaustible" theory was in a more vigorous stage of its existence. Then the colossal reserves were only deemed liable to contingent exhaustion, in the double event, first of the discovery (not yet accomplished) of "a cheap source of ammonia"; and, secondly, of the "excessive" use of such newly-found nitrogenous supplies: in which case, said the theorists, "the available mineral [cinereal] constituents might, in their turn, become exhausted."—(*loc. prec.*)

Reverting to the paper of 1861 for one more quotation,—and it shall be the last,—the doctrine that nitrogen is a "specific" for corn, and a "good substitute" for cinereals, is, in tolerably explicit terms, abandoned by its authors themselves; who, after referring to the comparative crops they obtained by means of (1) *ammonia salts* alone, and (2) *mineral* [cinereal] constituents only, thus epitomise their experience:—

"But in neither of these cases was there anything like the amount of mineral constituents obtained in the crop, that there was when the ammonia-salts and mineral manures were used together, or when farm-yard manure was employed."

To sum this matter up in plain words: the "good substitute" for cinereals, put forth in 1851, has had a fair trial, and has failed. Ammonia, judged by the experiments of its advocates (as well as by many other trials), proves not to be, as was alleged, a "specific" manure for corn. The "specific" value of potash and the phosphates, for leguminous and root crops respectively, stands equally disproved. Corn and meat cannot be continuously exported from soils for 6000, 2000, or 1000 years, without restitution (respectively) of the silica, potash, and phosphates, removed in their tissues from the soils. These illusory views, which their advocates (to do them justice) have already, to a large extent, honorably renounced, must be utterly abandoned. The celebrated "nitrogen theory" is at an end; and with it falls also the doctrine of "manurial specifics."

We now know that the costliest ammoniacal salt, and the cheapest and commonest of the cinereals (say for example silica or lime), judged by the spongiole of a plant's root, are of precisely equal value;—each priceless, so far as essential to the plant's nutrition; each worthless, as to every molecule beyond.

We know also that the great law of RESTITUTION applies equally to fixed and volatile, to scarce and to abundant, ingredients of plant-food; though the fulfilment of that law devolves unequally on man and nature, in every different case.

We know that the prosperity of the crop, which represents *dividend*, is but a delusive test of fertility, unless it be accompanied by the prosperity of the soil, which represents *capital*.

Every excess, whether on the side of expenditure or capitalisation, whether on the side of over-cropping the land or of unduly augmenting its reserves, is equally a dereliction of agricultural duty, and equally reprehensible as a form of *waste*. For, if disproportionate expenditure dissipates the substance of wealth in space, disproportionate capitalization (the miser's fault) squanders its usufruct in time. It is therefore our duty to call forth and consume the largest crops we can; but only and always on the condition of not infringing on the reserves of the soil. If, through indolence, we fail to produce the largest possible supply of food for the consumption of the present generation, we retard, *pro tanto*, the multiplication of our race, and fail in our duty to the unborn. If, on the other hand, greed of immediate gain tempt us to reduce the mineral balance in the soil (of which, be it, remembered, we are not *owners* but *trustees*), we equally sin against the unborn, by devouring their inheritance. We owe to our fathers, and we are bound to pay to our children, who are also theirs, a double debt,—life, and the means of its support. A generous race as scornfully disdains to hand down to its posterity an impoverished soil, as a degenerate blood. The nitrogen theory failed to recognize these principles, and hence its downfall.

Sewage-Manure Experiments at Rugby.—If, from the point of view now reached, attention be given to the course of experiments recently undertaken, and still in progress, at Rugby, to determine the value of sewage-manure, it will be readily perceived that these experiments are based on a misconception, as well of the problem to be solved, as of the experimental method which alone is adequate to its conclusive solution.

The nature of this twofold misconception is sufficiently manifested in the tests of value exclusively appealed to in these trials. These tests are, on the one hand the quantity, and on the other hand the quality, of the crops raised upon measured areas of land, under the influence of different volumes of sewage, as compared with the yield of a similar area kept purposely unmanured.

A few years ago this method would have met with very general approbation and concurrence. But in the present state of agricultural knowledge its fallacy will be readily perceived. We are now aware that the value of a manure does not bear any such fixed and exclusive relation, as the method in question supposes, to its immediate influence on the crop. The reader who has accompanied the reporter through the foregoing pages of this section will be prepared to recognize that, under conditions of frequent occurrence, a luxuriant crop, obtained by the use of an artificial manure, so far from manifesting increased fertility, may but be the sign and measure of accelerated exhaustion. He will also understand that a manure may have added not a single sheaf to the harvest, not so much as one blade to the yield of hay, and yet may have solved the great problem of agriculture, by exactly balancing the drain made on the soil by the crop.

An unlimited supply of the former manure might be a positive curse to a nation, by tempting them unduly to exhaust their soil. The gratuitous gift of the latter, on the contrary, in due adaptation to every field, would be the most precious boon a nation could receive; because it would place their agriculture on a footing of perdurable prosperity.

It may however be urged that the object of the Rugby experiments is simply to determine the intrinsic value of the Rugby sewage; meaning its degree of richness in available plant-food of all kinds, or its absolute crop-increasing power. And this information, it may be contended, the direct test to which the sewage is brought at Rugby (and which may be compendiously termed the *crop-test*), seems, at all events, well adapted to elicit.

But a very brief consideration of the matter, in the light of the above-stated principles, will suffice to show that these reasonings also are illusory; and that the crop-test, of itself, cannot afford any reliable or conclusive information as to the crop-increasing power of sewage.

For the benefit resulting to any given crop, from the use of any given manure, will vary from absolutely *nil* up to the maximum attainable effect, according to the nature and composition of the soil, which, in the Rugby experiments, does not appear to have been determined. The richer the soil of the experimental fields, the poorer must the Rugby sewage seem; because, however rich this sewage may be, the increase it can determine in the crop depends, not merely on the wealth it brings, but also on the want which it supplies.

The blowing sands at Craigentinny, manured with the Edinburgh sewage, want every form of plant-food but silica, and contain even that only in its insoluble variety. It is, accordingly, on these sands that the richest increase ever obtained by means of sewage has been achieved. It is impossible to infer from this increase what the effect of the Edinburgh sewage would be on the grass-crop of the Rugby meadows; or on any other crop elsewhere. Still less can the crops obtained, either at Craigentinny or Rugby, afford of themselves the slightest indication of the *area* to which the sewage of the British population is due.

It is not necessary, and it might seem invidious, to pursue these reasonings further, or to trace in minuter detail the erroneous conditions, which involve in doubt, and render inconclusive, the trials in progress at Rugby. Those trials are carried on by a body of able men, who will doubtless improve their method as they proceed. The reporter however is anxious, in quitting this subject, to record his conviction that no experiments on sewage can determine its value, or settle the problem of its utilization, unless the measurement of its influence on the *crop* be conjoined with that of its effect on the *soil;* unless, in other words, the maintenance of capital receive a share of attention, as well as the increase of expenditure; unless, to sum up all, we approach this question, not merely in the hope of advantage to ourselves, but also under a deep sense of our duty to posterity.

TRIBUTE TO MESSRS. LAWES AND GILBERT.—Having spoken in condemnatory terms of the "nitrogen theory," and of the doctrine of "manurial specifics," and having declared these theories, to the best of his judgment, defunct, the reporter is anxious in justice to add, that their career, if brief, has been brilliant; that they have been advocated courageously and conscientiously, in single desire to arrive at the truth; and that the princely experiments undertaken for their support, if they have failed in establishing untenable propositions, have nevertheless elicited incidental and collateral results, of very high interest and importance. Twenty years of indefatigable labor in a difficult field of research entitle Messrs. Lawes and Gilbert to an ample tribute of public recognition. It is indeed impossible to believe that reasoners so acute, and experimentalists so persevering, will long continue to maintain the slightest remnants of a doctrine so manifestly opposed to the laws of nature. In this respect their eminent antagonist, who, in 1845, found himself in a similar predicament,—*i. e.*, in unwitting opposition to a law of nature (as above explained),—has set a noble example.

HOMAGE TO JUSTUS LIEBIG.—The correction of his error by Way, Liebig frankly and unhesitatingly accepted. His genius instantly appreciated the value of the English chemist's observation; and shed upon it so bright a light as may be said to have doubled its importance. Liebig, in fact, studied the new truth in all its bearings, supplied its most generally-received interpretation, displayed its momentous consequences, elevated it to the rank of a law of nature, and embodied this law as one of the corner-stones of his great edifice.

Probably, in all Liebig's illustrious career, no incident bears higher testimony than this to the vigor and fertility of his intellect, to his undeviating candor, and to his disinterested solicitude, on all occasions, for truth and truth alone.

The writer would, indeed, be doubly untrue to his functions as reporter on this occasion, and to his feelings as Liebig's countryman and former pupil, if he failed to acknowledge here, in a few words uttered from his heart, the debt of Europe—nay, of mankind at large—to the illustrious regenerator of agriculture. Continuing the work of his revered predecessors, Lavoisier and Sir Humphrey Davy, Liebig has nobly trod the arduous path which it was their glory to point out. And, side by side, as long as husbandry shall last, will these three names shine in co-equal glory,—ANTOINE LAVOISIER, HUMPHREY DAVY, JUSTUS LIEBIG. To Lavoisier belongs the noble initiation of the work; to Davy, its splendid prosecution; to Liebig, its glorious consummation. Embracing in his masterly induction the results of all foregone and contemporary investigation, and supplying its large defects by his own incomparable researches, Liebig has built up on imperishable foundations, as a connected whole, the code of simple general laws on which regenerated agriculture must henceforth for all time repose.

In speaking thus of his illustrious countryman and revered master, the reporter does not fear to be misunderstood. No narrow spirit of patriotism animates his words. Genius, indeed, in its highest manifestations, transcends mere national boundaries; kingdoms are too narrow to be its birthplace; and in the homage it receives, not this or that country, or continent, or hemisphere, but humanity at large, is exalted.

NATURAL HISTORY SOCIETY.

Annual Meeting.

The annual meeting of the Society was held in its rooms on the evening of May 18th, Principal Dawson, President, in the chair. A large number of the members were present. Mr. J. F. Whiteaves, the Recording Secretary, read the minutes of the last annual meeting; after which the usual annual address of the President was read, as follows:—

Address of the President.

Gentlemen,—I labor on this occasion under the disadvantage of having had twice in succession to prepare the annual address of the President; a circumstance which should not ordinarily occur in a society of this character, in which, following the usage of our older sisters, we should endeavor to have a new mind brought to bear on this work in each successive year. I shall however take advantage of this circumstance to deviate somewhat from the course usual with us on such occasions, and, after merely glancing at the scientific work of the Society, to direct your attention to some speculations of my own on subjects now attracting the attention of naturalists.

The scientific papers laid before this Society in its session just concluded, if not quite so numerous as in some previous sessions, are not inferior in point of interest and importance. In geology, Sir William Logan has continued in our journal the discussion of the age and distribution of the Quebec Group of Rocks. Dr. Hunt has given further and important facts in chemical geology. Professor Bell has illustrated certain portions of the superficial deposits, and has described one of our most important quarries of roofing-slate. Mr. McFarlane has contributed an elaborate discussion of the interior condition of our planet and of the mode of formation of Metamorphic and Igneous Rocks. Professor Bailey has elucidated an obscure portion of the Geology of New Brunswick, indirectly of much interest to Canadian geologists. Mr. Billings has contributed a paper on a disputed genus of Brachiopods. Professor How has given us Analyses of Mineral Waters in Nova Scotia. Mr. Jones has sent us an interesting paper on the geological importance of Ocean Currents. I have myself occupied some space in our proceedings with my researches on Reptiles and Plants of the Coal-Period; and in connection with these, I would desire to say here that I regard the conclusions of Dr. Hunt in his short but valuable paper on the Climate of the Paléozoic period as of great importance. Whatever views we may adopt as to the original heated condition of the earth, if we take into account the enormous length of time required by the calculations of physicists * for the reduction of the earth's temperature even one degree, it seems chimerical to suppose that any appreciable effect on climate could have been produced by internal heat in the coal-period. Yet the character and distribution of the flora of that period would appear to imply a comparatively high and equable temperature in the northern temperate and sub-arctic zones. Now if the experiments of Tyndall, cited by Dr. Hunt, can be taken to establish that a small percentage of carbonic acid and an additional amount of aqueous vapour diffused through the atmosphere would largely economise the solar heat by preventing radiation, and thus give conditions similar to those of a glass-roofed conservatory, we have in this consideration, in connection with the known distribution of land and water in the carboniferous era, a sufficient cause for any difference of climatal conditions required by the flora. To appreciate more fully the value of this suggestion, it would be necessary to make experiments as to the amount of carbonic acid which might be beneficially present in the air, in the case of plants like those of the coal-period, for instance Ferns, *Lycopodiaceæ* and *Cycadaceæ*, and also to calculate the effect of such proportion of carbonic acid in impeding radiation.

Before leaving the work of the Society in the past year, I must not omit to mention that we have not neglected zoölogy and botany; and among contributions of this kind I could have wished to notice at some length those of Mr. Packard on the Marine Invertebrates of Labrador, and of Professor Lawson on Canadian Botany.

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* For example, those of Poisson and Hopkins, which would give 100,000,000,000 of years for a diminution of one to three degrees of temperature.

By far the most important publication of the past year, in the Natural History of Canada, has been the great Report of the Geological Survey, a work in which, as the achievement of members of this Society, we may very well take pride; and on which we may congratulate ourselves as facilitating the labors of those among us who pay attention to geology, either with a view to practical or scientific results, and as greatly raising the scientific reputation of this country.

The Report of the Survey has already been reviewed in the *Naturalist*, and I propose here not so much to say anything as to its general merits, as to refer to a few points in Canadian geology to which it directs our attention.

One of these is the discovery of fossils in the old Laurentian rocks, heretofore usually named *Azoic*, as being destitute of life, and much older than any rocks known to contain fossils. The oldest remains of living beings, until this discovery, had been found in rocks known as Cambrian, or Primordial, and equivalent in age to our oldest Silurian of Canada, or at the most to our Huronian. But the Huronian series in Canada rests on the upturned edges of the Laurentian, which had been hardened and altered before the Huronian series was deposited. Again, Sir William Logan has shown that the Laurentian system itself contains two distinct series of beds, the upper of which rests unconformably on the lower. There are thus in Canada at least two great series of rocks, of such thickness as to indicate two distinct periods each of vast length, below the lowest fossiliferous rocks of other countries. Yet in the lowest of these so-called Azoic groups fossils have now been found; Canada thus distancing all other parts of the world, so far as yet known, in the antiquity of its oldest fossils.

I have had the happiness to submit these remarkable specimens to microscopic examination, at the request of Sir W. E. Logan, and have arrived at the conclusion that they are of animal nature, and belong to the very humblest type of animal existence known, that of the *Rhizopods*, though they far outstrip in magnitude any known modern representatives of that group. The discovery of this remarkable fossil, to be known as the *Eozoön Canadense*, will be one of the brightest gems in the scientific crown of the Geological Survey of Canada.

In connection with this subject, it is to be observed that the grand order of succession in the Laurentian system seems to be the same with that so often repeated in other parts of the geological scale,—coarse fragmentary beds represented by conglomerate and gneiss; calcareous and fossiliferous bands represented by the Eozoön limestones; and finer earthy deposits, represented by felspathic rocks. This brings the Laurentian into a cycle somewhat similar to that of the Potsdam sandstone, the Chazy and Trenton limestone, and the Utica slate and Hudson River in the Lower Silurian; or to that of the Medina sandstone, the Niagara limestone, and Lower Helderberg in the Upper Silurian; or to that of the Oriskany sandstone, Corniferous limestone, and Hamilton and Chemung groups in the Devonian; or to that of the Lower Carboniferous conglomerates and sandstones, the Carboniferous limestones, and the Coal-measures in the Carboniferous period. This recurrence of cycles of deposit cannot be accidental. It is more or less to be seen throughout the geological scale, and in all countries; and as I have elsewhere pointed out, it includes numerous subordinate cycles within the same formation, as in the coal-measures. Eaton, Hunt, and Dana have referred to it; but it deserves a more careful study as a means of settling the sequence of oscillations of land and water in connection with the succession of life. It will also be important in giving fixity to our geological classifications, and may eventually aid in establishing more precise views of the dynamics of geology and of the lapse of geological time. The progress of the earth has, like most other kinds of progress, been not by a continuous evolution, but by a series of cycles, of great summers and winters, or days and nights, of physical and vital changes, in each of which all things seem to revolve back to the place of beginning; only to begin a new cycle or new turn of a spiral, similar to the last in its general course, though altogether different in its details, accompaniments, and results.

There is another subject of great geological importance on which the publication of the Report enables strong ground to be taken. I refer to the conditions under which the *Boulder-Drift* of Canada was deposited. It has been customary to refer this to the action of ice-laden seas and currents, on a continent first subsiding and then re-elevated. But this opinion has recently been giving way before a re-assertion of the doctrine that land-glaciers have been the principal agents in the distribution of the boulder-drift, and in the erosions with which it was accompanied. I confess that I have steadily rejected this last doctrine; being convinced that insuperable physical and meteorological objections might be urged against it, and that it was not in accordance with the facts which I had myself observed in Nova Scotia and in Canada. The additional facts contained in the present Report enable me to assert with confidence, though with all humility, that glaciers could scarcely have been the agents in the striation of Canadian rocks, the transport of Canadian boulders, or the excavation of Canadian lake-basins. In making this statement I know that I differ in some degree from many of my geological friends, but I know that they will be rejoiced that I should freely and frankly state the reasons of my belief.

The facts to be accounted for are the striation and polishing of rock-surfaces, the deposit of a sheet of unstratified clay and stones, the transport of boulders from distant sites lying to the northward, and the deposit on the boulder-clay of beds of stratified clay and sand, containing marine shells. The rival theories in discussion are—*first*, that which supposes a gradual subsidence and re-elevation, with the action of the sea and its currents, bearing ice at certain seasons of the year; and, *secondly*, that which supposes the American land to have been covered with a sheet of glacier several thousands of feet thick.

The last of these theories, without attempting to undervalue its application to such regions as those of the Alps or of Spitzbergen or Greenland, has appeared to me inapplicable to the drift-deposits of eastern America, for the following among other reasons:

1. It requires a series of suppositions unlikely in themselves and not warranted by facts. The most important of these is the coincidence of a wide-spread continent and a universal covering of ice in a temperate latitude. In the existing state of the world, it is well known that the ordinary conditions required by glaciers in temperate latitudes are elevated chains and peaks extending above the snow-line; and that cases in which, in such latitudes, glaciers extend nearly to the sea-level, occur only where the mean temperature is reduced by cold ocean-currents approaching to high land, as for instance in Terra del Fuego and the southern extremity of South America. But the temperate regions of North America could not be covered with a permanent mantle of ice under the existing conditions of solar radiation; for even if the whole were elevated into a table-land, its breadth would secure a suffi-

cient summer heat to melt away the ice, except from high mountain-peaks. Either then there must have been immense mountain-chains which have disappeared, or there must have been some unexampled astronomical cause of refrigeration, as, for example, the earth passing into a colder portion of space, or the amount of solar heat being diminished. But the former supposition has no warrant from geology, and astronomy affords no evidence for the latter views, which besides would imply a diminution of evaporation militating as much against the glacier-theory as would an excess of heat. An attempt has recently been made by Professor Frankland to account for such a state of things by the supposition of a higher temperature of the sea, along with a colder temperature of the land: but this inversion of the usual state of things is unwarranted by the doctrine of the secular cooling of the earth; it is contradicted by the fossils of the period, which show that the seas were colder than at present; and if it existed, it could not produce the effects required, unless a preternatural arrest were at the same time laid on the winds, which spread the temperature of the sea over the land. The alleged facts observed in Norway, and stated to support this view, are evidently nothing but the results ordinarily observed in ranges of hills, one side of which fronts cold sea-water, and the other land warmed in summer by the sun.

2. It seems physically impossible that a sheet of ice, such as that supposed, could move over an uneven surface, striating it in directions uniform over vast areas, and often different from the present inclinations of the surface. Glacier-ice may move on very slight slopes, but it must follow these; and the only result of the immense accumulation of ice supposed, would be to prevent motion altogether by the want of slope or the counteraction of opposing slopes, or to induce a slight and irregular motion toward the margins or outward from the more prominent protuberances.

It is to be observed, also, that, as Hopkins has shown, it is only the *sliding* motion of glaciers that can polish or erode surfaces, and that any internal changes resulting from the mere weight of a thick mass of ice resting on a level surface, could have little or no influence in this way.

3. The transport of boulders to great distances, and the lodgment of them on hill-tops, could not have been occasioned by glaciers. These carry downward the blocks that fall on them from wasting cliffs. But the universal glacier supposed could have no such

cliffs from which to collect; and it must have carried boulders for hundreds of miles, and left them on points as high as those they were taken from. On the Montreal Mountain, at a height of 600 feet above the sea, are huge boulders of feldspar from the Laurentide hills, which must have been carried 50 to 100 miles from points of scarcely greater elevation, and over a valley in which the striæ are in a direction nearly at right angles with that of the probable driftage of the boulders. Quite as striking examples occur in many parts of this country. It is also to be observed that boulders, often of large size, occur scattered through the marine stratified clays and sands containing sea-shells; and whatever views may be entertained as to other boulders, it cannot be denied that these have been borne by floating ice. Nor is it true, as has been often affirmed, that the boulder-clay is destitute of marine fossils. At Murray Bay and St. Nicholas, on the St. Lawrence, and also at Cape Elizabeth, near Portland, there are tough stony clays of the nature of true "till," and in the lower part of the drift, which contain numerous marine shells of the usual Post-pliocene species.

4. The Post-pliocene deposits of Canada, in their fossil remains and general character, indicate a gradual elevation from a state of depression, which on the evidence of fossils must have extended to at least 500 feet, and on that of far-travelled boulders to nearly ten times that amount. while there is nothing but the boulder-clay to represent the previous subsidence, and nothing whatever to represent the supposed previous ice-clad state of the land, except the scratches on the rock surfaces, which must have been caused by the same agency which deposited the boulder-clay.

5. The peat deposits with fir-roots, found below the boulder-clay in Cape Breton, the remains of plants and land-snails in the marine clays of the Ottawa, and the shells of the St. Lawrence clays and sands, show that the sea at the period in question had much the temperature of the present arctic currents of our coasts, and that the land was not covered with ice, but supported a vegetation similar to that of Labrador and the north shore of the St. Lawrence at present. This evidence refers not to the later period of the Mammoth and Mastodon, when the re-elevation was perhaps nearly complete, but to the earlier period contemporaneous with or immediately following the supposed glacier-period. In my former papers on the Post-pliocene of the St. Lawrence, I have

shown that the change of climate involved is not greater than that which may have been due to the subsidence of land, and to the change of course of the Arctic current, actually proved by the deposits themselves.

These objections might be pursued to much greater length; but enough has been said to show that there are in the case of northeastern America, strong reasons against the existence of any such period of extreme glaciation as supposed by many geologists; and that if we can otherwise explain the rock striation and polishing, and the formation of fiords and lake-basins, the strong points with these theorists, we can dispense altogether with the portentous changes in physical geography involved in their views, and which are not necessary to explain any of the other phenomena.

It is on these points more especially, that the Report of the Geological Survey throws new light; though Sir William, with his usual caution, has not committed himself to theoretical conclusions; and in one or two local cases he seems to favor the glacier theory. It has long been known to geologists, that in northeastern America, two main directions of striation of rock-surfaces occur, from northeast to southwest, and from northwest to southeast; and that locally the directions vary from these to north and south and east and west. Various attempts have been made, but without much success, to account for these directions of striation by the motion of glaciers; and while it is quite easy for any one prepossessed with this view to account in this way for the striation in a particular valley or part of a valley, yet so may exceptional facts occur as to throw doubt on the explanation, except in the case of a few of the smaller and steeper mountain-gorges.

In the Report of the Survey of Canada a valuable table of these striations is given, from which it appears that they are locally distributed in such a way as to throw a decided gleam of light on their origin.

It would seem that the dominant direction in the valley of the St. Lawrence, along the high lands to the north of it, and across western New York, is northeast and southwest; and that there is another series of scratches running nearly at right angles to the former, across the neck of land between Georgian Bay and Lake Ontario, down the valley of the Ottawa, and across parts of the Eastern Townships, connecting with the prevalent southeast striation which occurs in the valleys of the Connecticut and Lake Champlain, and elsewhere in New England. What were the determining conditions of these two courses, and were they contemporaneous or distinct in time? The first point to be settled in answering these questions, is the direction of the force which caused the striæ. Now, I have no hesitation in asserting, from my own observations as well as from those of others, that for the southwest striation the direction was *from the ocean toward the interior, against the slope of the St. Lawrence valley*. The crag-and-tail forms of all our isolated hills, and the direction of transport of boulders carried from them, show that throughout Canada the movement was from northeast to southwest.* This at once disposes of the glacier-theory for the prevailing set of striæ; for we cannot suppose a glacier moving from the Atlantic up into the interior. On the other hand, it is eminently favorable to the idea of ocean drift. A subsidence of America, such as would at present convert all the plains of Canada and New York and New England into sea, would determine the course of the Arctic current over this submerged land from northeast to southwest; and as the current would move *up a slope*, the ice which it bore would tend to ground, and to grind the bottom as it passed into shallower water; for it must be observed that the character of slope which enables a glacier to grind the surface, may prevent ice borne by a current from doing so, and *vice versa*.

Now we know that in the Post-pliocene period eastern America was submerged, and consequently the striation at once comes into harmony with other geological facts. We have of course to suppose that the striation took place during submergence, and that the process was slow and gradual, beginning near the sea and at the lower levels, and carried upwards to the higher grounds in successive centuries, while the portions previously striated were covered with deposits swept down from the sinking land or dropped from melting ice. It would be easy to show that this view corresponds with many of the minor facts.

Farther, the facts thus ascertained account for the excavation of the deep and land-locked basins of our great American lakes. Ocean currents, if cold, and clinging to the bottom, must cut out pot-holes, just as rivers do, though geologists are too apt to limit their function to the throwing up of banks. The course

* The few exceptional cases appear to belong mostly to the later period of the stratified sands.

of the present arctic current along the American coast has its deep hollows as well as its sand banks. Our American lake-basins are cut out deeply into the softer strata. Running water on the land would not have done this, for it could have no outlet; nor could this result be effected by breakers. Glaciers could not have effected it; for even if the climatal conditions for these were admitted, there is no height of land to give them momentum. But if we suppose the land submerged so that the Arctic current, flowing from the northeast, should pour over the Laurentian rocks on the north side of Lake Superior and Lake Huron, it would necessarily cut out of the softer Silurian strata just such basins, drifting their materials to the southwest. At the same time, the lower strata of the current would be powerfully determined through the strait between the Adirondac and Laurentide hills, and, flowing over the ridge of hard rock which connects them at the Thousand Islands, would cut out the long basin of Lake Ontario, heaping up at the same time in the lee of the Laurentian ridge, the great mass of boulder-clay which intervenes between Lake Ontario and Georgian Bay. Lake Erie may have been cut by the flow of the upper layers of water over the Middle Silurian escarpment; and Lake Michigan, though less closely connected with the direction of the current, is, like the others, due to the action of a continuous eroding force on rocks of unequal hardness.

The predominant southwest striation, and the cutting of the upper lakes, demand an outlet to the west for the Arctic current. But both during depression and elevation of the land, there must have been a time when this outlet was obstructed, and when the lower levels of New York, New England, and Canada were still under water. Then the valley of the Ottawa, that of the Mohawk, and the low country between Lakes Ontario and Huron, and the valleys of Lake Champlain and the Connecticut, would be straits or arms of the sea, and the current, obstructed in its direct flow, would set principally along these, and act on the rocks in north and south and northwest and southeast directions. To this portion of the process I would attribute the northwest and southeast striation. It is true that this view does not account for the southeast striæ observed on some high peaks in New England; but it must be observed that even at the time of greatest depression, the Arctic current would cling to the northern land, or be thrown so rapidly to the west that its direct action might not reach such summits.

Nor would I exclude altogether the action of glaciers in eastern America, though I must dissent from any view which would assign to them the principal agency in our glacial phenomena. Under a condition of the continent in which only its higher peaks were above the water, the air would be so moist, and the temperature so low, that permanent ice may have clung about mountains in the temperate latitudes. The striation itself shows that there must have been extensive glaciers as now in the extreme Arctic regions. Yet I think that most of the alleged instances must be founded on error, and that old sea-beaches have been mistaken for moraines. I have failed to find even in the White Mountains any distinct sign of glacier action, though the action of the ocean-breakers is visible almost to their summits; and though I have observed in Canada and Nova Scotia many old sea-beaches, gravel-ridges, and lake-margins, I have seen nothing that could fairly be regarded as the work of glaciers. The so-called moraines, in so far as my observation extends, are more probably shingle beaches and bars, old coast-lines loaded with boulders, trains of boulders or "ozars." Most of them convey to my mind the impression of ice-action along a slowly subsiding coast, forming successive deposits of stones in the shallow water, and burying them in clay and smaller stones as the depth increased. These deposits were again modified during emergence, when the old ridges were sometimes bared by denudation, and new ones heaped up.

I shall close these remarks, perhaps already too tedious, by a mere reference to the alleged prevalence of lake-basins and fiords in high northern latitudes, as connected with glacial action. In reasoning on this, it seems to be overlooked that the prevalence of disturbed and metamorphic rocks over wide areas in the north is one element in the matter. Again, cold Arctic currents are the cutters of basins, not the warm surface-currents. Further, the fiords on coasts, like the deep lateral valleys of mountains, are evidences of the action of the waves rather than of that of ice. I am sure that this is the case with the numerous indentations of the coast of Nova Scotia, which are cut into the softer and more shattered bands of rock, and show, in raised beaches and gravel ridges like those of the present coast, the levels of the sea at the time of their formation.

In conclusion, allow me to express my regret that the pressure of other occupations has allowed me so little time to discharge my duties as your president, and to hope that the course of the Society in the coming year may be still more prosperous and successful than in the past.

REPORT OF THE COUNCIL.

The Council of the Montreal Natural History Society, at their thirty-sixth annual meeting, and in conformity with their prescribed duty and the yearly custom, beg to lay before its members an account of their proceedings during their tenure of office, which this evening brings to a close: and in so doing have much pleasure to congratulate its members on the steady and onward progress which has characterized the proceedings of the past year.

THE MUSEUM.

The donations to the Museum have been numerous and valuable; and your Council would more especially acknowledge donations from the University of our sister city, the Laval University; of some 418 species of insects from Mr. Saunders of London, C.W.; also donations from our worthy president, Dr. Dawson, consisting of fishes and shells; several birds, and three cases of insects from Mr. Ferrier, our treasurer; and some valuable donations from Mr. Barnston; besides several small donations from other parties, which though not so numerous, are not the less valuable A list of these will be found appended to this report.

Your Council would beg to make special mention of the Scientific Curator, Mr. Whiteaves, who continues to give the most entire satisfaction. His work has been onerous and difficult. An inspection of the Museum will at once convince any one of the labor and care he has bestowed on the classification and labelling of the specimens in each department of Natural History. And your Council would congratulate the Society on this judicious and efficient appointment.

THE LIBRARY.

The donations to the Library have not been very numerous; the completion of Silliman's Journal (by purchase), and the usual exchanges from sister Societies form by far the greatest feature on the list of new books. The Council cannot but express its regret, that, owing to the want of funds, few new purchases have been able to be made. Notwithstanding, valuable donations of some twenty-four volumes have been received from the Literary and Historical Society of Quebec; and your Council have again to record the generosity of Mr. Ferrier, our treasurer, who has also presented some eleven or twelve volumes.

Original Papers Read.

During the past season twenty-four original papers have been read and discussed on the various departments of Natural History, viz., Geology, Zoology, and Botany. Most of these papers have been published in The Canadian Naturalist; which, besides being the record of our own transactions here, is the means of disseminating and spreading an account of our proceedings to other countries; and your Council cannot but regard this publication as an important feature in our future progress and usefulness.

Owing to the liberality of the publishers, Messrs. Dawson Brothers, The Canadian Naturalist has become second to no other publication of a like nature, containing, as it does, a great amount of useful and scientific knowledge. The Editing Committee deserve from your Council special mention for their successful labors in this important department.

Public Lectures.

The annual course of Sommerville Lectures was delivered in the Lecture Hall of the Society, to very large and respectable audiences. The following form the subjects of the course:—

First Lecture—18th February 1864, by W. Hingston, M.D., F.R.C.S.E., "On the Harmony observed in Nature."

Second Lecture—25th February, by Charles Smallwood, M.D., LL.D., "On Terrestrial Magnetism."

Third Lecture—3d March, by H. B. Small (Lin. Coll. Ox.), "On a Trip to our Satellite."

Fourth Lecture—10th March, by James Pech (Mus. Doc.), "On Music and the People."

Fifth Lecture—17th March, by T. Sterry Hunt, M.A., F.R.S., "On the Correlation of Forces."

Sixth and concluding Lecture on the 24th March, by Dr. Dawson, F.R.S., F.G.S., &c., (the President,) "On Man's Place in Nature."

Conversazione.

The second annual conversazione was held in the Society's rooms on the evening of the 2nd of February, and was, as on a former occasion, very well attended. Some works of art were exhibited, and also several microscopes and other philosophical instruments. A variety of very successful chemical experiments were shown by Prof. Robbins; and dissolving views were also kindly exhibited by Mr. C. Hearn, optician. Addresses were delivered by the President, Dr. Dawson, Hon. Mr. Sheppard, and Professor Miles. Efforts on the part of your Council were made to secure several scientific and literary friends from a distance, but who, from various causes, could not be present. The Hon. Mr. Sheppard of Drummondville, and Professor Miles of Lennoxville College, were the only two gentlemen who kindly assisted on the occasion.

Your Council would also beg to mention, that, owing to the kindness of Col. Dunlop, the Band of the Royal Artillery performed some choice pieces of music during the evening.

The success of these re-unions has been very decided; and your Council fondly hope, that they have proved a source of great intellectual enjoyment to those persons present,and which they trust will tend to prove the increasing desire on the part of the citizens of Montreal generally for the attainment of a knowledge of Natural History and its kindred sciences.

In connection with this subject your Council would state, that a Course of twelve Lectures on Geology, and twelve on Botany, were delivered by Mr. Whiteaves in the rooms of the Society and under its auspices during the past winter, at a reduced charge to members of the Society. The results were satisfactory, and some additional members were thus obtained, and some few donations to the library.

Miscellaneous.

Your Council, in accordance with the desire of the Society, have caused the silver medal to be transmitted to Dr. Daniel Wilson of Toronto, bearing an appropriate inscription, to which Dr. Wilson has returned a very suitable and feeling reply.

And your Council, in furtherance of the objects of the Society, and in accordance with its constitution, would recommend that the Society's silver medal for this year be presented to Sir W. E. Logan, one of the early and very active members of the Society, and who has so long and so well labored in developing the vast geological and mineral resources of Canada; and your Council would suggest that the present time seems a very appropriate one, on the occasion of the publication of his general work on Canadian Geology.

Some defects in the chimneys (caused by the method of warming the rooms of the Society) gave rise to some necessary repairs (which were stated to be of frequent occurrence); and it was deemed advisable to consult with Messrs. Prowse & McFarlane as to the cheapest and best way of keeping the rooms warm during the winter months. It was thought desirable to erect a hot-air furnace; but action in this matter was not taken until somewhat late in the season, which consequently incurred a somewhat large expenditure for coal, which will be obviated in future, by purchasing it at an earlier period. A contract was entered into with Messrs. Prowse & McFarlane, who, in a most generous and liberal spirit, offered to give a long credit if required, for the cost of its erection. Your Council fully believe that in the end it will effect a considerable saving. Double windows are also required, at a cost of about $100. Your Council would respectfully urge this on the attention of their successors.

New cases have been made for the reception of the mammals, and also a cabinet for the collection of insects. Some new cases have been set up for the reception of specimens of Canadian fishes, also four or five additional cases for birds. Much remains to be done in this department, and a still greater want of proper cases and cabinets for the reception of the numerous specimens already classified.

Your Council would beg to tender to Mr. Ferrier, the treasurer, the thanks of the Society for the liberality with which he has at all time made advances for the purposes of liquidating the more urgent demands of the current expenses of the Society. Your Council would also bear a willing testimony to the efficiency of Mr. Hunter, who has discharged his duties with satisfaction: and it is pleasing to be able to testify to his obliging and kind manner on all occasions, and also to make mention of many specimens of fishes and birds furnished by him to the Museum.

The Council would also report that they have received a grant of money (though of smaller amount than in any previous year) from the Government for the past year; and would also further state with regret, that no action has at present been taken to discharge the debt still due by the Society.

During the past winter your Council have permitted the Numismatic Society and the Montreal Literary Club to hold their meeting in their rooms on evenings not specially devoted to our own Society, and at a reasonable rate for fuel and light.

Your Council would further suggest, and in accordance with the amended act of Parliament, that the number of Vice-Presidents should not exceed nine, and that the Council should also consist of nine members.

Your Council would beg leave further to state, that they have received a communication from Mr. Leeming, calling attention to the fact that the remains of the late Rev. Mr. Sommerville are at present in the old Protestant burying-ground in Dorchester street, and calling on the Society to assist, conjointly with the Corporation of the Montreal General Hospital, the Trustees of St. Gabriel Church, and a clergyman now resident in Quebec, for the removal of the body to the Mount Royal Cemetery, and also the Monument at present erected over his remains. Your Council would therefore suggest that some action be taken in this matter at as early a period as possible.

They have also received a communication from the Board of Arts and Manufactures, in which it sets forth that it has "in its hands a considerable property, subject to a ground-rent, and burthened with hypotheques so large as to consume all its annual grant, and render the Board unable to carry on its proper operations, viz., to increase and maintain its free Library, to establish and keep up a Museum of Industrial Products, and to promote the education of mechanics and artizans.

"The property thus held has been set apart for the use of scientific and literary bodies who might wish to erect buildings for their accommodation, having been acquired with a view to such uses. In fact the Board has considered itself, in some sort, a trustee for these other public bodies, either existing or projected. But the members of the Board, hitherto disappointed of relief from the Provincial Government, feel that they cannot continue to hold this property for a much longer period, at a cost so great as the abdication of their own functions under the statute, and are therefore desirous, as speedily as possible, to come to an arrangement—if it be possible—with your own and other societies, by which a building-site may be transferred to you on easy terms, and co-operation secured between the Society and this Board in promoting objects which we may have in common.

"Either by transferring a portion of the land around the Exhibition building, by assisting your Society to erect upon it a building adapted for its uses, or by securing your co-operation in the extension of the present building upon a plan adapted to your wants, we hope that this Board may be of assistance to you, and receive co-operation and support in return.."

Your Council would recommend the consideration of this matter to the Society, in furtherance of the said object.

Your Council cannot but express its regret, that the report of the treasurer shows a balance against the Society; and would urge, that efforts be made by each individual member, to endeavor by all means to increase the funds so necessary for the support and furtherance of the objects for which it was founded.

Your Council must now resign their charge into the hands of others, wishing them a prosperous and increasing year of usefulness. One thing your Council would place on record, is the kindness and unanimity that has actuated the whole of the members, a sure prestige of increasing strength and usefulness; and they close their report with a fervent hope, that the Montreal Natural History Society may grow and prosper.

MONTHLY MEETING.

The monthly meeting of the Society took place at its rooms, on Monday evening, May 30th, Dr. Dawson, President, in the chair. The following donations were announced:

To the Museum.

From A. Ramsay, Esq.—Fine specimen of the Snow Goose (*Anser hyperboreus*, Pallas), shot at Nun's Island.

From James Ferrier, jun., Esq.—The Turnstone *Strepsilas interpres*, Illiger ; Curious Japanese Mirror and Case.

From Mrs. McCulloch.—138 skins of Canadian birds, 5 do foreign, 20 do. mammals.

From E. E. Shelton, Esq.—4 Indian pipes, from an excavation in Hospital Street.

From Jas. Claxton, Esq.—8 specimens of minerals (Quartz, Quartz with Pyrites, Calc Spar, and Sulphate of Barytes), from Devon and Cornwall, England.

From Mr. W. Hunter.—The yellow-bellied Woodpecker (*Centurus flaviventris*, Swainson); the golden-winged Woodpecker (*Colaptes auratus*, Linn.); 2 Robins (*Turdus migratorius*, Linn.); 1 blue yellow-backed Warbler (*Parula Americana*, Bonaparte).

To the Library.

Preliminary List of the Plants of Buffalo.—From the Buffalo Society of Natural Sciences.

Arboretum et Fruticetum Britannicum, by J. C. Loudon; 8 vols. 8vo., illustrated.—From James Ferrier, jun., Esq.

Bombay Magnetical and Meteorological Observations, 1862.

New Members.

John Tempest, and Alexander S. Ritchie, Esqs., were elected ordinary members of the Society.

Proceedings.

The Recording Secretary then read a communication by Dr. Bowerbank, on two new N. American Sponges. The first of these was a small marine form (of the genus *Tethea*), dredged by Dr. Dawson off the coast of Portland, Maine. The second was a green fresh-water species (of the genus *Spongilla*), occurring in quiet little bays along the St. Lawrence about Montreal, also in Upper Canada, in which places it has been taken by Dr. Dawson, Rev. A. F. Kemp, Mr. R. J. Fowler, and others. Dr. Dawson remarked that a great number of the N. American sponges differed somewhat from allied European forms, and were probably new species. The present paper, he remarked, might be looked upon as the first instalment of a somewhat elaborate memoir upon these very ill-understood and low forms of animal life, to the study of which Dr. Bowerbank has paid much attention. Dr. Dawson then gave an account of several species of Annelida and Bryozoa, from Mingan and Metis. The Mingan specimens were collected by Mr. Richardson, jun., of the Geol. Survey, and the Metis forms by Mrs. H. Parkinson. The doctor commenced by making drawings explanatory of the structure of the animal of the genus Spirorbis. He explained that these creatures were marine worm-like animals, which constructed small, flattened spiral shells, which were generally attached to sea-weeds, stones, or shells. He then exhibited eight different species of this genus, and pointed out lucidly the difference between them. After exhibiting a species of Serpula, with its irregular cylindrical shelly tube, the Doctor called attention to some of the Bryozoa of the Gulf. He stated that some of the species resembled brown sea-weeds, others corallines, but that the structure of the animals was nearest to that of some of the bivalve shells. He exhibited examples of some fifteen or sixteen species, illustrating the subject by diagrams, and by microscopical preparations showing the shape of the cells of these creatures, and some of their organs of defence. After some discussion as to the supposed uses of these animals, the meeting broke up.

On the Bivalved Entomostraca of the Carboniferous Strata of Great Britain and Ireland.

By Professor T. Rupert Jones, F.G.S., and J. W. Kirby, Esq.

After a review of what former observers have published on the Bivalved Entomostraca of the Carboniferous formations, the authors proceed to point out: 1st, a few rather doubtful *Cypridæ* or *Candonæ*, from the Coal-measures. 2ndly, *Cytheres;* of which there are about eight species, chiefly from the Coal-measures. 3rdly. *Bairdiæ;* about eight species, mostly from the Mountain-limestone and its shales. 4thly, *Cypridinidnæ;* comprising *Cypridina*, *Cypridella*, *Cyprella*, *Entomoconchus*, and *Cytherella*, from the Mountain-limestone. A fine collection of these rare forms from Little Island, Cork, liberally placed at Messrs. Jones and Kirkby's disposal by Mr. Joseph Wright, will elucidate the relationships of these hitherto obscure genera and their species. 5thly, *Leperditidæ;* comprising *Leperditia* (to which genus belong the so-called *Cypris Scotoburdigalensis*, *C. inflata*, *C. subrecta*, *Cythere inornata*, and others; many of them dwarf varieties of one species, and mostly belonging to the Mountain-limestone series); *Entomis* (Mountain-limestone), Devonian and Carboniferous forms of which have been mistaken for *Cypridinidnæ;* *Beyrichiæ* (from nearly all parts of the Carboniferous system, several species, of which *B. arcuata*, Bean, sp., is the most common); and *Kirkbyæ*, somewhat rare, and chiefly from the Mountain-limestone series.

Leperditia and *Beyrichia* are also Silurian and Devonian genera; they do not appear to pass upwards into the Permian formation. *Bairdia* and *Kirkbya* occur first in the Carboniferous and re-appear in the Permian deposits, even in the same specific forms; and *Bairdia* has been freely represented in Secondary and Tertiary deposits, and exists at present. Of the *Cypridinidæ* under notice, *Cypridella*, *Cyprella*, and *Entomoconchus* appear to be confined to the Mountain-limestone; *Cypridina* occurs in the Permian, and with *Cytherella* is found in Secondary and Tertiary rocks, and in existing seas. *Entomis* is a Silurian and Devonian genus, especially characterizing the so-called "Cypridinen-Schiefer" of Germany.

M'Coy's *Daphna primæva* is a *Cypridina*; De Koninck's *Cypridina Edwardsiana* and *Cypridella cruciata* are *Cypridellæ*: his *Cypridina annulata* and *Cyprella chrysalidea* are *Cyprellæ*; and his *Cypridina concentrica* is an *Entomis*.

MISCELLANEOUS.

THE LATE PRINCIPAL LEITCH.

Our issue of yesterday contained the sad, though not unexpected, announcement of Principal Leitch's death. William Leitch was born at Rothsay, in the Island of Bute, Scotland, in the year 1814, and was at his death under fifty years of age. The robust health of his boyhood was taken from him by an accident, which confined him for eighteen months, and threatened even his life before he recovered. When about fourteen years of age he fell from the mast of a yacht in the bay of his native town, and the fall produced a comminuted fracture of the hip-joint, which made him lame for life. This accident was the occasion of determining, in a somewhat remarkable way, the tendencies by which all his subsequent life has been characterized; for during his long and dreary confinement, the relief from intense suffering, which most boys of even high intellectual character would have sought in the fascination of fiction, he found in the study of mathematics; and his after life, which became almost from necessity that of a student, was devoted chiefly to the mathematical sciences. After finishing his preparatory studies for the Church of Scotland, he did not immediately enter on the practical work of his profession, but remained for some years in connection with the Glasgow Observatory, under the late Professor Nichol. In the year 1843 however, he accepted a presentation to the Parish of Monimail in Fifeshire, where he found that congenial quiet in which he was able to continue his studies and to extend his inquiries into other branches of physical science, as well as into those departments of philosophy and theology with which the physical sciences are more closely connected. During his residence at Monimail, he made himself known by extensive contributions to various periodicals and cyclopedias, on those subjects to which he had specially devoted his time; and by this means he enjoyed an intimate acquaintance with many of the most distinguished literary scientific men in Great Britain. The science to which he remained most fondly attached was that of astronomy; and from his thorough familiarity with the practical work of an Observatory, from the enthusiasm with which he studied every improvement in astronomical instruments, and hailed every fresh discovery to which it led, as well as from his general scientific attainments, it was thought probable that, had he not left Scotland, he would have been appointed to the chair of his teacher, the late Professor Nichol, in the University of Glasgow. De Quincey, in a noble article on Lord Rosse's telescope, speaks of his friend Professor Nichol as having contributed more than any other living man to keep general English readers, who have not time for the scientific investigations of astronomers, acquainted with the latest and profoundest results to which these investigations are leading; and during the two years which have passed since the Professor's death, it would be difficult to point to a man for whom the same distinction could have been so justly claimed as the late Principal of our University.

In 1860 he was invited by the Trustees of the Queen's University to become its Principal; and after spending session 1860-61 in the duties of the office, he decided to accept their invitation. His brief and sad career among us is so unfinished that even its imperfect results, and certainly, at least the larger and nobler aims by which it was guided, could be adequately described only at greater length than is possible in a hurried newspaper notice. Those who have been interested in his movements must have recognized the hopes which he entertained for the progress of science by the efficient working of our Observatory, and for the advancement of higher education by a more orderly government of our University, as well as by a reform in the general relations of all the Universities of Upper Canada.—*Kingston News, May 11th.*

Published, Montreal, June 15, 1864.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ N. Longitude, 4h. 54m. 11s. W. of Greenwich. Height above level of the Sea 182 feet. For the month of January 1864.

BY CHARLES SMALLWOOD, M.D., LL.D.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F.			Reading of Thermometer.			Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Highest	Lowest.	Mean.	Max.	Min.	Mean									
	Inches.	Inches.	Inches.												
1	29.133	29.414	29.242	35.0	13.4	27.2	.160	.898	S W	87.82	6.3	Inapp	....	2.6	Rain.
2	.900	.636	.766	8.0	-9.1	0.5	.044	.843	W	440.40	2.0	Inapp	....	1.3	Rain.
3	.898	.859	.872	18.9	-2.0	11.7	.079	.846	S W	455.90	1.3	....	Inapp	2.0	Snow.
4	30.100	.888	30.019	19.4	0.0	10 6	.076	.846	S W	200.00	1.6	....	....	1.6	Aurora Bor.
5	29.834	.700	29.772	10.0	-2.0	6.7	.067	.871	N E	34.40	6.6	....	2.20	2.6	Snow.
6	30.149	.893	30 074	6.2	0 0	5.4	.057	.895	S W	72.10	6.3	....	Inapp	2.0	Snow.
7	.330	30.110	.237	9.6	-16.9	-0.8	.044	.863	W	57.66	2.6	....	....	1.3	
8	29.800	29.790	29.844	24.2	5.0	15.7	.192	.883	S W	24.70	10.0	....	....	2.6	
9	.760	.541	.640	23.7	11.4	17.5	.100	.844	S W	56.52	6 6	....	Inapp	3.0	Snow.
10	.614	.600	.605	25.8	18.9	23.2	.127	.877	S W	299.44	10.0	....	....	2.6	
11	.604	.499	.554	27.1	18.1	23.2	.146	889	S W	104.06	6.6	....	1 20	2.6	Snow.
12	.648	.462	.559	29.6	16.4	24.4	.137	.902	N E	60.90	10 0	....	....	3.0	
13	.600	.433	.511	37.8	29 4	34·1	.205	.944	S W	77.30	10.0	....	....	3.0	
14	.900	.681	.801	34.9	23.2	27·6	.152	.869	S W	34 50	4.0	....	....	6.6	
15	.709	.572	.627	36.6	13.1	26.6	.147	.889	N E	96.50	10.0	....	3.20	4.6	Snow.
16	30.098	.837	.977	25.2	4 0	15.4	.086	.837	W	130.57	4.0	....	0.20	1.3	Snow.
17	.040	.971	30.037	32.2	21.0	28.3	.165	.920	S W	54 00	4.6	....	....	2.6	
18	29.998	.962	29.975	37.8	27 4	34.4	.188	.912	S W	202.80	10.0	....	3.10	4.0	Snow.
19	.879	.211	.520	26 7	24.0	25.9	.151	.936	N E	38.20	10 0	....	4.10	5.0	Snow.
20	30.094	.519	.791	28.0	18.1	22.1	.119	.849	W	239.12	9.3	....	2.05	2.6	Snow.
21	.255	30.200	30.234	32.2	8.8	16.6	.105	.860	W	174.38	0.0	....	....	2.3	
22	29.875	29.855	29.864	34.1	17.4	28.8	.169	.929	S W	45 19	6.6	Inapp	Inapp	2.6	Snow. Rain.
23	.845	.525	.723	35.2	21.2	30.9	.178	.919	W S W	124.10	7 6	Inapp	1.10	3.3	Snow.
24	.482	.298	.383	40.1	30.1	38.7	.231	.924	S W	28.14	10.0	0.100	....	4.6	Rain.
25	.533	.329	.424	47.1	30 1	36.8	.217	.902	W	58.13	6.6	....	....	2.6	
26	.781	.325	.602	38.7	17.8	27.7	.153	.867	N E	112.72	3 3	....	5.60	3.3	Snow.
27	.877	.568	.728	28 1	15.0	23.6	.131	.882	N E	146.04	10 0	....	Inapp	3.0	Snow.
28	.924	.829	.904	42.0	22.1	33.3	.180	.833	S W	91.68	10.0	....	....	3.0	
29	30.300	30.177	30.253	25.1	15.8	19.8	.198	.794	N E	115.48	7.0	....	....	2.6	
30	.314	.150	.221	19.0	11.5	16.8	.091	.811	N E	146.70	10.0	....	8.19	4.0	Snow.
31	.284	.148	.247	24.1	18.9	20.2	.106	.820	N E	243.80	6·6	....	2.00	2.6	Snow.

Remarks for the Month.

Barometer... { Highest, the 30th day, 30.314 inches. / Lowest, the 19th day, 29.211 " / Monthly Mean, 29.937 " / Monthly Range, 1.103 " }

Thermometer { Highest, the 25th day, 47°1 / Lowest, the 7th day, -16°9. / Monthly Mean, 21°52. / Monthly Range, 64°0. }

Greatest intensity of the Sun's rays, 64°7.
Lowest point of Terrestrial radiation, -18°4.
Mean of Humidity, .857.
Rain fell on 5 days, amounting to 0.100 inches.
Snow fell on 16 days, amounting to 32 85 inches.
Most prevalent wind, S. W.
Least prevalent wind, W.
Most windy day the 3rd day, mean miles per hour, 20.24.
Least windy day the 8th day, mean miles per hour, 1.02.
Aurora Borealis visible 1 night.
Zodiacal light, bright.
Imperfect Solar Halo, 20th day.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ *N. Longitude, 4h. 54m. 11s. W. of Greenwich. Height above the level of the Sea* 182 *feet. For the month of February* 1864.

BY CHARLES SMALLWOOD, M.D., LL.D.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F. Highest.	Lowest.	Mean.	Reading of Thermometer. Max.	Min.	Mean	Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Inches.	Inches.	Inches.												
1	29.986	29.643	29.809	26.1	2.5	24.2	.188	.898	S W	454.00	10.0	....	18.6	5 0	Snow.
2	.650	.450	.607	39.8	29.0	34.7	.199	.911	S W	428.60	10.0	Inapp	0.8	5.0	Snow.
3	.511	.424	.472	40.0	29.2	32.8	.178	.882	N E by E	28.80	10.0	Inapp	0.50	4.0	Rain—Snow.
4	.581	.495	.525	33.4	20.4	30.7	.165	.888	N E by E	46.86	8.0	Inapp	Inapp	5.0	Rain—Snow.
5	.682	.481	.585	36.8	4.2	33.8	.186	.882	S W	102.97	10.0	0.80	Inapp	4.8	Rain—Snow.
6	.690	.678	.681	37.2	25.2	33 1	.175	.884	W S W	87.77	9.8	....	0.80	2.0	Snow.
7	.571	.480	.477	35.4	28.0	32.2	.176	.887	S W	300.50	10.0	....	....	4.0	
8	.472	.201	.318	43.2	26.0	34.6	.169	.854	S W	588.00	6.6	....	0.40	8.8	Snow.
9	.816	.604	.789	27.0	7.4	16.6	.098	.847	W	175.59	1.8	....	0 40	2.0	Snow.
10	30.155	.924	30.028	15 8	-8.9	8.0	.065	.844	N W	112.20	1.8	..	....	1.0	
11	.146	.570	29.886	22.0	-4.7	12.2	.087	.851	S W	221 41	7.6	....	1.00	8.8	Snow.
12	29.581	.478	.522	41.1	18.4	28.6	.162	.879	W	190.99	4.0	....	2.40	8.6	Snow.
13	.489	.354	.414	33.8	25.1	33.4	.184	.877	S W	154.87	10.0	....	Inapp	8.0	Snow.
14	.728	.875	.501	27.9	14.0	22.0	.182	.885	N E	195.24	6.6	....	....	8.6	
15	30.010	.550	.823	7.1	-10.1	0.5	.065	.899	N	145.24	4.6	....	5.25	2.6	Snow.
16	29.262	.078	.154	20.0	6.8	14.2	.089	.884	N E	81.56	8.6	....	4.10	2.6	Snow.
17	.901	.824	.877	-6.8	-19.4	-12.5	.088	.824	W	128.50	5.8	....	0.50	2.0	Snow.
18	30.221	30.161	30.194	18.9	-20.4	-8.1	.042	.809	W S W	168.96	6.0	....	....	2.0	
19	.256	.025	.161	22.0	-12.0	8.1	.078	.824	W by S	78.48	2.6	....	....	2.6	
20	29.971	29.891	29.947	37.8	10.0	24.4	.188	.876	W by S	156.60	6.0	....	Inapp	2.6	Snow.
21	.900	.898	.900	37.4	29.2	33.1	.178	.862	W by S	108.00	8.6	....	....	2.8	
22	.861	.459	.629	40.8	29.2	36.8	.207	.880	S W	152.91	10.0	Inapp	....	8.6	Rain.
23	.600	.472	.525	48.9	33.1	41.8	.236	.858	W S W	277.96	6.0	0.380	....	8.8	Rain.
24	.500	.344	.482	58.2	34.0	45.5	.291	.874	S W	100.28	8.0	....	....	8.8	
25	.781	.626	.698	42.2	28.4	32.6	.174	.845	N E by E	66.79	8.6	....	....	2.8	
26	.762	.711	.748	36.1	14.5	28.3	.151	.847	N N W	207.89	2.0	....	....	2.8	
27	.882	.868	.878	42.8	11.2	28.7	.168	.860	W	125.47	0.0	....	....	2.0	
28	.642	.599	.624	33.9	33.4	37.1	.196	.809	S W	284.88	10.0	....	....	2.6	
29	.998	.599	.826	40.2	26.4	31.5	.167	.897	S W	96.82	3.8	0.110	....	2.6	Rain.

Remarks for the Month.

Barometer... { Highest, the 19th day, 30.256 inches. Lowest, the 16th day, 29.078 " Monthly Mean, 29.929 " Monthly Range, 1.178 "

Thermometer { Highest, the 24th day, 58°2. Lowest, the 18th day, -20°4. Monthly Mean, 25°32. Monthly Range, 78°6.

Greatest intensity of the Sun's rays, 74°0.
Lowest point of Terrestrial radiation, -22°7.
Mean Humidity .865.
Rain fell on 7 days, amounting to 0.790 inches.
Snow fell on 15 days, amounting to 28.75 inches.
Most prevalent wind, S. W.
Least prevalent wind, N. W.
Most windy day the 8th day, mean miles per hour, 24.50.
Least windy day the 3rd day, mean miles per hour, 1.40.
Zodiacal light, bright.

THE

CANADIAN NATURALIST.

SECOND SERIES.

ELEMENTARY VIEWS OF THE CLASSIFICATION OF ANIMALS.

By J. W. Dawson, LL.D. F.R.S.

[The matter of the following pages has been prepared principally for the benefit of students, who are in general much more apt to learn names and details than to attain to general views. It is introductory to the printed synopsis of lectures which I annually prepare for my classes, and is now published under the impression that, though but elementary and general, the views which it contains may prove interesting to naturalists, and useful to some of those who may be struggling with the difficulties incident to the study of zoölogy under the heterogeneous methods of classification which are found in most elementary books. Should time permit, it may be followed by illustrations of the details of some of the classes and orders of animals. The writer acknowledges his obligations, as sources of recent information, to Agassiz's Essay on Classification, Dana's Remarks on the Classification of Animals based on Cephalisation, and Huxley's Lectures on Classification, though he cannot follow throughout the systems of any of these authors.]

1. Introductory Remarks.

No subject is at present more perplexing to the practical zoölogist or geologist, and to the educator, than that of zoölogical classification. The subject in itself is very intricate, and the views given as to certain groups by the most eminent naturalists so conflicting, that the student is tempted to abandon it in despair, as incapable of being satisfactorily comprehended.

The reasons of this, it seems to the writer, are twofold. First, zoölogy is so extensive, that it has become divided into a number of subordinate branches, the cultivators of which attach an exaggerated value to their own specialties, and are unable to appreciate those of others. Thus we find naturalists subdividing one group more minutely than others, or raising one group to a position of equivalency with others, to which, in the opinion of the students of these others, it is quite subordinate. So also we have some zoölogists basing classification wholly on embryology or on mere anatomical structure, or even on the functions of some one class of organs. Secondly, there is a failure to perceive that, if there is any order in the animal kingdom, some one principle of arrangement must pervade the whole; and that our arrangement must not be one merely of convenience, or of a desultory and uncertain character, but uniform and homogeneous.

The writer of these pages does not profess to be in a position to escape from these causes of failure; but as a teacher of some experience, and as a student of certain portions of the animal kingdom, he has endeavoured carefully to eliminate from his own views the prejudices incident to his specialties, and to take a general view of the subject; and is therefore not without hope that the results at which he has arrived may be found useful to the young naturalist.

Classification in any department of Natural History is the arranging of the objects which we study in such a manner as to express their natural relationship. In other words, we endeavour in classification to present to our minds such a notion of the resemblances and differences of objects as may enable us to understand them, not merely as isolated units, but as parts of the system of nature. Without such arrangement there could be no scientific knowledge of nature, and our natural history would be merely a mass of undigested facts.

At first sight, and to a person knowing only a few objects, such arrangement may appear easy; but in reality it is encompassed with difficulties, some of which have not been appreciated by the framers of systems. The more important of these difficulties we may shortly consider.

1. There are in the animal kingdom a vast number of kinds or species. To form a perfect classification it would be necessary to know the characters or distinctive marks of all these species. To make even a tolerable approximation to a good system, requires an amount of preparatory labour which can be estimated only by those who have carefully worked up at least a few species in these respects.

2. So soon as we have ascertained the characters of a considerable number of species, we find that in their nearest resemblances these do not constitute a linear series, but arrange themselves in groups more or less separated from each other like constellations in the heavens, and having relationships tending with more or less force in different directions. This not only introduces complexity into our systems, but renders it impossible to represent them adequately in written or spoken discourse, or even by tables or diagrams. We think and speak of things in series, but nature's objects are not so arranged, but in groups radiating from each other like the branches of a tree; and our imperfect modes of thought and expression are severely tested in the attempt to understand nature, or to convey ideas of classification to the minds of others.

3. The considerations above stated oblige us to enquire what leading characters we may take as the principal thread of our arrangement, so as to make this as natural as possible and at the same time intelligible. It is simplest to take only one obvious character, as if for example we were to arrange all animals according to their colour or to the number of their limbs; but the greater the number of characters we can use, or the more completely we can represent the aggregate of resemblances and differences, the more natural will our arrangement be, and consequently also the more scientific and useful.

In attempting to weigh the several characters presented by any object, we find some that are of leading importance, others that are comparatively unimportant, though still not to be neglected; and we find that some indicate grades of complexity, others are connected with adaptations to certain uses, and others indicate plan of construction. Due weight must be given to all these kinds and degrees of characters. It is perhaps in the proper estimation and value of their relative importance and different modes of application that the greatest failures have been made.

Keeping in view these difficulties of the subject, we may now proceed to the consideration of the more elementary of the groups in which we arrange animals.

2. The Species in Zoology.

We cannot consider the animals with which we are familiar without perceiving that they constitute kinds or *Species*, which do not appear to graduate into each other, and which can be distinguished by certain *characters*. Yet simple though this at first sight appears, we shall find that many intricate questions are connected with it. Our idea of the species is based on the resemblance of the individuals composing it in all the characters which we consider essential. If, for instance, a number of sheep and goats are placed before us, we readily select the individuals of each species. In doing this we give no regard to differences of sex or age, but put the young and old, the male and female, of each species together. Nor do we pay attention to merely accidental differences: a mutilated or deformed specimen is not on that account separated from its species. Nor do we attach value to characters which experience has proved to vary according to circumstances, and in the same line of descent. Such, for example, are differences of colour, or fineness of the hair or wool. The remaining resemblances and differences are those on which we rely for our determination of the species, and which we term essential. We shall find that these essential characters of the species are points of structure, proportion of parts, ornamentation, and habits.

These characters constitute our idea of the species, which we can readily separate from the *Individuals* composing it. The individuals are temporary, but the species is permanent, being continued through the succession of individuals. If all the adult individuals are alike and indistinguishable from each other, then any one may serve as a specimen of the species. If there are differences of sex or *Varieties* subordinate to the species, then a suite of specimens showing these will represent the species. The species is thus an assemblage of powers and properties manifested in certain portions of matter called individuals, and which are its temporary representatives. It follows that the species is the true unit of our classification, and that the indefinite multiplication of individuals leaves this unchanged.

Our idea of the species will however be imperfect if we do not distinctly place before our minds its continued existence in time. This depends on the power of reproduction, whereby the individuals now existing have descended from similar progenitors, and will give birth to successors like themselves. A moment's thought will suffice to show that, independently of this, species could have no real existence in nature. If animals were not reproductive, the species would become extinct after the lapse of a generation. If their reproduction followed no certain law, and the progeny might be different from the parents, then the characters of the species would speedily become changed, and it would practically cease to be the same. Again, it is necessary that the reproduction of species should be pure or unmixed; for an indiscriminate hybridity would soon obliterate the boundaries of species. It is impossible, therefore, to separate the idea of species from the power of continuous unchanged reproduction, without depriving it of its essential characters.

In like manner it is obvious that we must assume a separate origin for each species, and that we need not assume more than one origin. Practically, species remain unchanged, and do not originate from one another; and if all the individuals of a species were destroyed except one pair, this would, under favourable circumstances, be sufficient to restore the species in its original abundance.

The questions which have been raised as to the origin of species by descent with indefinite variation, and as to the possible creation of individuals of the same species in different places or at different times, are not of a practical character, at least in zoology proper, and the whole burden of proof may be thrown on those who assert such views.

We are thus brought to the definition of species, long ago proposed by Cuvier and De Candolle, and may practically unite in one species all those individuals which so resemble each other that we may reasonably infer that they have descended from a common ancestry. All our practical tests for the determination of species resolve themselves into this general consideration. The only modification of this statement on which even a Darwinian can insist, is, that a sufficient time and great geological changes being given, one species may possibly split into two or more; and since this is an unproved hypothesis, we may practically neglect it, except as a warning to be very sure that we do not separate as distinct species any forms which may be merely varieties of a single species, an error exceedingly prevalent, and which vitiates not a little of our reasoning on such subjects.

The origin of the first individuals of a species may be, and probably is, a problem not within the province of natural history. In the case of vital force it is the same as in the case of gravitation and other forces. We can observe its operation and ascertain the laws of its action, but of the force itself we know nothing. It is to us merely an expression of the power and will of the

Creator. With regard to the creative force or power, we are still more ignorant. We do not witness its operation. We know nothing, except by inference, of its laws; and whatever we may succeed in ascertaining as to these, we may be sure that in the last resort we shall, as in the case of all other natural effects, be obliged to pause at that line where what we call force resolves itself into the will of the supreme spiritual Power. The "miracle" of enactment must necessarily precede law; the "miracle" of creation, the existence of matter or force. Those who deny this have no refuge but in a bald scepticism, discreditable to a scientific mind, or in metaphysical subtilties, into which the zoologist need not enter.

We must not suppose, however, that the species is absolutely invariable. Variability, in some species to a greater extent than in others, is a law of specific existence. It is the measure of the influence of disturbing forces from without in their action on the specific unity. In some cases it is difficult to distinguish varieties from true species, and with many naturalists there has been a tendency to introduce new species on insufficient grounds. Such errors can be detected ordinarily by comparing large suites of specimens and ascertaining the gradations between them, which always occur in the case of varieties, but are absent in the case of species truly distinct. Such comparisons require much time and labour, and must be pursued with much greater diligence than heretofore, in order to settle finally the question whether the varietal perturbations always tend to return to a state of equilibrium, or whether in any case they are capable of indefinite divergence from the specific unity.

The species is the only group which nature furnishes to us ready made. It is the only group in which the individuals must be bound together by a reproductive connection. There might or might not be affinities which would enable us to group species in larger aggregates, as *genera* and *families;* and the tie which binds these together is merely our perception of greater or less resemblance, not a genetic connection. We say for example, that all the individuals of the common Crow constitute one species, and we know that if all these birds were destroyed except one pair, the species would really exist, and might be renewed in all its previous numbers. We can make the same assertion with reference to the Raven or to the Blue Jay, considered as species. But if, because of resemblances between these species, we group them in the genus *Corvus* or in the family *Corvidæ*, we express merely our belief in a certain structural resemblance, not in any genetic connection. Nor need we suppose that if any of the species of a genus were destroyed they would be reproduced from the others. Further, while all the individuals of any of the species may be precisely similar to each other and still be distinct individuals, all the species of the genus cannot be similar in all their characters, otherwise they would constitute but one species.

In other words, the species and the genus, considered as groups, differ not in degree but in kind. To make this very plain, let us take a familiar illustration. I have a number of maps, all uniform in size and in style of execution; but in the whole there are only two kinds,—maps of the eastern hemisphere, and maps of the western hemisphere. Now all of the maps of *one* kind constitute a species; those of *both* kinds, a genus. The individuals of one species, say of the eastern hemisphere, are all alike. They have all been struck from one plate, from which many similar maps may be produced. But the other map, though necessary to make up the set or genus, may be quite dissimilar in all its details from the first, and could not be produced from its plate. We have no difficulty here in understanding that the specific unity is of a different kind from the generic unity, and that the distinction is by no means one of mere grade of resemblance. A very little thought must convince any one that this applies to species and genera in zoology; and that those naturalists who affirm that species have no more real existence in nature than genera, have overlooked one of the essential elements of classification. Nor would this distinction be invalidated by the assumption of a descent with modification, unless it could be shown that in actual nature species shade into each other; and this is certainly not the case in those which are reckoned as good species.

I have been thus careful to insist on the nature of the species in natural history; because I believe that loose views on this subject have caused a large proportion of the errors in classification.

Though the groups higher than species do not exist in nature in the same sense in which species exist, they are not arbitrary, but depend on our conception of resemblances and differences which actually exist. We go out into the forest and perceive different species of trees; but, at the same time, we find that these species can be grouped in genera, as Oaks, Birches, Maples, &c., under each of which generic names there may be several species. It is evidently not an arbitrary arrangement of ours thus to group species: they naturally arrange themselves in such groups, under the action of our comparing powers.

3. Genera and Higher Groups.

In comparing species with each other for purposes of classification, there are four distinct grounds on which such comparison can be made. These are:—1st. intimate structural or anatomical resemblance; 2nd. Grade or rank; 3rd. Use or function; 4th. Plan or type. All of these may be, indeed must be, used in classification, though in very different ways.

1. *Intimate structural relationship* is the ground on which we frame *Genera*. Two or more species resemble each other structurally to such an extent that the same definition will in many important points apply to both. Such species we group in a genus. It is most important to observe, as Agassiz has well pointed out, that this close resemblance in structure is really our main ground for the formation of genera. But for this very reason it is not to be expected in our higher groups. It is the mistaken application of this criterion to classes, which constitutes the leading defect of a work otherwise very valuable, and which I cordially recommend to students,—Huxley's "Lectures on Classification."

2. *Grade or rank* refers to degree of complexity of structure, or to the degree of development of those functions that are the highest in the animal nature. A coral polyp is more simple in structure than a fish, and is therefore lower in rank. A fish is less highly endowed in brain, sensation, and intelligence, than a mammal, and is therefore of lower rank. An egg or an embryo is simpler than the adult of the species to which it belongs; and when one animal resembles the embryo of another, it ranks lower in the scale. A worm ranks lower than an insect whose larva it resembles.

We use this difference of grade or rank in grouping genera in *Orders;* but it occupies a very subordinate place in the construction of other groups. Many grave errors have arisen from its indiscriminate application; most heterogeneous assemblages being formed when we construct groups larger than orders merely on the ground of lower grade: and when, on the other hand, we separate the lower members of natural groups on the ground of simplicity of structure, we fall into an equal mistake of another kind. Of errors of these kinds still current, I may instance the attempt of some naturalists to establish a province or sub-kingdom of *Protozoa*, to include all the simplest members of the Animal Kingdom, and the separation of the Entozoa or intestinal worms from the other worms as a distinct class. The classification in Owen's "Lectures on the Invertebrate Animals," which I have long used with advantage as a text-book, is defective in some parts in this respect.

There are two kinds of investigation much used in classification, which more especially develope the idea of grade or rank among animals. One is that of embryology, or the development of animals from the ovum. Another is that of cephalisation, or the development of the head and organs connected therewith. Both of these are of great importance, but, on the principles above stated, they aid us chiefly in referring animals to their *Orders*. Other limitations of the criterion of grade or rank will appear when we arrive at the consideration of *Classes*.

3. *Function or Use.*—In different animals we often find the same use served by different kinds of organs, as, for instance, the wing of a bird and the wing of an insect, which, though both used for flying, are constructed in very different ways. It would lead us astray were we to arrange animals primarily on this ground: for instance, if we were to group together fishes and crustacea because both swim; or birds and insects, because both fly. Again, in different groups of animals, certain functions and the organs which subserve them are greatly developed in comparison with others. For example, the enormous reproductive power of fishes, or the remarkable development of the locomotive organs in birds, as compared with other vertebrates. This consideration is not applicable in our primary division of animals, but it constitutes the principal ground on which naturalists have based the secondary divisions or *Classes*; and it serves also to indicate the *analogies* between the corresponding members of different primary groups, as, for instance, of the birds in one group to the insects in another.

4. *Plan or Type.*—Under this head we consider the similarity of construction in different animals or organs, without regard to uses. We say, for example, that the wing of the bird and the bat, the paddle of the whale, and the fore-leg of the dog, are similar in type or *homologous* to each other, because they are made up of similar sets of bones. They are modifications of one general plan

of structure. Animals thus constructed on similar plans are said to have an *affinity* to each other.

It is evident that this consideration of homology or affinity, if we can really detect it in nature, should be a primary ground in our arrangement; because, if we regard nature as an orderly system, and still more if we regard it as the expression of an intelligent mind, this must be the aspect in which we can best comprehend its scheme or plan of construction.

As a simple illustration of this and the preceding heads, we may suppose that we are writing a treatise on architecture, or the art of building. We observe 1st, that there are differences of material employed, as stone, brick, or wood; 2nd, that there are various grades of buildings, from the simplest hut to the most elaborate palace or temple; 3rd, we find a great variety of uses for which building are constructed, and to which they are adapted; 4th, there are different orders of architecture or styles, which indicate the various plans of construction adopted. It will, in studying such a subject, be the most logical order to consider, 1st, the several orders of architecture or plans or types adopted; 2nd, under each of these to classify the various kinds of buildings according to their uses; 3rdly, under each of these secondary heads, to treat of buildings more or less elaborate or complex; and 4thly, to consider the materials of which the structures may be composed. This is precisely what the most successful formers of systems have done in natural history, in dividing the animal kingdom into provinces or branches, classes, orders, and genera. On the other hand, classifications produced by mere anatomists who content themselves with a close adherence to similarity of structure and rigid definitions based on these, may be compared to a system of architecture produced by a mere bricklayer, who regards only the materials used and the manner of putting them together.

4. The General Nature of the Animal.

Having settled the more important of the general principles of classification, we now proceed to their practical application; and first, as a necessary preliminary, to ascertain what we understand by the term *Animal*, and what are the *precise limits of the Animal Kingdom*.

In answer to the question, What is an animal? we may say in the first place that the animal is a being possessing organisation based on cell-structures, and vital force. This suffices to distinguish it from mineral substances, but not from the plant, which is also organised and living, though in a mode somewhat different.

To distinguish the animal from the plant, we may affirm, 1st, that it is reproductive by eggs and not by seeds; 2nd, that in its processes of nutrition it digests organic food in an internal cavity, subsequently consuming a part of this food at the expense of the oxygen of the atmosphere; and that it builds up its tissues principally of nitrogenised matter; 3rd, that the animal possesses the power of voluntary motion, and, to subserve this, muscular tissue; 4th, that it possesses sensation, and, to subserve this and motion as well, a nervous system and external senses.

We thus find four general characteristics of the animal:

1. *Sensation*—by means of a nervous system and special senses.
2. *Voluntary motion*—by means of the muscular and nervous systems.
3. *Nutrition*—by means of a stomach and intestines, with absorptive, circulatory, and respiratory apparatus.
4. *Reproduction*—by ova and sperm-cells.

In every animal, even the simplest, these functions are in greater or less perfection performed; and it is the presence of the aggregate of these functions or the organs proper to them, that enables us to call any organism an animal. It is important to carry with us this definition of the animal; first, as indicating the limits of the creatures which the zoologist has to classify; and secondly, as pointing out to us the nature of the characters on which we must rely, in our classification. For the student I hold it to be necessary, before proceeding further, to understand well these functions and structures, as they exist in some one of the higher animals.

5. Primary Division of Animals into Provinces or Branches.

This, on the principles already stated, must be made solely on the ground of type or plan, and this taken in its most general aspects.

If we bring before us mentally the several members of the animal kingdom, we shall probably be struck in the first instance with the general prevalence of bilateral symmetry, or the arrangement of parts equally on the right and left sides. We may observe, however, that there is a large group of animals to which this general style of construction does not apply, and which have, in the words of Agassiz, a "vertical axis around which the primary elements of their structure are symmetrically arranged," conforming in this respect, and also often in other points, to the symmetry of the plant, rather than to that of the more perfect animals. We would thus obtain what is perhaps the most obvious of all primary divisions of animals,—that into those with bilateral symmetry and those that are radiated, or the *Artiozoaria* and the *Actinozoaria* of Blainville. We shall soon find, however, on more detailed examination, that this division is very unequal, since the first group includes by far the greater part of the animal kingdom, and its members are nearly as dissimilar among themselves as any of them are from the radiates.

Penetrating a little deeper into structural character, we find that one large group of the bilateral animals possesses an internal skeleton, arranged in such a way as to divide the body into an upper chamber holding the brain and nervous system, and an under chamber for holding the ordinary viscera; whereas in the greater number of the bilateral animals and all the radiates, there is but one chamber for containing the whole of the organs. The first of these groups, from the vertebræ or joints of the backbone, peculiar to its members, we name *Vertebrata*, and all the other animals *Invertebrata*, as proposed by Lamarck: this division corresponds to the *enaima* and *anaima* of Aristotle. Here also however we have a very unequal division,—the invertebrata being a vast and heterogeneous assemblage.

If, however, after separating the vertebrata on the one hand, and the radiata on the other, we study the remainder of the animal kingdom, we find that it readily resolves itself into two groups, known as the *Articulata* and the *Mollusca*. We thus reach the fourfold division of Cuvier; which is by much the most natural and philosophical yet proposed, however much it may be carped at by some merely anatomical systematists. This system may be summarised as follows:

Provinces or Branches of the Animal Kingdom.

1. VERTEBRATA, including Mammals, Birds, Reptiles, and Fishes. All these animals are bilateral and symmetrical, have an internal vertebrated skeleton, a brain and a dorsal nerve-cord lodged in a special cavity of the skeleton. With reference to the general

form, they may be termed doubly symmetrical animals; with reference to their nervous system, *Myelencephalous*.

2. ARTICULATA,* including Arachnida, or spiders and scorpions; Insects; Crustaceans, and Worms. These animals are bilateral and symmetrical, have an external annulose skeleton, a nervous system, consisting of a ring and ganglion around the gullet, connected with a double abdominal nerve-cord. They are otherwise named *Annulosa*, longitudinal animals, or *Homogangliata*.

3. MOLLUSCA, including Cuttle-fish and their allies; Gasteropods or univalve shell-fishes and their allies; Lamellibranchiates or bivalve shell-fishes, &c.; Brachiopods and their allies. They are bilateral but not always symmetrical, have no skeleton, and an œsophageal nervous ring with nerve-fibres and ganglia not symmetrically disposed. They are otherwise named massive animals, or *Heterogangliata*.

4. RADIATA, including Sea-urchins and starfishes; Sea-nettles and hydras; Polyps and coral-animals; and Sponges and their allies. These have the parts arranged radially around a central axis, and the nerve-system when discernible consisting of a central ring with radiating fibres. They may be otherwise named peripheric animals, or *Nematoneura*.

This fourfold division includes the whole animal kingdom, and is the only rational one which can be based on type or plan of structure. Since the time of Cuvier, though modifications in detail have become necessary, it has been strengthened by the progress of discovery; and more especially Von Baer has shown that the study of embryology establishes Cuvier's branches, by showing that in their development, animals pass through a series of forms belonging to their own branch and to that only.

The attempts which have been made to introduce additional branches or provinces, I regard as retrograde steps. Such for example is the province *Cœlenterata* of Leuckart, including the Polyps and the Acalephs, both of them good classes, but not together constituting a group equivalent to a Province; the Province *Protozoa* of Siebold, which to resume our architectural figure, includes merely the huts and cabins which it is difficult to refer to any style of architecture, but which do not, on that

* I prefer this term to "Annulosa," as being Cuvier's original name—a fact which should overrule merely verbal objections.

account, themselves constitute a new style; and the Provinces *Molluscoida* and *Annuloida* of Huxley, which, as their names indeed import, are in the main merely simple forms of Mollusca and Articulata.

6. Division of Provinces into Classes.

Having formed our Primary divisions or Provinces on the ground of type or plan, we must, in dividing these into classes, have regard either to subordinate details of plan, or to some other ground. In point of fact, naturalists seem to have tacitly agreed to form classes, on what Agassiz terms the "manner in which the plan of their respective great types is executed, and the means employed in their execution." In other words, they have in forming classes adopted, perhaps unconsciously, a *functional* system, similar to that employed by Oken in forming his primary groups. They have taken the relative development of the four great functional systems of the animal,—the sensative, the locomotive, the digestive, and the reproductive. This is very manifest in the ordinary and certainly very natural sub-division of the vertebrates into the four classes of Mammals, Birds, Reptiles,* and Fishes. The Mammals are the nerve or sensuous animals, representing the highest development of sensation and intelligence. The Birds are eminently the locomotive class. The Reptiles represent merely the alimentary or vegetative life. The Fishes are the eminently reproductive or embryonic class.

If this is a natural division of vertebrates into classes, and if the other three Provinces are of equivalent value, then there should be but four classes in each, one corresponding to each of the great functional systems. We may name the first of these the nervous class; the second, the motive class; the third the nutritive class; the fourth, the reproductive or embryonic class. Let us then endeavour, as a test of the truth of this system, to make such an arrangement of the classes of the animal kingdom.

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* The *Amphibia*, as Dana well argues on the principle of cephalisation, are clearly Reptiles, because we arrange animals in their mature and not in their embryonic condition, and because the points of reproduction in which Amphibia differ from ordinary reptiles, have relation to an aquatic habitat, and are ordinal or rank characters merely.

TABLE OF CLASSES OF ANIMALS.

Provinces or Branches.	Vertebrata.	Articulata.	Mollusca.	Radiata.
1. Nervous class.	*Mammalia*..	*Arachnida* .	*Cephalopoda*.....	*Echinodermata.*
2. Motive class...	*Aves*.......	*Insecta*	*Gasteropoda* (including *Pteropoda*)	*Acalephæ.*
3. Nutritive class.	*Reptilia*....	*Crustacea*...	*Lamellibranchiata.*	*Anthozoa.*
4. Embryonic or Reproductive class.	*Pisces*.....	*Annulata*..	*Molluscoida* (including *Tunicata*, *Brachiopoda*, *Bryozoa*,......	*Protozoa.*

All of the above groups are recognized by common consent as classes, except a few which have been already incidentally adverted to, and to which it is not necessary again to refer here.*

It will be observed that the order in descending the columns is that of *affinity;* that in reading across the columns is the order of *analogy*. The affinities no naturalist will seriously doubt. The analogies may be less familiar. In examining them, it will be seen that the first class in each province includes animals remarkable for condensation of the head and body, where the former exists; for high nervous energy, sensation, and intelligence; for prehensile apparatus, and for absence or simplicity of metamorphosis. The classes in the second line are characterized by the greatest locomotive powers in their respective provinces; those in the third line by the development of the nutritive apparatus and of vegetative growth; those in the fourth line by embryonic characters when mature, and by abundant reproductive energy.

It will be observed also as a necessary consequence of the system we have pursued, that each of our classes includes animals of very various rank or grade. Indeed, most of them have at their bases forms so simple or imperfect that it is almost impossible to include them in the class-characters. This is no objection to our arrangement, but a proof of its correctness; for we have now arrived at the point where we must form *Orders* based solely on

* The rank given to the *Arachnida* will be disputed by some naturalists; but a consideration of the structures of these animals will show that their relations to the insects and the crustacea are similar to those of the mammals to the birds and the reptiles; and that it is no more reasonable to say that the arachnidans are nearer to the crustaceans than to the insects, on the ground of general structure, than it would be to do the same in the case of the mammals and the reptiles as compared with the birds.

this consideration of rank. Of these humbler members of our classes we may mention the *Marsupials* and the *Monotremes* among the mammals, the *Amphibia* among the reptiles, the *Mites* among the arachnidans, the *Myriapods* among the insects, the *Entozoa* among the worms. Indeed it is quite possible on this ground to divide each of our classes into two or more *Sub-classes*. This is sometimes convenient for the sake of more accurate definition; but it is not necessary, since the division into orders sufficiently expresses these grades of complexity or elevation.

7. Division of Classes into Orders and Families.

Orders, as already stated, are based principally on rank or grade, to be ascertained by relative complexity or by the development of the higher nature of the animal. The last section, however, obliges us to take this with some limitation; for since we have four descriptions or sorts of classes, each of these must have the grade within it ascertained on special grounds. For example, the orders of birds, insects, gasteropods, and acalephæ, should be ascertained chiefly by reference to the locomotive organs, as being the system of organs most eminently represented in the class. If we glance for a moment at the systems which have been proposed, we shall see that this view has unconsciously commended itself to naturalists. The orders of insects, for example, are very plainly based on such characters, being founded mainly on the wings. This is nearly equally manifest in the ordinarily received orders of birds. It appears in the division into Pteropods, Heteropods, and Gasteropods proper among the Gasteropoda. It is also seen in the orders *Ctenophora*, *Discophora*, *Siphonophora*, among Acalephæ. It would be easy to show by a detailed review of the orders in the animal kingdom, that, in so far as they have been distinctly defined, they have in most cases been framed with a reference to the prevailing characteristics of the class; and also with the idea of grade or rank as a leading ground of arrangement. As previously observed, also, it is in the construction of orders, and in ascertaining rank in other divisions, that embryology and the doctrine of cephalisation are chiefly useful. For the present, however, we must leave this subject until we shall have an opportunity to enter into descriptive zoology.

In Botany, orders and families are identical. In Zoology we use the term *Family* for a group inferior to an order, and equivalent to the sub-order or tribe in botany. The family consists of an assemblage of genera resembling each other in general aspect. Most large orders are readily divisible into such assemblages, which, though in themselves somewhat vague, have the advantage of being formed on grounds which, being conspicuous and obvious at first sight, much aid the naturalist in the preliminary parts of his work. For example, among the carnivorous mammalia such groups as the *Mustelidæ* or weasels, the *Canidæ* or dogs, the *Felidæ* or cats, are so obvious that any member of one of these groups can be referred to that to which it belongs almost at first sight. Still I do not regard families as necessary divisions of the order. Some small orders may not admit of division into families; and even where such division is admissible, the genera may be studied as members of the order, without being grouped in families, though this grouping is often very useful and convenient.

It is important to observe, before leaving this part of the subject, that, in consequence of the great multiplication of species in some groups, and the close scrutiny of their structures, it is the tendency of specialists to form many small genera. This leads to the construction of numerous families, many of which would more properly remain as genera. A still worse consequence is, that, instead of forming sub-orders and sub-classes, such specialists often call sub-orders or even families orders, and raise sub-classes or orders to the rank of nominal classes, thus introducing a confusion which leads the student to suppose that these terms have no definite meaning. I would further observe here, that I do not so much insist on the use of one name for a group rather than another, as on the constant use of each term for groups truly equivalent in the system.

It may be necessary here to state that the formation of orders on the ground of rank, and of families on the ground of general aspect, does not exclude the ideas of rank and general aspect from the province or class. On the contrary, as a secondary ground, general aspect is a good character in the province and class, and a gradation of rank can be perceived in provinces and classes. In the provinces, the *Vertebrata* stand highest, and the *Radiata* lowest, the *Articulata* and the *Mollusca* being nearly equal, and their lower members not so high as the highest *Radiata*; so that they would stand in a diagram thus:

Vertebrates

Articulates *Mollusks*

Radiates.

So among classes, the nerve class in each province is the highest and the embryonic class the lowest, and the other two intermediate; but the idea of rank is not here the primary one, as it is in forming the orders. It is also true that from the province downward the idea of type or plan is constantly before us.

We have now in descending from provinces reached the genera and species, with the consideration of which we commenced; and if the preceding views have been understood, we shall be prepared to commence the study of Descriptive Zoology, or to enter upon the details which fill up the outline which has been sketched. In doing this we must take specimens of known species and study them in their structural and physiological peculiarities, and in their relations to the other species congeneric and co-ordinate with them.

ON THE OCCURRENCE OF PIERIS RAPÆ IN CANADA.

By G. J. Bowles, Sec. Ent. Soc. of Canada, Quebec Branch.

During the summer of 1863—my first collecting season—I captured in the vicinity of Quebec numerous specimens of a butterfly of which no description could be found in any work on American entomology. Mr. Couper, to whom I applied for assistance, was equally at a loss to determine the species, considering it, as I did, to be indigenous to Canada. In order to solve the problem, however, he forwarded some specimens of the imago to Mr. William Saunders, of London, C. W., who pronounced them to be identical with *Pieris rapæ*, the small white butterfly of England, one of the most common and injurious lepidopterous insects of that country. In the meantime I had enclosed a drawing of the butterfly, together with the wings, to Mr. S. H. Scudder, of Boston, Mass., from whom I received a reply, stating that after comparing the drawing and wings with specimens of *P. rapæ* in the Museum of Comparative Zoology at Cambridge, he saw no reason to consider them distinct: at the same time he desired further investigation to be made respecting the larva and pupa states of the insect. This investigation has been successfully carried out, and places beyond doubt the identity of the butterfly with the English *P. rapæ*, thus establishing another instance of the transportation of a lepidopterous insect across a wide expanse of ocean, and its naturalization in a new country,—an instance which, when the evidence is considered, must be regarded as the most conclusive on record.

The identity of the English and Canadian species is thus proved by the exact similarity of the two insects in all their stages. That the imagines are alike, in both sexes, I have on the authority of the gentlemen above named; for in Quebec I could have no opportunity of comparing specimens taken in both countries. It is singular, too, that a curious variety of the male is common to both: in Canada, however, (perhaps from the effect of a different climate) it is more frequently met with than in England. Two males of a bright canary color, but with the usual markings of the species, were captured here last summer—one by Mr. Couper, the other by me; and this season I have already seen several similar individuals. On referring to a valuable work in the library of Parliament, (Curtis's Farm Insects,) I was gratified to find that the author mentions having in his collection a male *P. rapæ*, "taken near Oldham, in Lancashire, which has all the wings of a bright yellow color." As to the pupa, in size, color and markings, it exactly agrees with engravings and descriptions of the English chrysalis, and also in its usual place of deposition, &c. The last link in the chain is furnished by the similarity of the caterpillar, which also agrees with the best English descriptions. I took several of these larvæ from cabbage-plants in hotbeds on the 8th of June, and have reared four of them to maturity. When about half-grown, they began to exhibit the characteristic markings of the species,—these markings becoming more decided as they increased in size.

That this insect is not native to Canada, is certain from two interesting circumstances connected with its history. A limit can be set to its existence in Canada; and the place where it first appeared can be specified. Until within a few years, the butterfly was unknown in this country. No description of it is found in Kirby's "Fauna Boreali Americana"; nor in the "Canadian Naturalist," by Gosse, who visited Quebec, and collected here about 1839. The "Synopsis" of the Smithsonian Institution is also wanting in this respect; and I have carefully examined the volumes of our magazine of natural history, (the "Canadian Naturalist," Montreal) without finding any notice of the species. This periodical contains two lists of lepidoptera collected in Lower Canada; one by Mr. R. Bell, Jun., of butterflies taken on the Lower St. Lawrence; the other by Mr. D'Urban, of those found in the vicinity of Montreal in 1857-8-9. The only *Pieris* mentioned in these lists is *P. oleracea*, a species which may be distinguished at a glance from *P. rapæ*, the markings being altogether different. Mr. Couper captured a specimen of *P. rapæ* within the city limits of Quebec, about five years ago, but did not investigate the subject, though considering the insect a rare one, his special study being coleoptera. This is the earliest notice of the butterfly in Canada; and it evidently points out Quebec as the *locality* of introduction, and fixes the *period* at about seven or eight years ago.

With respect to the means by which it has been brought into the country, some plausible conjectures may be advanced. Of course the introduction took place during the season of navigation. The turnip, cabbage, and other kindred vegetables, constitute the principal food plants of the insect; and, adhering to one of these, it must have been carried across the ocean, either in the egg, larva, or chrysalis,—the last being the most unlikely, as the larva always forsakes its food-plant, and becomes a pupa in some sheltered situation, usually under the coping of a wall, &c. The eggs are laid on the under side of cabbage and turnip leaves, where the larva, on emerging, find themselves in close proximity to their food. Perhaps the vegetable refuse thrown from one of our ocean steamers on her arrival, has contained a few eggs or larvæ, which under these unfavourable circumstances, have retained their vitality; and from these have sprung the imagines destined to become the parents of the species in Canada.

The habitat of the insect is still very limited. After making enquiry, I do not think that it has extended more than forty miles from Quebec as a centre, so that a circle of eighty miles diameter would include the present habitat. This may seem great progress during the short period of its naturalization, but, considering the fecundity and habits of the species, it is not surprising.

There is some importance connected with the introduction of this butterfly, apart from the scientific interest of the subject to entomologists. Hitherto, Lower Canada has possessed but one species of the genus *Pieris* (*P. oleracea*, Harris; *Pontia casta*, Kirby,) and this species so insignificant in numbers, at least in the Quebec region, that its depredations have passed unnoticed. The new importation, however, must be regarded in a different light. As the insect is now permanently settled in the country, is very prolific, and the larvæ extremely voracious, we may anticipate its becoming a great pest to farmers and gardeners, not only where it is now found, but ultimately in the whole of Canada, and parts of the United States. And that it will in the course of time spread over these regions, admits of no doubt. The food-plants of the species are cultivated in every part of the country, and besides, the insect has the power of accommodating itself to altered circumstances. Mr. Curtis, in the work before mentioned, states that the caterpillars have been found feeding on the willow, and on mignionette, nasturtiums, &c. It is therefore probable that its progress westward will not be impeded by the scarcity of its favorite food in certain localities, but that it will overcome all difficulties of this nature by resorting to other plants, not confining itself to the cruciferæ.

Last autumn, in the vicinity of Quebec, the ravages of these larvæ were very great. Large plots, and even fields of cabbages, cauliflowers, &c., were completely destroyed; the caterpillars only rejecting the strong supporting ribs of the leaves. Serious loss was thus occasioned to market gardeners and others. One informed me that he had sustained a loss of more than two hundred dollars by their depredations; another that nearly the whole of his crop of cabbages was destroyed, the small portion saved requiring to be carefully washed before being sent to market. A gentleman also told me that they had not only eaten up his garden produce, but had demolished a bed of mignionette, even to the stalks.

Nature has provided more than one means of checking the increase of the species. The chrysalis is attacked by a parasite, (probably one of the Ichneumonidæ) as several collected by me this spring gave evidence. Large numbers of the pupæ are also killed by the frost, where they have been placed in exposed situations, and thus the spring brood of butterflies is materially lessened. I noticed a singular circumstance connected with these winter pupæ. Living chrysalids, brought into the warm house from the cold outside, invariably shrivelled and dried in a few days. Out of many that I gathered during last winter, not one produced a butterfly.

Last year the species was exceedingly abundant in the neighborhood of Quebec, flying by hundreds over the fields and gardens, and even in the most crowded parts of the city; and this season it promises to be equally numerous. Early in March, the butterflies began to appear in houses, from pupa which had been suspended on the walls during the previous autumn. On the 6th April, at Laval, about fifteen miles from Quebec, several specimens were taken in the open air; and on the 26th May, I counted more than fifty individuals, met with on about a mile of road within a short distance of the city.

Considering their great abundance within their present habitat, and their prospective dissemination over the Province, it is desirable that information respecting the appearance and habits of these insects should be given to the public, and means devised for their destruction. Farmers and gardeners should kill every caterpillar on their turnips, cabbages, &c., and be provided with nets to capture the perfect insects. The chrysalids should also be sought for on the fences during the fall and winter, and destroyed. Unless these precautions be taken, the injury caused by this butterfly to the green crops in Canada may become very serious.

The following is a description of the insect:

Male—wings white, (or light yellow) with one blackish spot on the fore wings above, and two beneath, a black band on the apex on the upper side, extending a short distance along the adjacent margins, a black dash on the fore edge of the hind wings, which are beneath of a pale yellow sprinkled with black. Body black, antennæ annulated with black and white. Female has *two* blackish spots on upper side of anterior wings. Expands about two inches.

Chrysalis—Pale green, speckled with black, suspended horizontally by the tail and a thread across the middle.

Caterpillar—About 1½ inches long when full grown, green finely dotted with black, a yellow stripe along the back, and a row of yellow spots along each side in a line with the spiracles.

The caterpillars reared by me were about one-twelfth of an inch long when I procured them, and attained their full size in eleven days. On the 19th June they beeame pupæ, and seven days after the perfect insects appeared. The butterfly therefore passes through all its changes in less than a month. Three or four broods are produced during the season.

(Read before the Quebec Branch, Entomological Society of Canada. 7th July, 1864.)

SYNOPSIS OF CANADIAN FERNS AND FILICOID PLANTS.

BY GEORGE LAWSON, PH.D., LL.D.

The following Synopsis embraces a concise statement of what is known respecting Canadian ferns and filicoid plants. Imperfect as it is, I trust that it will prove useful to botanists and fern fanciers, and stimulate to renewed diligence in investigation. The whole number of species enumerated is seventy-four. Of these eleven are doubtful. Farther investigation will probably lead to the elimination of several of the doubtful species, which are retained for the present with a view to promote inquiry; but a few additional species, as yet unknown within the boundaries of Canada, may be discovered. The above number may be regarded, then, as a fair estimate—perhaps slightly in excess—of the actual number of ferns and filicoid plants existing in Canada. The number certainly known to exist, after deducting the species of doubtful occurrence, is sixty-three.

The number of species described in Professor Asa Gray's exhaustive Manual, as actually known to inhabit the northern United States, that is to say, the country lying to the south of the St. Lawrence River and Great Lakes, stretching to and including Virginia and Kentucky in the south, and extending westward to the Mississippi River, is seventy-five. This number does not include any doubtful species.

The number described in Dr. Chapman's Flora, as inhabiting the Southern States, that is, all the states south of Virginia and Kentucky and east of the Mississippi, is sixty-nine.*

From these statements it will be seen that we have our due share of ferns in Canada.

The whole number of ferns in all the American States, and the British North American Provinces, is estimated, in a recent letter from Mr. Eaton, as probably over 100.

In the British Islands there are about 60 ferns and filicoid plants. In islands of warmer regions the number is greatly increased. Thus Mr. Eaton's enumeration of the true ferns collected by Wright, Scott, and Hayes, in Cuba, embraces 357 species. The proportions of ferns to phanerogamous plants in the floras of different countries are thus indicated by Professor Balfour, in the Class-Book of Botany, page 998, §1604:—"In the low plains of the great continents, within the tropics, ferns are to phanerogamous plants as 1 to 20; on the mountainous parts of the great continents, in the same latitudes, as 1 to 8, or 1 to 6; in Congo as 1 to 27; in New Holland as 1 to 26. In small islands, dispersed over a wide ocean, the proportion of ferns increases; thus while in

* Mr. D. C. Eaton, M.A., is author of that portion of Dr. Chapman's Flora which relates to the ferns.

Jamica the proportion is 1 to 8, in Otaheite it is 1 to 4, and in St. Helena and Ascension nearly 1 to 2. In the temperate zone, Humboldt gives the proportion of ferns to phanerogamous plants as 1 to 70. In North America the proportion is 1 to 35; in France 1 to 58; in Germany 1 to 52; in the dry parts of southern Italy as 1 to 74; and in Greece 1 to 84. In colder regions the proportion increases; that is to say, ferns decrease more slowly in number than phanerogamous plants. Thus in Lapland the proportion is 1 to 25; in Iceland 1 to 18; and in Greenland 1 to 12. The proportion is least in the middle temperate zone, and it increases both towards the equator and towards the poles; at the same time it must be remarked, that ferns reach their absolute maximum in the torrid zone, and their absolute minimum in the arctic zone."

Canada consists of a belt of land, lying to the north of the St. Lawrence River and the Great Lakes. By these it is separated, along nearly the whole extent of its south-eastern and western boundaries, from the northern United States, which thus enclose Canada on two sides. A striking resemblance, amounting almost to identity, is therefore to be looked for in the floras of the two countries. Yet species appear in each that are absent in the other.

The species of ferns and filicoid plants which are certainly Canadian, amount to..63
Of these there inhabit the Northern States, ...58
Do. do. Southern States, ...38
Do. do. Europe, ...36

The following table is designed to show some of the geographical relations of our Canadian ferns. The first column (I.) refers exclusively to the occurrence of the species within the Canadian boundary. The plus sign (+) indicates that the species is general, or at least does not show any decided tendency towards the extreme eastern or western, or northern or southern parts of the Province. The letters N, S, E, W, &c., variously combined, indicate that the species is so limited to the corresponding northern, southern, eastern or western parts of the province, or at least has a well-defined tendency to such limitation. The mark of interrogation (?) signifies doubt as to the occurrence of the species. The second column (II.) shows what Canadian species occur also in the Northern States, that is the region embraced by Gray's Manual; and the third column (III.) those that extend down south into Chapman's territory. The fourth column (IV.) shows the occurrence of our species in

Europe; C in this column indicating Continental Europe, and B the British Islands. The fifth or last column (V.) shows the species that extend northwards into the Arctic circle—35 in all, of which however, only 14, or perhaps 15, are known to be Arctic in America. Am., As., Eu., and G., indicate respectively Arctic America, Arctic Asia, Arctic Europe, and Arctic Greenland. The information contained in the last column has been chiefly derived from Dr. Hooker's able Memoir in the Linnæan Transactions (vol. xxiii., p. 251).

Hitherto no attention whatever has been paid, in Canada, to the study of those remarkable variations in form to which the species of ferns are so peculiarly liable. In Britain, the study of varieties has now been pursued by botanists so fully as to show that the phenomena which they present have a most important bearing upon many physiological and taxological questions of the greatest scientific interest. The varieties are studied in a systematic manner, and the laws of variation have been to a certain extent ascertained. And as the astronomer can point out the existence of a planet before it has been seen, and the chemist can construct formulæ for organic compounds—members of homologous series—in anticipation of their actual discovery, so in like manner the pteridologist now studies the variations of species by a comparative system, which enables him to look for equivalent forms in the corresponding species of different groups. Studies so pursued are calculated to evolve more accurate and definite notions as to the real nature of species, and the laws of divergence in form of which they are capable. I would therefore earnestly invite Canadian botanists to a more careful study of the *varieties* of the Canadian ferns, after the manner of Moore and other European leaders in this comparatively new path. The elasticity, or proneness to variation, of the species in certain groups of animals and plants has been somewhat rashly used to account for the origin of species, by what is called the process of variation. It seems to tell all the other way. Innumerable as are the grotesque variations of ferns, in forkings and frillings, and tassellings, and abnormal veinings, &c. (see the figures in Moore's works), we do not know of a single species in which such peculiarities have become permanent or general, that is *specific*, so that the species can be traced back to such an origin. Surely something of the kind would have happened had all species originated by a process of variation.

*Tabular View of the Distribution of Canadian Ferns and Allied Plants over Certain Parts of the Northern Hemisphere.**

Name.	I. Canada.	II. Northern States.	III. Southern States.	IV. Europe.	V. Arctic Circle.
Polypodiaceæ.					
1. Polypodium vulgare, . .	+	+	+	C.B.	Eu.
2. P. hexagonopterum, . .	+	+	+	...	...
3. P. Phegopteris, ...	+	+	...	C.B.	Eu. G.
4. P. Dryopteris, ...	+	+	...	C.B.	Eu.Am.G
5. P. Robertianum, . . .	+	+	..	C.B.	...
6. Adiantum pedatum, . .	+	+	+	...	...
7. Pteris aquilina, ...	+	+	+	C.B.	Eu.
8. Pellæa atropurpurea, . .	S.	+	+	...	...
9. Allosorus Stelleri, . . .	+	+	...	...	...
10. Cryptogramma acrostichoides	W W	...	..	?	·Am.
11. Struthiopteris Germanica .	+	+	...	C	Eu.
12. Onoclea sensibilis, . . .	+	+	+	...	...
13. Asplenium Trichomanes, .	+	+	+	C.B.	...
14. A. viride, ...	N.E.	...	...	C.B.	Eu. G.
15. A. angustifolium, . . .	S.W.	+	+	...	...
16. A. ebeneum, ...	+	+	+	...	...
17. A. marinum, ...	E. ?	...	..	C.B.	...
18. A. thelypteroides, . . .	+	+	+	...	...
19. A. montanum, ...	?	+	+	...	...
20. A. Ruta muraria, . . .	?	+	+	C.B.	Eu.
21. Athyrium Filix fœmina, .	+	+	+	C.B.	Eu.
22. Woodwardia Virginica, .	S. W.	+	+	..	...
23. Scolopendrium vulgare, .	W W	+	...	C.B.	...
24. Camptosorus rhizophyllus,.	W.	+	+	...	...
25. Lastrea dilatata, ...	+	+	÷	C.B.	Eu. Am.
26. L. marginalis, ...	+	+	+	...	...
27. L. Filix-mas, ...	? ?	...	...	C.B.	Eu. G.
28. L. cristata, ...	+	+	...	C.B.	...
29. L. Goldieana,.	W.	+	...	...	...
30. L. fragrans, ...	N W?	+	...	...	As.Am.G.
31. L. Thelypteris, ...	+	+	+	C.B.	...
32. L. Nov-Eboracensis, . .	+	+	+	...	...
33. Polystichum angulare, . .	+	+	..	C.B.	Eu.
34. P. Lonchitis, ...	N.W.	+	...	C.B.	Eu.Am. G
35. P. acrostichoides, . . .	+	+	+	...	..
36. Cystopteris fragilis, . . .	+	+	+	C.B.	Eu.Am. G
37. C. bulbifera, ...	+	+	+	..	...
38. Dennstædtia punctilobula, .	+	+	+	...	...

* In the above Table, the doubtful species are included, but all reference to varieties is omitted.

NAME.	I. Canada.	II. Northern States.	III. Southern States.	IV. Europe.	V. Arctic Circle.
39. Woodsia Ilvensis, . . .	+	+	+	C.B.	{ Eu. As. Am. G.
40. W. alpina, ...	+	...	...	C.B.	Eu. G.
41. W. glabella, ...	+	+	...	...	Am.
42. W. obtusa, ...	?	+	+	...	...
43. Osmunda regalis, . . .	+	+	+	C.B.	...
44. O. cinnamomea, ...	+	+	+	...	...
45. O. Claytoniana, ...	+	+	+	...	...
46. Schizæa pusilla, ...	?	+	...	...	...
OPHIOGLOSSACEÆ.					
47. Botrychium Virginicum, .	+	+	+	...	Eu. G.
48. B. lunarioides, ...	+	+	+	?	...
49. B. lunaria, ...	N.	...	...	C. B.	Eu. G.
50. Ophioglossum vulgatum, .	?	+	+	C. B.	Eu.
LYCOPODIACEÆ.					
51. Plananthus Selago, . . .	N.?	+	+	C. B.	{ Eu. As. Am. G.
52. P. lucidulus, ...	+	+	+	C.	...
53. P. alopecuroides, . . .	??	+	+	...	...
54. P. inundatus, ...	+	+	+	C.B.	...
55. Lycopodium clavatum, . .	+	+	+	C. B.	Eu. G.
56. L. annotinum, ...	+	+	+	C. B.	Eu.Am.G
57. L. dendroideum, . . .	+	+	+	...	...
58. L. complanatum, . . .	+	+	+	C.	Eu. As.
59. Selaginella spinulosa, . .	N.E.	+	+	C. B.	Eu. G.
60. Stachygynandrum rupestre,	+	+	+	...	...
61. Diplostachyum apodum, .	+	+	+	...	...
MARSILEACEÆ.					
62. Azolla Caroliniana, . . .	S.	+	+	...	...
63. Salvinia natans, ...	??	...	+	C.	...
64. Isoëtes lacustris, ...	+	+	+	C.B.	Eu. G.
EQUISETACEÆ.					
65. Equisetum sylvaticum, .	+	+	...	C. B.	Eu.Am.G
66. E. umbrosum, ...	+	+	...	C.B.	Eu.
67. E. arvense, ...	+	+	...	C.B.	{ Eu. As. Am. G.
68. E. Telmateja, ...	W.	+	...	C.B.	...
69. E. limosum, ...	+	+	...	C.B.	Eu.
70. E. hyemale, ...	+	+	...	C.B.	Eu.
71. E. robustum, ...	+	+	...	...	...
72. E. variegatum, ...	N. E.	+	...	C.B.	{ Eu.Am G.
73. E. scirpoides, ...	+	+	...	C.	{ Eu. As. Am. G.
74. E. palustre, ...	N.	...	...	C. B.	Eu. Am.

Nat. Ord. POLYPODIACEÆ.

POLYPODIUM.

P. vulgare, Linn.—Frond linear-oblong or somewhat lanceolate, more or less acuminate, deeply pinnatifid, in some forms almost pinnate; lobes (or pinnæ) linear-oblong, obtuse, often acute, rarely acuminate, entire or crenate or serrate; sori large; very variable as regards outline of the frond, form, &c., of the lobes, and serrature. *P. vulgare*, Linn., A. Gray, Moore, &c. *P. Virginianum* of English gardens. *P. vulgare*, var. *Americanum*, Hook., Torrey, Fl. N. Y., ii, 480.—On rocks in the woods, not rare around the city of Kingston; abundant on the rocky banks of the St. Lawrence, in Pittsburg; in the woods at Collins's Bay; and on Judge Malloch's farm, a mile west from Brockville; Gananoque lakes and rivers; Farmersville; Newboro on the Rideau; Toronto; on the great boulder of the Trent Valley, near Trenton; on rocks west from Brockville, outcrop of Potsdam sandstone at Oxford, and Hull, mountains near Chelsea, C. E., B. Billings, jun.; near Gatineau Mills, D. M'Gillivray, M.D.; Mount Johnson, C. E., and Niagara River, P. W. Maclagan, M.D.; Brighton, in the crevice of a rock in a field, and abundant on rocky banks right bank of the Moira, above Belleville, J. Macoun; Ramsay, Rev. J. K. McMorine, M.A.; north-west from Granite Point, Lake Superior, R. Bell, jun.; mountain top, near Mr. Brydge's house, Hamilton, C. W., Judge Logie; River Rouge and lower end of Gut Lake, W. S. M. D'Urban; Cape Haldimand, Gaspé, John Bell, B A.; Red River Settlement, Governor M'Tavish; foot of Cape Tourmente, Abbé Provancher; L'Orignal and Grenville, C. E., J. Bell, B.A. The habitats above cited show that although this fern is not so common in Canada as in Britain, it is nevertheless widely distributed. It is common in New York State, according to Professor Torrey, and in the Northern States generally according to Professor Asa Gray; rarer in the South, according to Dr. Chapman.

P. hexagonopterum, Mich.—Frond triangular in outline, acuminate, pinnate, hairy throughout; pinnæ broadly lanceolate, pinnatifid; lowest pair of pinnæ larger than the others, not deflexed; lobes of the pinnæ linear-oblong or lanceolate, strongly toothed, or almost pinnatifid. The decurrent pinnæ have a tendency to form conspicuous irregular-angled wings along the rachis. Stipe not scaly except at the base. Rhizome long, slender, ramifying. Whole plant much larger than *P. Phegopteris*, and quite a different species.

P. hexagonopterum, Michx., A. Gray, &c. The figure in Lowe's Ferns, vol i, p. 143, tab. 49, is a little too much like Phegopteris, *P. Phegopteris*, *γ majus*, Hook. Fl. Bor. Amer., ii, p. 258. Hooker's *β. intermedia* of Phegopteris is *connectile*, Willd., which A. Gray refers to *P. Phegopteris*, *L.* *Phegopteris hexagonoptera*, J. Sm. Cat., p. 17.—Canada, Goldie in Hook. Fl. B. Amer.; Chippawa, C. W., P. W. Maclagan, M.D.; Mirwin's Woods, near Prescott, rare, B. Billings, jun.; near Westminster Pond, London, W. Saunders. Not by any means so general in Canada as in New York State, where Professor Torrey states it is common.

P. Phegopteris, Linn.—Frond acutely triangular in outline, acuminate, pinnate; the pinnæ linear-lanceolate, pinnatifid, lowest pair deflexed; lobes of the pinnæ oblong, scythe-shaped, obtuse approximate, entire; rachis hairy and minutely scaly to the apex of the frond, as well as the mid-ribs of the pinnæ. *P. Phegopteris*, Linn., A. Gray, Moore, &c. *Phegopteris vulgaris*, J. Sm., *P. connectile*, Michx, Pursh Fl. Am. Sept., 2nd ed., vol. ii, p. 659.—Canada, Hooker, Black-Lead Falls and DeSalaberry, west line, W. S. M. D'Urban; Ramsay, Rev. J. K. McMorine, M.A.; Nicolet, P. W. Maclagan, M.D.; Prescott, damp woods, not common; Osgood Station of the Ottawa and Prescott Railway; also Gloucester, near Ottawa, growing on the side of a ravine, and Chelsea, C. E., B. Billings, jun; opposite Grand Island, Lake Superior, R. Bell, jun.; L'Orignal and Harrington, J. Bell, B.A.

P. Dryopteris, Linn.—Frond thin, light-green, pentangular in outline, consisting of three divaricate triangular subdivisions, each of which is pinnate, with its pinnæ more or less deeply pinnatifid; pinnules oblong, obtuse, nearly entire; stipe slender and weak, not glandulose. *P. Dryopteris*. Linn. A. Gray, Moore, &c. *Phegopteris Dryopteris*, J. Sm.—Abundant in the woods around Kingston; Ramsay, Rev. J. K. M'Morine, M.A.; very common in woods about Prescott. B. Billings, jun.; Montreal and Nicolet Rivers, C.E., P. W. Maclagan, M.D.; Belleville, common in the woods, J. Macoun; opposite Grand Island, Lake Superior, R. Bell. jun.; River Rouge, Round Lake, Montreal, De Salaberry, west line, and Black Lead Falls, W. S. M. D'Urban; Newfoundland, Labrador, Somerset, and St. Joachim, Abbé Provancher; L'Orignal, J. Bell, B.A.

Var. β. erectum.—Frond erect, rigid, with a very stout and very long glabrous stipe (18 inches long); beech woods at Collins's Bay, near Kingston, with the normal form. This variety resembles *P. Robertianum* in general aspect, but is not at all glandulose.

P. Robertianum, Hoffman.—A stouter plant than *P. Dryopteris*; fronds more rigid and erect; rachis, &c., closely beset with minute stalked glands. *P. Robertianum*, Hoffman, Moore. &c. *P. calcareum*, Sm., *P. Dryopteris*, var. *calcareum*, A. Gray. Canada, Moore and other authors; United States, Gray and others. This species is commonly spoken and written of as a Canadian fern. Not having had an opportunity of seeing Canadians specimens, I cannot cite special habitats. The minutely glandulose rachis serves at once to distinguish it.

Adiantum.

A. pedatum, Linn.—Stipe black and shining, erect, forked at top, the forks secundly branched, the branches being oblique triangular oblong pinnules. *A. pedatum*, Linn., A. Gray, &c., Low's Ferns, vol. iii, pl. 14. Abundant in vegetable soil in the woods around Kingston; woods around the iron-mines at Newboro-on-the-Rideau; Farmersville; Toronto; Montreal, Chippawa, Wolfe Island, and Malden, P. W. Maclagan, M.D.; Belleville, in rich woods, abundant, J. Macoun; Ramsay, Rev. J. K. McMorine, M.A.; Ke-we-naw Point, R. Bell, jun; at the Sulphur Spring, and common everywhere about Hamilton, Judge Logie; Lake Huron, Hook. Fl. B. A.; De Salaberry, west line, W. S. M. D'Urban; on the Gatineau near Gilmour's rafting-ground, D. M'Gillivray, M.D.; London, W. Saunders; St. Joachim and Isle St. Paul, Montreal, Abbé Provancher; West Hawkesbury and Grenville, C. E., J. Bell, B. A. Apparently common everywhere in Upper Canada. I cannot speak so definitely of the Lower Province. This is one of our finest Canadian ferns; "the most graceful and delicate of North American ferns," says Torrey. It is easily cultivated. Fine as it is in the Canadian woods, I have specimens even more handsome from Schooley's Mountains (A. O. Brodie, Ceylon Civil Service); their fan-like fronds spread out in a semicircle, with a radius of 2½ feet. It is not a variable species in Canada. T. Moore, in "Index Filicum," gives its distribution as N. and N. W. America, California to Sitka, North India, Sikkim, Neapal, Gurwhal, Simla, Kumaon, Japan. There is a var. *β. Aleuticum*, Rupr., in the Aleutian Islands.

Pteris.

P. aquilina, Linn.—Stipe stout, 1 to 3 feet high, frond ternate, branches bipinnate, pinnules oblong lanceolate, sori continuous under their recurved margins. *Pt. aquilina*, Linn., A. Gray, Moore, &c.—Abundant on Dr. Yates's farm in Pittsburg, and elsewhere about Kingston; Waterdown Road, Hamilton, common, Judge Logie; Chippawa and Malden, C. W., P. W. Maclagan, M.D.; Ramsay, Rev. J. K. M'Morine, M.A.; Prescott, common, B. Billings, jun., Belleville, very common on barren ridges, J. Macoun; Grand Island, Lake Superior, R. Bell, jun.; Red Lake River, also between Wild Rice and Red Lake Rivers, and Otter Tail Lake and River, between Snake Hill River and Pembina, &c., J. C. Schultz, M.D.; Black Lead Falls, and Portage to Bark Lake, W. S. M. D'Urban; Gatineau Mills, very common, D. M'Gillivray, M D.; Lakefield, North Douro, Mrs. Traill; New Brunswick, Hook. Fl. Bor. Amer.; L'Orignal, J. Bell, B.A.; London, W. Saunders.

a. vera.—Pinnules pinnatifid (the normal or typical form of Moore), Dr Yates's farm, Kingston.

β. integerrima.—Pinnules entire (a sub-variety), common in Canada and westward. There are various other sub-varieties; differing in size, pubescence, &c.

γ. decipiens.—Frond bipinnate, thin and membranous, lanuginose, pinnules pinnatifidly toothed, or in small forms, entire, barren; L'Anse à Cabielle, Gaspé, John. Bell, B.A. This is a very remarkable fern, resembling a Lastrea, and in the absence of fructification, it is doubtfully referred to *Pteris aquilina*, yet the venation seems to indicate that it belongs to that species, which is remarkable for its puzzling forms. Being at a loss what to make of this fern, I sent it to Mr. D. C. Eaton, M.A., who is justly looked up to by American botanists as our best authority on American ferns, and he likewise failed to recognise it. I hope some visitor to Gaspé will endeavor to obtain it in a fertile state, and thus relieve the doubt.*

[Var. δ. *caudata* appears occasionally in lists. I have as yet no satisfactory evidence of its occurrence in Canada proper. The nearest approach to it is a specimen from the Hudson Bay territories, probably from the Red River District (Governor M'Tavish). In the South it is a very distinct form, of which there are beautiful specimens in Wright's Cuban Plants (No. 872), and is very close to the *Pteris esculenta* of Australia.]

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* Since the above was written, I have had an opportunity of studying the forms and development of *Pteris aquilina* and am quite satisfied that the doubtful plant is a state of that species, not old enough to be fertile.

PELLÆA.

P. atropurpurea, Link.—Stipe and rachis almost black, shining, 6 to 12 inches high, frond coriaceous, pinnate, divisions opposite, linear-oblong or somewhat oval. *Pteris atropurpurea*, Linn. *Platyloma atrop.*, J. Sm., Torr. N. Y., ii. p. 488. *Allosorus atropurpureas*, A. Gray. *Pellæa atropurpurea*, Link., Fée, J. Sm. in Cat., Eaton.—Niagara River, at the Whirlpool, three miles below the Falls. This fern seems to retain its fronds all winter, for I have fertile specimens, in a fine state collected at the Whirlpool at the end of February, 1859, by A. O. Brodie. Dr. P. W. Maclagan has also collected it there. It is not common anywhere on the American continent so far as I can learn. Mr. Lowe speaks of it as in cultivation in Britain, " an evergreen frame or greenhouse species, not sufficiently hardy to stand over winter's cold." There must be some other reason for want of success in its cultivation in Britain.

ALLOSORUS.

A. Stelleri, Ruprecht.—Fronds pale green, thin and papery, 3 to 9 inches long, bipinnate and tripinnate, some of the smaller barren fronds scarcely more than pinnate; pinnæ five or six pairs; lobes of the barren frond, rounded, oval, veiny; of the fertile frond, much narrower, linear-lanceolate, firmer; sori at the tips of the forked veins along the margins, stipe red, whole plant glabrous. A beautiful and delicate fern, growing in the crevices of rocks, rare. *Allosorus Stelleri*, Ledeb, Fl. Rossica. *Allosorus gracilis*, Presl., A. Gray, Torrey Fl. N. Y. ii. p. 487. In a letter from Mr. T. Moore (1857), he mentioned to me that he had learned from specimens from Dr. Regel, St. Petersburg, that " the North American *Allosorus gracilis* is the old *Pteris Stelleri* of Amman, so that it spreads from North America through Siberia to India, whence Dr. Hooker has it." *Allosorus minutus*, Turcz. Pl. Exs. *Cheilanthes gracilis*, Klf. *Cryptogramma gracilis*, Torrey. *Pteris Stelleri*, Gmelin, *Pteris minuta*, Turcz. Cat. Pl. Baik. Dah. *Pt. gracilis*, Michaux. —Near Lakefield, North Douro, C. W., on rocks, Mrs Traill; abundant in crevices of limestone rocks, on the rocky banks of the Moira, Belleville, Co. Hastings, J. Macoun; Lake of Three Mountains, W. S. M. D'Urban; Canada to the Saskatchewan, Hook. Fl. Bor. Am.; Dartmouth, Gaspé, John Bell, B.A. This is a Northern species, and rare in the United States.

Cryptogramma.

C. acrostichoides, R. Br.—" Remarkable for its sporangia extending far down on the oblique veins, so as to form linear lines of fruit." I have not seen the plant. It is referred by Sir William Hooker to *Allosorus crispus*(A. Gr. in Enum. of Dr. Parry's Rocky Mt. Plants). *Cryptogramma acrostichoides*, R.Br., Moore. *Allosorus acrostichoides*, A. Gr.—Isle Royale, Lake Superior. Placed in Dr. Hooker's Table as a Canadian species that does not extend into the United States. It has recently been found on the Rocky Mountains. *Allosorus crispus* is general throughout Europe, and occurs at Sitka, in North-West America. Mr. Moore observes that the Eastern (Indian) species, A. *Brunoniana*, is very doubtfully distinct from the European plant.

Struthiopteris.

S. Germanica var. β *Pennsylvanica*.—Rhizome stout, erect; fronds tufted; sterile ones large pinnate, erect-spreading, deeply pinnatifid; the fertile ones erect, rigid, with revolute contracted divisions, wholly covered on the back by sporangia. A very graceful fern, well-suited for cultivation in gardens. *Strupthiopteris Pennsylvanica*, Willd., Pursh, J. Sm. Cat. *S. Germanica*, Hooker, Torrey Fl. N. Y., ii, p. 486, Gray. *Osmunda Struthiopteris*, Linn.; *Onoclea Struthiopteris*, Schkr.; *Onoclea nodulosa*, Schkr., according to Hooker. Torrey refers *O. nodulosa*, Michx., to *Woodwardia angustifolia*.—Frankville, Kitley; Longpoint; Lansdowne; Hardwood Creek; usually found along the margins of creeks, &c.; common in rich, wet woods near Prescott, and abundant around Ottawa, B. Billings, jun.; low rich grounds, Belleville, abundant along Cold Creek, J. Macoun; Ke-we-naw Point, Lake Superior, in low ground, at times under water, R. Bell, jun.; Ramsay, Rev. J. K. M'Morine, M.A.; near Lakefield, North Douro, Mrs. Trail; field beyond Waterdown, Hamilton, Judge Logie; Osnabruck and Prescott Junction, Rev. E. M. Epstein; near Montreal, W. S. M. D'Urban; Assiniboine River, John C. Schultz, M.D.; Canada, to the Saskatchewan. Hook. Fl. Bor. A.; foot of Cape Tourmente, Abbé Provancher. This is the commonest plant in the Bedford swamps; Gaspé and L'Original, J. Bell, B.A.; London, W. Saunders. Found in the western part of New York State, but rare, according to Torrey.

Onoclea.

O. sensibilis, Linn.—Rhizome creeping; barren frond broad, leafy, deeply pinnatifid; fertile ones erect, spicate, contracted, doubly pinnate, with small revolute pinnules, enclosing the sporangia, not at all leafy. *Onoclea sensibilis*, Linn., Gray, J. Sm., &c. Lowe's Ferns, vol. vi. pl. 1.—In woods along the banks of the Little Cataraqui Creek in great abundance, and in moist swampy places in the woods in various other places about Kingston; west end of Loughborough Lake; Becancour, Abbé Provancher; London, W. Saunders; common in marshy ground at Hamilton, Judge Logie; Lakefield, North Douro, Mrs. Traill; St. John's, C. E., Niagara and Malden, P. W. Maclagan, M.D.; Belleville, in low marshy places, abundant, J. Macoun; Ramsay, Rev. J. K. M'Morine, M.A.; Amagos Creek, Lake Superior, R. Bell, jun.; Prescott, common, B. Billings, jun.; on the river shore, Gatineau Mills, D. M'Gillivray, M.D.; L'Anse au Cousin, Gaspé and L'Orignal, J. Bell; Nova Scotia. This curious fern has been cultivated in England since 1699; at Kew, since 1793. It is very variable as regards the outline and subdivision of the barren frond.

Var. *β. bipinnata*.—Fronds bipinnate; perhaps not a constant form. Fertile fronds of this variety originated the *O. obtusilobata*, Schkr. Pêche River, and near Cantley, Hull, D. M'Gillivray, M.D.

Asplenium.

A. Trichomanes, Linn.—Frond small, narrow, linear, pinnate; pinnæ roundish-oblong or oval, oblique, almost sensile, crenate: rachis blackish brown, shining, margined; sori distant from the midrib. *Asplenium Trichomanes*, Linn., Moore, Gray, &c., Lowe's Ferns, vol. v. pl. 22. *Asp. melanocaulon*, Willd., Pursh. Fl. Sept. Americ., ii., p. 666. *Asp. anceps*, Lowe.—Inhabits rocky river banks, &c., but is not common in Canada. On rocky banks, at Marble Rock, on the Gananoque River; Mamainse, dry ground on the top of a mountain, R. Bell, jun.; rocky woodlands west from Brockville, rare, B. Billings, jun.; Montreal, Jones's Falls and Niagara, P. W. Maclagan, M.D.; Lake Medad, Hamilton, Judge Logie; Pittsburg, near Kingston, John Bell, B.A.; foot of Cape Tourmente, Abbé Provancher; near Belleville, J. Macoun.

β. delicatulum.—Frond narrower, pinnæ much smaller, thinner, and wider apart than in the normal form. This is a sub variety, passing by intermediate states into the typical plant, which is the common form of northern Europe. The variety is the prevalent form in Canada, but also occurs farther south in the United States, for I have specimens from Catskill (A O. Brodie); and is not confined to the American continent, for Professor Caruel, the acute author of "Flora Italiana," sends specimens of a similar form from Florence. There is an *A. Trich.* var. *majus*, in Cuba (according to Mr. Eaton's enumeration of Wright's Cuban ferns). *A. anceps* is a Madeiran form, not distinguishable, so far as I can see, from common European states of *A. Trichomanes*.

A. viride, Hudson.—Frond small, linear, pinnate; pinnæ roundish-oblong or oval, more or less cuneate at base, slightly stalked, crenate or slightly lobed; rachis bright green; sori approximate to the midrib; in outline of frond and general aspect resembles the preceding species. *A. viride*, Hudson, Flora Anglica, 385; Sm., Bab., Moore, &c. *A. Trichomanes*, *β ramosum*, Linn.—This beautiful alpine fern was found in Canada for the first time last summer, having been collected in considerable quantity at Gaspé, C.E., by John Bell, B.A., who formed one of a party of the Provincial Geological Survey. It was previously known to occur sparingly in N. W. America, at one spot on the Rocky Mountains, and in Greenland. Mr. Bell's discovery of its occurrence in Gaspé is therefore extremely interesting in a geographical point of view. The Gaspé specimens, although young, agree perfectly with the typical European form of *A. viride*, of which I have a full series of Scotch examples, as well as others collected in Norway by T. Anderson, M.D. In young specimens the pinnæ are usually large, thin, and more cuneate and lobed than in the mature plant, in which they are roundish-ovate.

A. angustifolium, Michx.—Frond large (1 to 3 feet high), annual, lanceolate, pinnate; pinnæ long, linear-lanceolate, acute; fertile fronds more contracted than the barren ones, "bearing sixty to eighty curved fruit-dots on the upper branches of the pinnate forking veins," (Eaton). *A. angustifolium*, Michaux, A. Gray, Eaton, J. Smith, Lowe's Ferns, vol. v, pl. 24.—In Canada this fern appears to be confined to the extreme south-western point of the province;* Malden, P. W. Maclagan, M.D.; at the Oil Wells, township of Enniskillen, Lady Alexander Russell. For

* Subsequently found in the Belleville district by Mr. Macoun.

information of the latter station I am indebted to the kindness of Judge Logie of Hamilton. This fern appears to be still rare in cultivation among the fern-fanciers of Europe. It was introduced to Britain in 1812 by Mr. John Lyon of Dundee.

A. ebeneum, Aiton.—Frond erect, lance-linear, pinnate; pinnæ numerous, lanceolate (the lower oblong), sessile, slightly auricled at base and finely serrate; rachis blackish-brown, shining. *Asplenium ebeneum*, Aiton, Hortus Kewensis, ed. 2, vol. v, p. 516, Gray, Eaton, J. Smith, Lowe's Ferns, vol. v, pl. 2. *A. polypodioides*, Schkr.—Rocky woods, Brockville, B. Billings, jun.; the only locality in Canada from which I have seen specimens.* Although so rare with us, this species appears to be not uncommon in the United States. Gray speaks of it as "rather common;" I have specimens from Schooley's Mountains, West point, N. Y., Providence, Philadelphia, &c. Judging from Mr. Eaton's indication in Chapman's Flora, it again seems to decrease in the south, so that its present headquarters are in the Nothern States.

[*A. marinum*, Linn.—Frond broad and leafy, linear-lanceolate, tapered above, pinnate; pinnæ ovate-oblong or linear, oblique, shortly stalked, rarely pinnatifid, the upper ones confluent, stipe brownish, rachis brown below, green and winged above, sori large, linear, oblique; grows on rocks. *Asplenium marinum*, Linn., Moore, J. Smith, &c. *A. lætum*, Hort.—New Brunswick, E. N. Kendal, in Hook. Fl. Bor. Am. I cannot learn that this fern has been subsequently found in North America, and hope, therefore, that botanists will look for it on the rocky shores of New Brunswick. It usually grows out of the crevices of shore-cliffs, and is very limited in its geographical range, growing, according to Moore, only in the western part of Europe, crossing from Spain to Tangiers on the African coast, and being again met with in Madeira, the Azores, and Canary Isles.]

A. thelypteroides, Michaux.—Fronds large oblong-ovate, pinnate; pinnæ lancelolate, acuminate, from a broad sessile base, and deeply pinnatifid, the lobes oblong, minutely toothed. *Asplenium thelypteroides*, Michaux, Pursh, Bigelow, Torrey, Beck, Darlington, Gray, Eaton. *Diplazium thelypteroides*, Presl, J. Sm.—In rich woods, DeSalaberry, west line, W. S. M. D'Urban; Minvin's woods, &c., Prescott, B. Billings, jr.; Belœil Mountain, P. W. Maclagan, M.D.; moist woods near the Hop Garden, Belleville, rare, J. Macoun (a deeply serrated, leafy form); Ramsay, Rev.

* Subsequently found near Belleville by Mr. Macoun.

J. K. M'Morine, M.A.; St. Joachim, Abbé Provancher; London, W. Saunders. Not a common fern in Canada; perhaps more plentiful in the United States. I have a fine series of specimens from Schooley's Mountains (A. O. Brodie), and others from Providence.

β. *serratum*.—Lobes of the pinnæ ovate-oblong, approximate, strongly and incisely serrate. This may be regarded as a sub-variety.—Belleville, J. Macoun.

[*A. montanum*, Willd., which extends along the Alleghanies, has not yet been found in Canada, but may possibly occur. It grows on cliffs.]

[*A. Ruta-muraria*, Linn.—The wall-rue, a small species, which grows in the crevices of limestone cliffs in the Northern States, and is common on stone walls and old buildings in Britain, is to be looked for in Canada.]

Athyrium.

A. Filix-fœmina, R. Br.—Frond ample (1–3 feet long), broadly oblong-lanceolate, bipinnate; pinnæ also lanceolate; pinnules ovate-lanceolate or oblong, incisely toothed. Grows in large tufts, the fronds delicate, of a bright green hue. Lady Fern of the poets. *Athyrium Filix-fœmina*, R. Br., Spreng., Roth., Hook., Moore, &c. *Aspidium Filix-fœmina*, Swartz, Pursh, Beck. *Aspidium asplenioides*, Swartz, Willd., Pursh. *Asplenium Athyrium*, Schkr. *Asplenium Michauxii*, Spreng. *Asplenium Filix-fœmina*, A. Gray, Man., p. 595. *Nephrodium asplenioides* and *Filix-fœmina*, Michx. *Asplenium angustum*, Willd., Pursh.—Common in the woods near Kingston, Toronto, Trenton, &c.; Pêche River, Ottawa, Dr. M'Gillivray; Temiscouata, Chippawa and Malden, P. W. Maclagan, M.D.; Belleville, moist woods, very common, several varieties, J. Macoun; Ramsay, Rev. J. K. M'Morine, M.A.; mouth of the Awaganissis Brook, Gulf of St. Lawrence, C. E., and Schibwah River, Lake Superior, R. Bell, jun.; Cemetery grounds, Hamilton, and on Prince's Island, Judge Logie; Hamilton's farm and base of Silver Mt., W. S. M. D'Urban; Mountain Fall, H. B. T., Governor M'Tavish; Snake Hill River, John C. Schultz, M.D.; L'Anse à la Barbe, Gaspé and L'Orignal, John Bell, B.A.; St. Tite, Abbé Provancher; London, W. Saunders.

β. *angustum*.—Frond narrow, linear-lanceolate; pinnæ rather crowded; pinnules not pinnatifid, but incisely toothed, with recurved margins; sori short, curved (*Aspidium angustum*, Willd.?)—Farmersville; Delta; Belleville, J. Macoun.

γ. rhæticum.—Frond rather small, firm, narrowly lanceolate in outline; pinnæ more or less distant and narrowly lanceolate; pinnules incisely toothed or deeply pinnatifid, linear, or more frequently lanceolate-acute, and acquiring a linear aspect from the reflection of the lobes, often crowded with confluent sori.—Dr. Yates's farm, on the banks of the St. Lawrence, near Kingston; near Montreal, Rev. E. M. Epstein, M.D.; near Lakefield, North Douro, Mrs Traill.

δ. rigidum.—Frond small, rigid; pinnules approximate, connected at the base by a broad decurrent membrane, sori confined to the lower part of each pinnule.—Lakefield, North Douro, Mrs. Traill.

There are other forms of this species, dependent in many cases, no doubt, upon situation; some with thin veiny fronds of great size, bearing few scattered sori. One form, very like the British var. *molle*, was gathered at Belleville by Mr. Macoun. I know no fern more variable than this. Our Canadian forms require careful examination.

WOODWARDIA.

W. Virginica, Willd.—Frond pinnate; pinnæ lanceolate, pinnatifid; sori arranged in line on either side of the midribs of pinnæ and pinnules. *Woodwardia Virginica*, Willd.; Gray Man., p. 593. (*Doodia*, R. Br.)—Millgrove Marsh, C. W., Judge Logie; sphagnous swamp near Heck's mills, ten miles from Prescott, Augusta, C. W., B. Billings, jun.; Pelham, C. W., P. W. Maclagan, M.D.; Belleville, J. Macoun.

SCOLOPENDRIUM.

S. vulgare, Smith.—Fronds (in tufts) strap-shaped, with a cordate base undivided, margin entire, stipe scaly. *Scolopendrium vulgare*, J. E. Smith, Bab., J. Sm., Moore, &c. *S. officinarum*, Swartz, Schkr., Gray, Man., p. 593; Torr. Fl. N. Y. ii, p. 490. *S. Phyllitis*, Roth. *S. officinale*, DC. *S. lingua*, Cavanilles. *Asplenium Scolopendrium*, Linn. Sp. Plantarum, &c. *A. elongatum*, Salisb. *Blechnum linguifolium*, Stokes. *Phyllitis Scolopendrium*. Newman.—Owen Sound, Georgian Bay, Lake Huron, on soft springy ground, amongst large stones, growing in tufts, abundant, 1861, Robert Bell, jun. This interesting addition to our list of Canadian ferns has been collected in the same place by the Rev. Prof. William Hincks, F.L.S. Mr. Bell's specimens agree, in every respect, with the typical European form of the species, which is exceedingly variable. Only one station was previously known for this fern in all North America, viz., limestone rocks along Chittenango Creek, near the Falls, respecting which Professor Torrey observed:—"This fern is undoubtedly indigenous in the locality here given, which is the only place where it has hitherto been found in North America." It was first detected by Pursh, who found it in shady woods, among loose rocks in the western parts of New York, near Onondago, on the plantations of J. Geddis, Esq. This species (he said) I have seen in no other place but that here mentioned, neither have I had any information of its having been found in any other part of North America. (*Pursh.*) Nuttall states that he found it in the western part of the state, without giving the locality; but according to Dr. Pickering, the specimens of Mr. Nuttall, in the herbarium of the Academy of Sciences in Philadelphia, are marked, "near Canandaigua, at Geddis's farm, in a shady wood, with *Taxus Canadensis*," Torrey Fl. N. Y., ii, p. 490. This fern occurs throughout Europe, and also in Northern Asia. Mr. Moore considers the Mexican *S. Lindeni* as a mere veriety of this species. In Europe there are many remarkable varieties, of which Mr. Moore has figured and described more than fifty that occur in Britain. The great beauty and remarkable character of many of these render them very suitable for cultivation. None of the abnormal forms have as yet been found in America, probably merely because they have not been looked for.

Camptosorus.

C. rhizophyllus Presl.—Frond lanceolate, broad and hastate, or cordate at base, attenuated towards the tip, which strikes root and gives rise to a new plant; hence this fern is called the Walking Leaf; fronds evergreen. *Camptosorus rhizophyllus*, Link, Presl, A. Gray, Eaton, Hooker. *Asplenium rhizophyllum*, Linn. in part (Linnæus's name included *Fadyena prolifera*, a totally different plant), Michaux, Pursh, Fl. Am. Sept. ii, p. 666, Bigelow, Torrey, Beck, Darlington, Lowe's Ferns, vol. v, pl. 14 *a*. *Antigramma rhizophila*, J. Sm., Torrey, Fl. N. Y. ii. p. 494. *Camptosorus rumicifolius*, Link.—On the flat perpendicular face of a rock in the woods, on the Spike's Corners side of the mills at High Falls, township of Portland, C. W., July 1862. In a rocky wood, a mile north-west from the Oxford station of the

Ottawa and Prescott Railway, upon a rock slightly covered with mould, B. Billings, jun.; mountain-side west from Hamilton, also at Ancaster and at Lake Medad, Judge Logie; Wolfe Island, E. J. Fox; not rare about Owen Sound, Rev. Prof. W. Hincks; Montreal Mountain, Abbé Provancher; rather northern in its range in North America, but not common anywhere in Canada. This curious fern has been long in cultivation in the botanic gardens of Europe.

Lastrea.

L. dilatata, Presl.—Fronds spreading, broadly lanceolate, rather pale but vivid green, bipinnate; the pinnules pinnate or pinnatifid with pointed lobes; on the lower pinnæ the posterior pinnules are longer than the anterior ones; stipe with rather distant pale unicolorus scales; sori small. This description refers only to the commonest form in Canada. It is a very variable species. *Aspidium spinulosum*, Gray.—Abundant in the woods about Kingston, as Collins's Bay, &c., Smith's Falls, Odessa, woods near the Falls of Niagara, Hinchinbrook, Gananoque lakes, Farmersville, Hardwood Creek, Delta, Upper Rideau Lake, Newboro-on-the-Rideau, Longpoint; Mouth of the Awaganissis Brook, Gulf of St. Lawrence, Goulais River, also Grand Island, and at Ke-we-naw Point, Lake Superior, R. Bell, jun.; Ramsay, Rev. J. K. M'Morine, M.A.; Prescott, very common. B. Billings, jun.; St. John's, St. Valentine, and Belœil, P. W. Maclagan, M.D.; Belleville, very common, J. Macoun; St. Foy Woods, W. S. M. D'Urban; Daniel's Harbor, Newfoundland, James Richardson (a peculiar form); Pêche River, Chelsea and Cantley, Hull, D. M'Gillivray, M. D. Of varieties referable to var. *Boottii*, Gray, var. *dumetorum*, Gray, or others, differing from the common (which, however, is perhaps not the typical) form, I have seen specimens from, or obtained information of their having been collected in, the following localities:—Malden, Brighton, Point Rich, Newfoundland, Hamilton's Farm, Murray, Hamilton, &c. These varieties still require careful study, with a view to their identification with European forms, which are now well understood.

β. tanacetifolia.—Frond large and very broad, triangular, tripinnate, with the pinnules pinnatifid or deeply incised, lobed. *P. tanacetifolium*, DC. ?—Pointe des Morts, Gaspé, John Bell, Mr. Bell's specimen seems to agree well with Mr. Moore's description of var. *tanacetifolia*. The typical *L. dilatata*, with dark-centred scales, so common in Scotland, I have not yet seen growing in the Canadian woods; but a fragment, the upper portion of a frond, from Point Rich, Newfoundland, James Richardson, looks like it.

L. marginalis, J. Smith.—Frond ovate oblong, a foot, more or less, in length, bipinnate, pale green, somewhat coriaceous, lasting the winter; pinnæ linear-lanceolate, broad at base; pinnules oblong, very obtuse, obsoletely incised; sori marginal; stipe of a pale cinnamon color when old, with large thin pale scales profuse below. *L. marginalis*, J. Sm., *Aspidium marginale*, Swartz, Pursh, Bigelow, Beck, Darlington, Gray, Eaton, Lowe's Ferns, vol. vi, pl. 6 (a bad figure), Torrey Fl. N. Y. ii, p. 495. *Polypodium marginale*, Linn. *Nephrodium marginale*, Michaux.—This species is as common in the Canadian woods as *Lastrea Filix-mas* is in those of Britain; woods around Kingston, abundant; near Odessa; Newboro-on-the Rideau; along the course of the Gananoque River and lakes, in various places; very fine at Marble Rock; Farmersville; Hardwood Creek; Valley of the Trent, found on the great boulder, &c.; on Judge Malloch's farm and elsewhere about Brockville; on limestone rocks above the Rapids at Shaw's Mill, Lakefield, North Douro, Mrs. Traill; Sulphur Spring, Hamilton, Judge Logie; Cedar Island, A. T. Drummond, jun., B.A.; Smith's Falls, and Chippawa, P. W. Maclagan, M.D.; Ramsay, Rev. J. K. M'Morine, M.A.; Prescott, common, B. Billings, jun.; Belleville, in rich low moist woods, common, J. Macoun; above Blacklead Falls, W. S. M. D'Urban; Gatineau Mills, D. M'Gillivray, M.D.; Cape Tourmente, Abbé Provancher; Harrington, J. Bell, B.A.; London, W. Saunders. This is exclusively an American fern. It varies in size and appearance; in some specimens the pinnæ are wide apart, their divisions small and narrow; in others, the pinnæ overlap each other, and their divisions are broad and leafy, also overlapping, and in such forms they are usually toothed into rounded lobes. Mr. Macoun sends a form from Belleville, more deeply serrate than usual.

β. *Traillæ*.—Fronds very large ($3\frac{1}{2}$ feet long), bipinnate, all the pinnules pinnatifid.—Lakefield, North Douro, Mrs. Traill. This is a very handsome variety, and would form an attractive plant in cultivation. It has the same relation to the type of *L. marginalis* which *L. incisa* (*erosa*) has to typical *Filix-mas*.

Lastrea Filix-mas is erroneously referred to in some American works on Materia Medica as a common North American and Canadian fern. It has recently, however, been found on the Rocky Mountains by Dr. Parry. Professor Gray says that Dr. Parry's specimens are apparently identical with the European plant. Nothing like it occurs in Canada, so far as I can ascertain. Varieties of *L. marginalis* have been sent to me under the name of *L. Filix-mas.*

L. cristata, Presl.—Fronds erect, rigid, linear-oblong in outline, vivid green, pinnate or slightly bipinnate; pinnæ triangular-lanceolate; pinnules large, oblong, approximate, decurrent; sori large, in a single series on each side of, and near to, the vein; stipe with few pale scales. *Lastrea cristata*, Presl, Moore, &c. *Polypodium cristatum*, Linn. *Aspidium cristatum*, Swartz, Willd., Pursh, E. B., Beck, Torrey Fl. N. Y., ii, p. 496. Gray. *Aspidium cristatum*, *β. Lancastriense*, Torrey ; *A. Lancastriense*, Spreng., Bigelow, Beck, Darlington, Hooker.—Woods around Kingston; near the Pêche River, Gatineau, a tributary of the Ottawa, D. M'Gillivray, M.D.; Three Rivers, St. John's and Chippawa, P. W. Maclagan, M.D.; Sproule's Swamp, east from Belleville (a cedar swamp), not common, J. Macoun ; Ramsay, Rev. J. K. M'Morine, M.A.; Prescott, common, B. Billings, jun.; Lake of Three Mountains, W. S. M. D'Urban; Silver Brook, Gaspé, John Bell, B.A.; St. Fereol, Abbé Provancher; L'Orignal, J. Bell ; London, W. Saunders.

L. Goldieana, J. Smith.—Frond very large (3 or 4 feet or more in length), dark green, bipinnate; pinnæ 6 to 8 inches long, narrow, linear-lanceolate, not much attenuated towards the tips; pinnules (12–20 pairs), linear-oblong, approximate, uniformly curved forwards, scythe-shaped, sometimes with an extra lobe at base; sori small, near the midrib ; stipe with pale shaggy scales above and larger dark-centred ones below; our largest Canadian fern, usually barren. *Lastrea Goldieana*, J. Smith. *Aspidium Goldianum*, Hooker, Edin. New Phil. Jour. vi, p. 333, and Fl. Bor. Am., ii, p. 260, Gray. *Nephrodium Goldieanum*, Hook. and Grev. *Aspidium Filix-mas*, Pursh, not of Willd., &c.—Farmersville, in woods near the village, abundant and very fine, forming immense tufts; near Hamilton's farm and De Salaberry, town-line, W. S. M. D'Urban; Belœil Mountain, Montreal and Malden, P. W. Maclagan, M.D.; Belleville Woods, near Castleton; woods below Heely's Falls, west side, and in Simon Terrill's

Woods, Brighton, J. Macoun; Augusta, Robert Jardine, B.A.; about Montreal, Mr. Goldie in Hook. Fl. Bor. Amer. London, W. Saunders. This fine fern was appropriately named by Sir William Hooker in honor of its discoverer, a successful investigator of Canadian botany, now resident at Paris, C.W. The species belongs exclusively to the American continent. In Canada we have two sub-varieties:—

a. serrata, in which the divisions of the pinnæ are coarsely serrate. Montreal.

β. integerrima, in which the divisions of the pinnæ are almost or quite entire. Farmersville.

L. fragrans, Moore.—Frond 8 to 12 inches long, coriaceous, bipinnate, pinnæ triangular, of few (4 or 5 pairs) of pinnules, which are crowded and covered beneath by the large rusty membranous indusia, which conceal the sori. Rachis with profuse, large, palish scales, especially near the base. *Aspidium fragrans*, Swartz, A. Gray.—Rocks, Penokee Iron Ridge, Lake Superior, Mr. Lapham, and north-west—Professor Wood, in Class-Book; shaded trap rocks, Falls of the St. Croix, Wisconsin, Dr. Parry, and high northward, Gray's Manual. I have not yet seen Canadian specimens of this species, which is quite a northern fern, stretching along the northern shores of the Russian Artic dominions. I have specimens from Repulse Bay, collected by Captain Rae's party while wintering there in 1855. This plant does not appear to be in cultivation in any European garden.

L. Thelypteris, Presl.—Frond erect, lanceolate, mostly broad at base, and narrowed upwards, thin, and herbaceous, or slightly coriaceous, glabrous or downy, pinnate; pinnæ linear, rather distant, deeply pinnatifid; pinnules with revolute margins, veins forked, sori near their middle, becoming confluent. Stipe as long as, or longer than, the frond, and naked. *Lastrea Thelypteris*. Presl, Moore, J. Sm. *Aspidium Thelypteris*, Swartz, E. B. Willd., Pursh, Bigelow, Beck, Darlington, Torrey Fl. N. Y. ii, p. 596, A. Gray, Man. *Polypodium Thelypteris*, Linn. *Dryopteris Thelypteris*, Gray.—Swamps in the woods, townships of Hinchinbrook, Portland, Ernestown, &c.; Millgrove Marsh, Hamilton, Judge Logie; Gatineau Mills on the Ottawa, D. M'Gillivray, M.D.; Prescott, common, B. Billings, jun.; Temiscouata, Thorold and Malden, P. W. Maclagan, M.D.; Belleville, very common in swamps, J. Macoun; Ramsay, Rev. J. K. M'Morine, M.A.; portage to Bark Lake, and on lumber-road through the woods east from Hamilton's farm, W. S. M. D'Urban; Montreal, Drs. Maclagan and Epstein; Hudson Bay Territories near Red River Settlement, Governor M'Tavish; St. Joachim, Abbé Provancher; L'Orignal, J. Bell, B.A.; London, W. Saunders. In the State of New York the species is common in swamps and wet thickets (Torrey). I have it from West Point, N. Y. In the south, Eaton indicates Florida and northward. Very seldom found with fructification (Pursh). Fertile specimens are not rare with us. The forked veins of the pinnules distinguish this species from the next. In the Canadian plant, the outline of the frond is a little different from Scotch and Irish specimens, being less narrowed at the base. There are three forms of this species in Canada. The first (α) seems to be the plant of Gray's Manual, the second (β) is more like the *L. Thelypteris* of Europe, and the third (γ) is intermediate between this species and the next.

α. *pubescens*.—Frond somewhat coriaceous densely pubescent or downy throughout. Odessa, Hudson Bay.

β. *glabra*.—Frond thin, herbaceous, glabrous. Montreal, Chelsea, Hichinbrook, &c.

γ. *intermedia*.—Frond narrowed below, glabrous; stipe slightly elongated (veins forked). Gaspé, J. Bell, B. A.

L. *Nov-Eboracensis*.—Frond lanceolate, narrow at the base, thin and herbaceous, pinnate; pinnæ linear-lanceolate, more or less approximate, deeply pinnatifid; pinnules oblong, usually flat; veins simple (not forked), sori never confluent; stipe short. rachis, &c., downy, pinnules more or less distinctly ciliate. *Lastrea Noveboracensis*, Presl. *Polypodium Noveboracense*, Linn., Schk. *Aspidium thelypteroides*, Swartz. *Aspinium Noveboracense*, Willd., A. Gray, Eaton—Pittsburg near Kingston; Lakefield, North Douro, Mrs. Traill; Mountain side, Hamilton, Judge Logie; Prescott, common, B. Billings, jun., Mounts Johnson, Montreal, and Belœil, P. W. Maclagan, M. D.; Ramsay, Rev. J. K. M'Morine, M.A.; near Chelsea, D. M'Gillivray, M.D.; London, but not common, W. Saunders; L'Orignal, J. Bell. This fern belongs exclusively to the American continent. It seems to be more abundant and more distinct in the United States than with us. In *Flora Boreali-Americana*, Sir William Hooker observed: "The *Aspidium Noveboracense* is quite identical with *A. Thelypteris*." In the recently-published volume of *Species Filicum* (which at present I can only quote at second hand), doubts are still expressed as to it being a species really distinct from L. *Thelypteris*. Mr. Eaton and other American pteridologists think it quite distinct. Its most obvious characters are—(1.) The tapering form of the lower part of the frond (although there is also a form of *L. Thelypteris* having this peculiarity; (2.) sori few, mostly near the base of the pinnules, and not confluent, not overlapped by a recurved margin; (3.) veins of the pinnules simple, not forked. The outline of the frond must not be depended upon, as the Scotch and Irish *L. Thelypteris* is narrowed at the base like *L. Nov-Eboracensis*, This species is allied to *L. montana*, Moore (*Oreopteris*, Bory.)

POLYSTICHUM.

P. angulare, *β. Braunii.*—Frond soft, herbaceous, lanceolate, bipinnate; pinnules stalked, serrate; the small teeth tipped by soft bristles; stipe and rachis scaly throughout; In the Canadian plant the scales of the rachis are larger than in the typical *P. angulare* of England, from which it may be specifically distinct: *Aspidium Braunii*, Spenner. *Aspidium aculeatum* var. *Braunii*, A. Gray, Man. Bot., p. 599, A. *aculeatum*, Abbé Provancher; Harrington, Cape Bon-Ami and Dartmouth, N. fork, Gaspé, John Bell, B. A.; base of Silver Mountain, W. S. M. D'Urban.

P. Lonchitis, Roth.—Frond rigid and shining, linear-lanceolate, simply pinnate; pinnæ scythe-shaped, auricled, spinose. *Polystichum Lonchitis*, Roth, Moore, J. Sm., &c. *Polypodium Lonchitis*, Linn. *Lapidium Lonchitis*, Swartz, Schk.—Limestone rocks, Owen Sound, C. W., 1859, Rev. Professor Hincks. Professor Hincks has also kindly furnished me with specimens from the above locality. Woods, southern shore of Lake Superior and north-westward, Professor Asa Gray, in Man.; British America, Professor Wood in Class Book. It will be observed that Professor Hincks's station is the only definite Canadian one with which we are acquainted. Mr. T. Drummond found this fern on the Rocky Mountains many years ago.

P. acrostichoides, Schott.—Frond pale green shining, long and narrow, linear-lanceolate, simply pinnate; pinnæ long and narrow, linear-lanceolate, shortly stalked, auricled anteriorly at the base, more or less distinctly serrate, with hair-tipped teeth; fertile (upper) pinnæ slightly contracted, covered beneath by the large confluent sori stipe profusely chaffy, with pale scales. *Polystichum acrostichoides*, Schott, J. Sm. *Aspidium acrostichoides*, Swartz, A. Gray, Eaton. *Aspid. auriculatum*, Schk. *Nephrodium acrostichoides*, Michx.—Abundant in the woods a few miles from

Kingston; also not rare in the woods of the Midland District of Canada generally; Upper Rideau Lake; woods around Toronto, Rev. Dr. Barclay; Stanfold, Abbé Provancher; L'Orignal, J. Bell; London, W. Saunders; Sulphur Spring, Hamilton, Judge Logie, Prescott, common, B. Billings, jun; Nicolet and St. Valentine, C. E., and Chippawa, C. W., P. W. Maclagan, M.D.; Belleville very common in rocky woods, as in Hop Garden, J. Macoun; Ramsay, Rev. J. K. M'Morine, M.A.; hills and woods, portage to Bark Lake, W. S. M. D'Urban; Gilmour's Farm, Chelsea, D. M'Gillivray, M.D,; Osnabruck and Prescott Junction, Rev. E. M. Epstein. This species is exclusively American.

[*β. incisum*, pinnæ strongly serrate or incised into lobes. *Aspidium Schweinitzii*, Beck. This form, which I have from Schooley's Mountains, &c. (A. O. Brodie), will no doubt be found in Canada.]

CYSTOPTERIS.

C. fragilis, Bernhardi—Fronds delicate, green, lanceolate in outline, glabrous, bipinnate; pinnæ and pinnules ovate-lanceolate or oblong; the latter obtuse, incisely toothed, thin and veiny; sori large; stipe dark purple at the base. *Cystopteris fragilis*, Bernhardi, Hook., Bab., Moore, Newm., A. Gray. *Polypodium fragile*, Linn. *Cystopteris orientalis*, Desvaux. *Polypod. viridulum*, Desv. *Athyrium fragile*, Sadler. *Cyathea fragilis*, Sm. *C. cynapifolia* and *C. anthriscifolia*, Roth. *Cystea fragilis*, Sm. *Cyclopteris*, S. F. Gray.—Rocky woods and cliffs about Kingston, in various places but not abundant; Farmersville; Mountain side, Hamilton, on moist rocks, Judge Logie; rocks by the bay-shore, L'Anse au Cousin and Dartmouth River, Gaspé, John Bell, B.A.; Mirwin's woods, Prescott, common, B. Billings, jun.; Montreal and Jones's Falls, P. W. Maclagan, M.D.; rocky bank of the Moira, rather rare, J. Macoun; Ramsay, Rev. J. K. M'Morine, M.A.; camp at base of Silver Mount, on rocks, also River Rouge, abundant; De Salaberry, west line, and at Black Lead Falls, W. S. M. D'Urban; St. Joachim, Abbé Provancher; Grenville, C. E. John Bell, B. A.; London, W. Saunders. In Dr Hooker's valuable Table of Arctic Distribution this plant is indicated as a Canadian species that does not enter the United States, which, I presume, arises from a misprint, as the species is not uncommon in the Northern States, and extends south to the mountains of Carolina. The delicate *C. tenuis* is the form known in the south, but in Canada we have the stout typical European form of *C. fragilis*.

β. *angustata.*—Pinnules incised, with longish and spreading teeth. *Cyst. frag.* var. *cynapifolia*, J. Lowe.—Gaspé, John Bell, B.A. Specimens referable to this form were likewise gathered at Lake of Three Mountains by Mr. D'Urban. Mr. Bell's specimens agree perfectly with English specimens from Dr. John Lowe (*C. f. cynapifolia*). Italian specimens from Professor Caruel of Pisa, labelled "*Cyst. fragilis*," belong to this variety. Mr. Bell has a fertile frond from Gaspé with very broad veiny pinnæ, deeply incised, but not pinnate.

C. bulbifera, Bernhardi.—Frond thin, green, lanceolate or linear-lanceolate, bipinnate, bulbiferous towards the apex on the under surface; pinnæ oblong-lanceolate, narrowed at the tips; pinnules oblong-obtuse, incisely toothed; sori small, not very numerous; indusium short. Very variable in the size and form of the frond. *C. bulbifera*, Bernhardi, A.Gr., J. Sm.; *Aspidium bulbiferum*, Swartz, Schk., Pursh. *Aspidium atomarium*, Muhl.—Moist, swampy woods about Kingston, as Collins's Bay, Kingston Mills, &c.; abundant on Judge Malloch's farm, a mile west from Brockville; Petit Portage, &c., Gaspé, John Bell, B.A.; Wolfe Island, A. T. Drummond, B.A.; Mirwin's woods, Prescott, common, B. Billings, jun. (short form); Belœil Mountain, P. W. Maclagan, M.D.; rocky banks of the Moira, Belleville, and in cedar swamps and wet woods, very common, J. Macoun; Ramsay, Rev. J. K. M'Morine, M.A.; Mountain side, Hamilton, common, Judge Logie; Black Lead Falls, on limestone rock, W. S. M. D'Urban; Foot of Cape Tourmente, Abbé Provancher; Grenville, C. E., J. Bell; London, W. Saunders. There are two distinct forms or varieties of this species.

a. *horizontalis.*—Frond triangular-lanceolate, broad at base, not more than three or four times longer than broad; pinnæ horizontal. Niagara Falls, within the spray, Collins's Bay, &c.

β. *flagelliformis.*—Frond linear, attenuated upwards, very long and narrow, six or seven times longer than broad; pinnæ less horizontal. Frankville, Montreal, Gaspé, &c.

DENNSTÆDTIA.

D. punctilobula, Moore.—Frond broadly lanceolate, pale green, thin, with a stout rachis, bipinnate; the pinnules pinnatifid; sori minute, usually one on the anterior basal tooth of each lobe of the pinnule, which is reflexed over the sorus; the proper indusium is pale, cup-shaped, opening at top. Rhizome slender, creeping through the soil; whole plant glandular-downy. *Dennstædtia* (Bernhardi, 1800) *punctilobula*, Moore, Index Filicum, p. xcvii. *Dicksonia punctilobula*, Hooker, A. Gray, J. Sm. *D. pilosiuscula*, Willd., Hook. Fl. Bor. Amer. *Nephrodium punctilobulum*, Michx. *Aspidium punctilobulum*, Swartz. *Patania*, Presl. *Dicksonia pubescens*, Schkr. *Sitolobium pilosiusculum*, Desv., J. Sm. Gen. Fil.—Pittsburg near Kingston, John Bell, B.A.; River Rouge, W. S. M. D'Urban; Montreal, P. W. Maclagan, M. D.; Prescott, on Dr. Jessup's moist pasture-land, B. Billings, jun.; New Brunswick, E. N. Kendal, in Hook. Fl. Bor. Amer.; Ramsay, Rev. J. K. M'Morine. Mr. Eaton has mentioned to me that the drying fronds have the odor of new hay.

WOODSIA.

W. Ilvensis, R. Br.—Frond lanceolate, usually four or five inches long, bipinnate, or nearly so, pinnæ approximate, pinnules oblong, obtuse, stipe (red), rachis and whole lower surface of the frond clothed with chaffy scales, which are rusty at maturity. Sori usually confluent around the margins of the pinnules. First observed in the Isle of Elba (Ilva), hence named, after Dalechamp, *Acrostichum Ilvense* by Linnæus, whose Phœnix was very wroth thereat; see English Flora, vol. iv, p. 323. *Woodsia Ilvensis*, R. Br., Hook., Moore, J. Sm., Gray, &c. *Nephrodium lanosum*, Michx.—Abundant on the ridge of Laurentian rocks at Kingston Mills; Rocks west from Brockville and at Chelsea, B. Billings, jun.; Mount Johnson and Belœil Mountain, P. W. Maclagan, M.D.; mountain gneiss rocks, opposite Rouge River, W. S. M. D'Urban. I have likewise specimens from the Hudson Bay territories (Governor M'Tavish), but without special locality. On rocks, Canada, Pursh; Canada to Hudson Bay, Hook. Fl. B. A.; foot of Cape Tourmente, Abbé Provancher. I think our plant must be much larger and more scaly than the European one. A tuft which I have from Catskill Mountains (A. O. Brodie) has richly fruited fronds a foot long and two inches wide. (I find that large American forms of this species have been mistaken for *W. obtusa*. The involucre, which is large and *not* split into hairs in the latter species, serves readily to distinguish it.) Much of the *W. Ilvensis* in cultivation in Europe is probably the American form.

β. gracilis.—Frond more slender, more hairy and less scaly than the type; pinnæ rather distant, deeply pinnatifid, or partially pinnate. Dartmouth River, Gaspé, John Bell, B.A. In technical characters, this form agrees better with *W. alpina* (*hyperborea*), but it has quite a different aspect.

W. alpina, S. F. Gray.—Frond small (from one to two or three inches long), broadly linear, pinnate, somewhat hairy without distinct scales; pinnæ ovate, somewhat triangular, obtuse, pinnatifidly divided into roundish lobes. *Woodsia alpina*, S. F. Gray, Brit. Pl., Moore. *Woodsia hyperborea*, R. Br. in Linn. Trans., vol. xi; Pursh, Fl. Am. Sept. ii, 660.—In the clefts of rocks, Canada, Pursh; Canada to the Saskatchewan, Hooker. Noticed in Dr. Hooker's Table of Arctic Plants as a Canadian species that does not extend into the American States.

W. glabella, R. Br.—Frond a few (2–4) inches long, linear, bright green and glabrous on both sides, simply pinnate; the pinnæ short, rounded or rhombic, cut into rounded or wedged lobes. Stipe with a few scales at the base only. *Woodsia glabella*, R. Br., Hook. Fl. Bor. Amer., tab. 237; Gray. Canada, Prof. Wood in Class Book. Sir W. Hooker, in the Fl. Bor. Amer., gave Great Bear Lake as the only station then known for *W. glabella*. Mr. D. C. Heaton has kindly furnished me with specimens from Willoughby Lake, Vermont (Goodale leg.), and Professor Gray notices its occurrence on rocks at Little Falls, New York (Vasey), and " high northward."

β. Belli.—Frond larger (6–7 inches long); pinnæ more elongated, pinnatifidly incised in rounded lobes (bright green, glabrous). Gaspé, on the Dartmouth River, twenty miles from its mouth, John Bell, B.A.

W. obtusa, Torrey.—Frond nearly a foot long, linear-lanceolate-glandulose, bipinnate; pinnules slightly decurrent, oblong, obtuse, crenate, or somewhat pinnatifid; indusium large, enveloping the sorus, torn into a few marginal lobes; stipe with few scattered, pale, chaffy scales. *Woodsia obtusa*, Torrey, A. Gray, J. Sm. *Aspidium obtusum*, Willd. *Physematium obtusum*, Hook, Fl. Bor. Amer. *Woodsia Perrineana*, Hook. and Grev. Ic. Fl. *Polypodium obtusum*, Swartz.—An impression prevails that this plant, which is said to be common in the Northern States, especially towards the west, grows also in Canada. Mr. D. C. Eaton, in the kindest manner, cut out of his own herbarium a specimen for me, from near High Bridge, New York city, in an excellent state for examination, which has enabled me to understand the species, and to ascertain that we have as yet no satisfactory evidence of its occurrence in Canada. Large forms of *W. Ilvensis* have in some cases passed for it. (I introduce this notice of the plant with a view to promote further inquiry.)

OSMUNDA.

O. regalis β. spectabilis.—Fronds erect, pale green, glabrous, bipinnate; pinnules oblong-lanceolate, oblique, shortly stalked, very slightly dilated at the base, nearly entire; fertile pinnules forming a racemose panicle at the summit of the frond. *Osmunda spectabilis*, Willd., J. Smith. Farmersville; Hardwood Creek, Hinchinbrook, and other places in rear of Kingston, usually in thickety swamps, by corduroy roads, &c.; Millgrove Marsh, Hamilton, Judge Logie; Ramsay, Rev. J. K. M'Morine, M.A.; woods near the Hop Garden, Belleville, not common, J. Macoun; Prescott, common, B. Billings, jun.; around Metis Lake, &c.; opposite Gros Cap; also Sou-sou-wa-ga-mi Creek and Schibwah River, R. Bell, jun.; near Montreal, Rev. E. M. Epstein and W. S. M. D'Urban; mountain, Bonne Bay, Newfoundland, on rocks 1000 feet above the sea, James Richardson (a small form); Welland, J. A. Kemp, M.D.; Osnabruck and Prescott Junction, Rev. E. M. Epstein, Nicolet; Wolfe Island and Navy Island, P. W. Maclagan, M.D.; Lake St. Charles, Abbé Provancher; Caledonia Springs and L'Orignal, J. Bell; Portland. Thos. R. Dupuis, M.D.; Bedford; London, W. Saunders. The fronds of our plant are a little more drawn out than those of the European one; the pinnules are often distinctly stalked, and the overlapping auricles either altogether absent or only slightly developed. This is *O. spectabilis*, Willd.; *O. regalis*, β. Linn. Sp. Pl. Some botanists distinguish two American forms, one agreeing with the typical *O. regalis* of Europe; but it is difficult to do so. The typical *O. regalis* is a larger, more robust, and more leafy plant, with more widely spreading or divergent pinnæ, and more leafy auricled sessile pinnules, more or less pinnatifid at the base; in our Canadian plant they are quite entire. The divisions of the fertile portion of the pinnæ are also more widely divergent in *a regalis.* The frond, moreover, is of a darker color.

O. cinnamomea, Linn.—Sterile and fertile fronds distinct, the former ample, broadly lanceolate, pinnate; the pinnæ rather deeply pinnatifid; lobes regular, entire; fertile frond contracted, erect, in the centre of the tuft of sterile fronds, and not at all foliaceous. Sporangia ferruginous. Fertile frond decaying early in the summer. *Osmunda cinnamomea*, Linn., Gray, J. Sm. *O. Claytoniana*, Conrad, not of Linn.—Fairfield farm and elsewhere about Kingston, not uncommon; Millgrove Marsh, Hamilton, Judge Logie; Sandwich and Montreal, P. W. Maclagan, M.D.; opposite Gros Cap; also Two-Heart River, Lake Superior, R. Bell, jun., C.E.; Belleville, swamps and low grounds, common, J. Macoun; Ramsay, Rev. J. K. M'Morine, M.A.; St. Joy Woods, on the river shore, near Gatineau Mills, D. M'Gillivray, M.D.; Newfoundland, Miss Brenton, in Hook. Fl. Bor. Am.; Prescott, common, B. Billings, jun.; Nicolet, Abbé Provancher; L'Orignal, J. Bell; near London, W. Saunders.

O. Claytoniana, Linn.—Frond narrowly lanceolate, pinnate; pinnæ lanceolate, about three pairs of pinnæ near or below the middle of the frond contracted and fertile; sporangia brown, with green spores. This species, when fresh, has a strong odor, resembling that of rhubarb (Pie-plant) stalks. *O. Claytoniana*, Linn., Gray, J. Sm. *O. interrupta*, Michaux.—Between Kingston and Kingston Mills, in wet swampy places by the roadside; Little Cataraqui Creek; Waterloo; banks of the Humber, near Toronto; Princes Island, Hamilton, Judge Logie; Ramsay, Rev. J. K. McMorine, M.A.; Ke-we-naw Point, in wet soil, R. Bell, jun.; Belleville, low rich grounds, not rare, J. Macoun; Prescott, common, B. Billings, jun.; Round Lake, W. S. M. D'Urban; Lake Settlement, and on the river shore near Gatineau Mills, D. McGillivray, M.D.; Newfoundland, Miss Brenton, in Hook. Bor. Am.; Osnabruck and Prescott Junction, Rev. Dr. Epstein; on Judge Malloch's farm and elsewhere about Brockville; Dartmouth River, Gaspé, John Bell, B.A.; St. Fereol, Abbé Provancher. Abundant on uncleared land along the Bedford Road, where the dried fronds are used by the farmers as winter-fodder for sheep. Augmentation of Granville, C. E., J. Bell, B.A.; near Komoka, C. W., W. Saunders. This fern is common also in the Northern States. I have a lax form, with long stipes and remarkably short somewhat triangular pinnæ, from Schooley's Mountain.

SCHIZÆA.

[*S. pusilla*, Pursh.—Newfoundland, De la Pylaie. I have no further information respecting its occurrence in British America. Professor A. Gray indicates its distribution in the United States thus:—"Low grounds, pine-barrens of New Jersey, rare," which is not at all favorable to its being found in Newfoundland or Canadal

Mr. Eaton has sent me beautiful specimens from sandy swamps in Ocean County, New Jersey.]

Nat. Ord. OPHIOGLOSSACEÆ.

Botrychium.

B. Virginicum, Swartz.—Barren branch sessile, attached above the middle of the main stem, thin, delicate, veiny, tripinnate, lobes of the pinnules deeply incised; fertile branch bi- or slightly tripinnate. Very variable in size, usually a foot or more in height, but sometimes only a few inches. *Botrychium Virginicum*, Swartz, A. Gray, J. Sm. *B. Virginianum*, Schk. *Osmunda Virginica*, Linn. Sp. Pl. *Botrypus Virginicus*, Michx.—Not uncommon in the woods about Kingston and the surrounding country, as near Odessa, in Hinchinbrook, &c.; Delta; Toronto; Sulphur Spring, Hamilton, Judge Logie; Prescott, in woods, common, B. Billings jun.; Nicolet, Montreal, Wolfe Island and Chippawa, P. W. Maclagan, M.D.; Belleville, rich woods, very common, J. Macoun; Ramsay, Rev. J. K. M'Morine, M.A.; River Marsouin, St. Lawrence Gulf, also opposite Grand Island, Lake Superior, R. Bell, jun., C.E.; Riviere Rouge, and De Salaberry, west line, W. S. M. D'Urban; Montreal, Osnabruck, and Prescott Junction, Rev. E. M. Epstein; Hill Portage above Oxford House, Governor McTavish; Newfoundland, Miss Brenton, in Fl. Bor. Amer.; Lake Huron to Saskatchewan, Hook. Fl. Bor. Am.; Gaspé, John Bell, B.A.; Stanfold, Abbé Provancher; Grenville, C. E., J. Bell; London, W. Saunders.

β. gracile.—Very small (5 or 6 inches high), fertile branch less divided. *B. gracile*, Pursh. Hill Portage, above Oxford House, Governor McTavish.

γ. simplex.—Barren branch oblong, pinnatifid, the lobes ovate, incised, veiny. *B. simplex*, Hitchcock. Grenville, C. E., John Bell, B.A.

B. lunarioides, Swartz.—Barren branch long-stalked, arising from near the base of the main stem, thick and leathery, bipinnate, the pinnules slightly crenate; fertile branch bipinnate. Root of long thick tuber-like fibres. *Botrychium lunarioides*, Swartz, Gray. *B. fumarioides*, Willd., Provancher. *Botrypus lunarioides*, Michx. Gananoque Lake, May 1861; Plains near Castleton, and woods near the Hop Garden, Belleville, rare, J. Macoun; Three Rivers, C.E., P. W. Maclagan, M.D.,; Waste places west from Prescott

Junction, rare, B. Billings, jr.; St. Joachim, Abbé Provancher; L'Orignal, J. Bell: English's Woods, W. Saunders; in the Northern States this species grows in dry rich woods, "mostly southward," according to Professor Gray's Manual.

B. obliquum, Muhl., appears to be chiefly distinguished by its larger size, more compound fertile frond, and the narrower oblique divisions of the barren one. *B. obliquum* (Muhl.), Pursh. Fl. Amer. Sept., vol. ii, p. 656. Newfoundland, Dr. Morrison in Hook. Fl. Bor. Amer; Wesleyan Cemetery, London, W. Saunders.

B. Lunaria,—Swartz.—Barren branch sessile, arising from the middle of the stem, thick and leathery, oblong, pinnate; pinnæ lunate or fan-shaped slightly incised on the rounded margin. *Botrychium Lunaria*, Swartz, Schk., Hook., Moore, J. Sm. *Osmunda Lunaria*, Linn.—Nipigon, 1853, Governor McTavish; N.E. America, Dr. Hooker's tab.; Newfoundland, Saskatchewan, and Rocky Mountains to Behring's Bay in N. W. Am., T. Moore, Hbk. Brit. Ferns.

Ophioglossum.

[*O. vulgatum*, L., which is widely distributed throughout Europe and Northern Asia, and grows also in the Northern United States, although there "not common," is to be looked for in Canada. In one of its forms (*O. reticulatum*, Linn.), it extends to the West Indies.]

Nat. Ord. LYCOPODIACEÆ.*

Plananthus.

P. Selago, Pallisot-Beauvois.—Stem dichotomously branched, erect fastigiate; leaves in about 8 rows, more or less convergent or spreading, lanceolate, acuminate, entire; sporangia in the axils of the common leaves (not in spikes). *Lycopodium Selago*, Linn., E. B., Bigelow, Beck, Hook. and Grev., Torrey Fl. N. Y. ii, p. 508, Gray.—Labrador, Hudson Bay to Rocky Mountains, Hook. Fl. B. A.; shore of Lake Superior and northward, Professor A. Gray, Man. Bot., N. S., p. 603. I have not seen Canadian speci-

* In this order the arrangement of A. M. F. J. Pallisot-Beauvois is adopted, as it seems to afford the best basis for a re-adjustment of the genera of *Lycopodiaceæ*, which is much required. For P.-B.'s genus *Lepidotis*, I have thought it better to substitute the name *Lycopodium*, an old name that should not be discarded.

mens of this plant. The stations known show that it encircles Canada, and some of them are probably within our limits. Principal Dawson obtained the alpine variety on the White Mountains, Herb. Bot. Soc. Canada, It is a rare plant in the United States. There are two forms of this species (both of which are figured by Dillenius): *a. sylvaticus*, leaves convergent, almost appressed; *β. alpinus*, leaves widely-spreading, stems shorter.

P. lucidulus. Stem dichotomously divided into long erect branches; leaves bright green, in about 8 rows, reflexed, linear-lanceolate, acute, denticulate; sporangia in the axils of the common leaves (not in spikes). *Lycopodium lucidulum*, Michaux, Pursh, Bigelow, Torr. Fl. N. Y. ii, p. 508, Gray, Beck, Darlington, Hook. and Grev. Bot. Mis. *L. reflexum*, Schk. *Lycopodium suberectum* of Lowe, a Madeira plant. *Selago Americana, foliis denticulatis reflexis*, Dill. Hist. Mus. t. lvi.—Gananoque Lakes, Collins's Bay, Newboro-on-the-Rideau, woods in rear of Kingston, &c.; Prescott, common, B. Billings, jun.; Nicolet, C. E., St. Catherines and Grantham, P. W. Maclagan, M.D.; Belleville, in swamps and cold woods, rather common, J. Macoun; River Ristigouche, St. Lawrence Gulf, R. Bell, jun., C.E.; L'Orignal, J. Bell, B.A.; London, W. Saunders; Ramsay, Rev. J. K. McMorine, M.A. This species is stated by Professor Torrey to be rather common in New York State. "Frequently bears bulbs instead of capsules," Pursh.

[*P. alocuperoides*, P. Beauv.—The habitat "Canada" is given for *Lycopodium alocuperoides*, Linn., in the "Species Plantarum," ed. 3, vol. ii, p. 1565; but it is probably not a Canadian plant.]

P. inundatus, P. Beauv. Stems prostrate, adherent to the soil, the fertile ones erect? leaves secund, yellowish-green, lance-awl-shaped, acute; sporangia in distinct, terminal, leafy, sessile, solitary spikes. *Lycopodium inundatum*, Linn., E. B., Michaux, Pursh, Beck, Tuckerman, Torr. Fl. N. Y. ii, p. 508, Gray. *Plananthus inundatus*, Beauv. *L. alocuperoides*, Linn., in part?—In cedar swamps and overflowed woods, Canada, Pursh. Professor Torrey notices its occurrence in the north-western part of the State of New York. Professor Gray observes, that the leaves are narrower in the American than in the European plant, and suggests that it may be a distinct species. I have not yet seen Canadian specimens.

Lycopodium.

L. clavatum, Linn.—Stems robust, and very long, prostrate, rooting, forked, with short ascending branches; leaves pale, in-curved, linear-awl-shaped, tipped with a white hair point; sporangia in scaly catkins, which are usually in pairs on common peduncles. *Lycopodium clavatum*, Linn., E. B., Michaux, Pursh, Bigelow, Beck. Darlington, Spring, Hook., Torrey, Gray. *L. tristachyum*, Pursh? *L. integrifolium*, Hook. *L. aristatum*, Humboldt.—Occasionally found in the woods in rear of Kingston, but not common; Newfoundland, Hook. Fl. Bor. Amer.; between Thessalon and Missisagui Rivers, Lake Huron, R. Bell, jun.; Prescott, common, B. Billings, jun.; Three Rivers, Temiscouata, and Wolfe Island, P. W. Maclagan, M.D.; Seymour, in pine woods, rare, J. Macoun; Ramsay, Rev. J. K. McMorine, M.A.; River Ristigouche, St. Lawrence Gulf, R. Bell, jun.; London, W. Saunders, L'Orignal and L'Anse au Cousin, Gaspé, J. Bell; Belmont. The spores, chiefly of this species, constitute the *pulvis lycopodii*, which is used by apothecaries, and was at one time employed for making artificial lightning in the theatres.

L. annotinum, Michaux.—Stems very long, prostrate, creeping, forked, with ascending branches; leaves bright green, spreading or slightly deflexed, in about five rows, linear-lanceolate, mucronate, serrulate; sporangia in scaly catkins, which are sessile, solitary, oblong-cylindrical, thick. *Lycopodium annotinum*, Michaux, E. B., Pursh, Beck, Tuckerman, Torrey, Fl. New York State, ii, p. 509.—Pine forests in Hinchinbrook; rocky woods in Pittsburgh, on the north bank of the St. Lawrence, near Kingston; Gananoque Lakes; L'Anse au Cousin, Gaspé, John Bell, B.A.; Prescott, common, B. Billings, jun.; Rivière du Loup, Nicolet, Montreal, and Kingston, P. W. Maclagan, M.D.; Belleville, in cool woods, common, J. Macoun; Ramsay, Rev. J. K. McMorine, M.A.; Priceville, C. I. Cameron, B.A.; Newfoundland, Hook. Fl. Bor. Amer.; St. Augustin and Cape Tourmente, Abbé Provancher. Frequent in New York State, according to Professor Torrey. Of this species there are two forms, only one of which, the normal one, or type, I have as yet observed in Canada. The var. *β alpestre*, Hartm. Scan. Fl., having broader, shorter, paler, less spreading leaves, I have from the Dovrefield (T. Anderson, M.D.), Lochnagar, Scotland (A. Croall), and entrance to Glen Fee, Clova, where I found it growing with the typical form.

L. dendroideum, Michx.—Stems upright, bare below, bushy above (giving the plant a tree-like aspect), arising from a long creeping rhizome, leaves more or less appressed; sporangia, in scaly catkins, which are sessile, cylindrical. *Lycopodium dendroideum*, Michx., Pursh, Bigelow, Hook., Beck, Darlington. *L. obscurum*, Linn., Bigelow, Oakes.—White-cedar woods near Bath, abundant, and throughout the woods generally in rear of Kingston; Gananoque River; Priceville, C. I. Cameron, B.A.; Prescott, common, B. Billings, jun.; Nicolet, Mount Johnson, and Montreal, P. W. Maclagan, M.D.; Seymour and Cramahe, in cool moist woods, J. Macoun; River Ristigouche, Gulf of St. Lawrence, R. Bell, jun.; Ramsay, Rev. J. K. McMorine, M.A.; New Brunswick, Hook, F.B.A.; Osnabruck and Prescott Junction, Rev. E. M. Epstein; London, W. Saunders; Harrington, L'Orignal, and Gaspé, John Bell, B.A.; St. Joachim, Abbé Provancher.

L. complanatum, Linn.—Stems rhizome-like with ascending branches, which are dichotomously divided, flattened; leaves short, in four rows, those of two rows imbricated, appressed, of the other two somewhat spreading; sporangia in scaly cylindrical catkins, in twos, threes, or fours, on a common peduncle. *Lycopodium complanatum*, Linn., Gray, Blytt. *L. chamæcyparissias*, Braun. *L. sabinæfolium*, Willd.—Not uncommon in the woods about Kingston, and in rear; Newboro-on-the Rideau; Gananoque River; River Ristigouche, St. Lawrence Gulf, and St. Joseph's Island opposite Campment d'Ours, Lake Huron, R. Bell, jun.; Ramsay, Rev. J. K. McMorine, M.A.; pine grove near Blue Church Cemetery and woodlands west from Brockville, not common, B. Billings, jun.; Three Rivers and Temiscouata, C.E., P. W. Maclagan, M.D.; sandy woods around Castleton, sterile hills, Brighton and Murray; J. Macoun; L'Orignal and L'Anse au Cousin, Gaspé, J. Bell, B.A., Trois Pistoles, Abbé Provancher; London, W. Saunders. To this species is referred *L. sabinæfolium*, Willd., *L. chamæcyparissias*, A. Braun; with branches more erect and fascicled. Prof. Asa Gray remarks:— "The typical form of *L. complanatum*, with spreading, fan-like branches, is abundant southward (in N. States), while northward it passes gradually into the var. *sabinæfolium*." I have only one rather imperfect specimen of the European *L. chamæcyparissias*, collected at Bonn on the Rhine, by my friend Professor G. S. Blackie, which does not differ in the branching from ordinary Canadian forms of *L. complanatum*. It appears to be quite a common species in the States, for I have it from a great many places.

Selaginella.

S. spinulosa, A. Braun.—Small, prostrate, leaves lanceolate, acute, spreading, spinosely toothed; fertile branch stouter, ascending spike sessile. *Selaginella spinulosa*, A. Braun, Blytt, Norges Fl.; *Lycopodium selaginoides*, Linn. Pursh Fl. Am. Sept, ed. ii, p. 654. *Selaginella spinosa*, Beauv. *Selaginella selaginoides*, A. Gray, Man. Bot. N. States, p. 605.—Gaspé, John Bell, B.A.; Canada, Michaux; Lake Superior and northward, pretty rare, Professor Asa Gray in Man. Bot. N. States; Canada, Pursh, who observes, " the American plant is smaller than the European."

STACHYGYNANDRUM.

S. rupestre, P. Beauv.—Much branched, leaves slightly spreading when moist, appressed when dry, carinate, hair-tipped; compact and moss-like, growing on bare rocks. *Selaginella rupestris*, Spring, A. Gray, Eaton. *Lycopodium rupestre*, Linn., Pursh Fl. Am. Sept., ed. ii, p. 654.—On the perpendicular faces of Laurentian rocks, along the north bank of theSt. Lawrence, in Pittsburgh, and on the Thousand Islands at Brockville, &c.; Long Point on the Gananoque River; near Farmersville, C. W., T. F. Chamberlain, M.D.; rocks in pine groves two miles west from Prescott, near the river, and on rocks west from Brockville, not common, B. Billings, jun.; Ramsay, Rev. J. K. McMorine, M.A.; Belœil and Mount Johnson, C. E., P. W. Maclagan, M.D.

DIPLOSTACHYUM.

D. apodum, P. Beauv.—Stems creeping, branched; leaves pale vivid green, of two kinds,—the larger spreading horizontally, ovate-oblique, the smaller appressed, acuminate, stipule-like. Forms compact tufts. *Lycopodium apodum*, Linn., Pursh. Fl. Am. Sept., ed. 2. ii, p. 654. *Selaginella apus*, Gray, Eaton.—Abundant on low wet ground east of Front street, Belleville, below the hill, where it was pointed out to me by Mr. J. Macoun, July 1863. In September 1863, I found it sparingly but fertile, on grassy flats by the river side at Odessa. Near London, ... Saunders; Detroit River, C. W., P. W. Maclagan, M.D. Apparently not common in the United States. I have it from Schooley's Mountain. This is a very small, compactly-growing moss-like species, well adapted for cultivation under a glass shade. It was a great favorite with the late Dr. Patrick Neill, in whose stove-house, at Canonmills, Edinburgh, I first saw it many years ago.

Nat. Ord. MARSILEACEÆ.

AZOLLA.

A. Caroliniana, Willd.—Pinnately branched with cellular, imbricated leaves; plant reddish, circular in outline, ½–1 inch in diameter; leaves ovate obtuse, rounded and roughened on the back (Eaton). Resembles a floating moss or Jungermannia (Torrey). Gray, Man. Bot., t. 14. Floating on the waters of Lake Ontario, Pursh Fl. Am. Sept., ed. 2, ii, p. 672. In the adjoining states, Professor Asa Gray notices it as occurring in pools and lakes, New York to Illinois and southward, and observes that it is probably the same as *A. magellanica* of all South America.

Salvinia.

[*Salvinia natans*, = *Marsilea natans*, Linn. Sp. pl. "Floating like Lemna on the surface of stagnant waters, in several of the small lakes in the western parts of New York and Canada."— Pursh Fl. Amer. Sept. ed. 2, ii, p. 672. Professor Asa Gray states, that it has not been found by any one except Pursh, and he therefore omits it from his Manual of Botany of the Northern States.]

Isoetes.

I. lacustris, L.—Belœil, C. E., P. W. Maclagan, M.D.; Saskatchewan, Hook. Fl. Bor. Amer. This plant is spoken of by Pursh as growing in the Oswego River, near the Falls; and Professor Gray and others allude to it as not rare in the New England States. It should be carefully looked for in the numerous lakes and creeks of Upper Canada. It grows in muddy bottoms, forming green meadows under water. Much interest is attached to the genus *Isoëtes*, since Professor Babington has shown tha instead of one there are many species, or at least distinct races or forms, in Britain. In the United States four are known:— *I. lacustris*, Linn.; *I. riparia*, Engelm.; *I. Engelmani*, Braun; and *I. flaccida*, Shuttlew., the last a southern form. Professor Babington is certain of the existence of at least eight European species:—*I. lacustris*, L.; *I. echinospora*, Dur.; *I. tenuissima*, Bor.; I. *adspersa*, A. Br.; *I. setacea*, Del.; *I. velata*, Bory.; *I. Hystrix*, Dur.; and *I. Duriæi*, Bory. As yet we know of only one Canadian species, which is here rendered, rather uncertainly, *I. lacustris*. The American species are described in Gray's Manual, the British ones in the new Journal of Botany, London.

Nat. Ord. EQUISETACEÆ.

Equisetum.

The *Equiseta* having been described in a previous paper, it will be sufficient to give here a mere list of the species, with some additional notes obtained since the former paper was written.

E. sylvaticum, Linn. Newfoundland and New Brunswick, Hook. Fl. Bor. Amer.

E. sylvaticum, *β. capillare*. Much branched; branches very long straight, and exceedingly slender (capillary). Farmersville.

E. umbrosum, Willd. Belmate.

E. arvene, Linn. West from London, W. Saunders. The rhizome bears large spherical pill-like modules, which are however more conspicuous in var. *β. granulatum*.

E. arvense, *β. granulatum*.

E. Telmateja, Ehrhart. Shores of Lake Ontorio, Beck.

E. limosum, *Fories*.—The great value of this species and of *E. arvense* as fodder-plants, is confirmed. On the western prairies horses are said to get "rolling fat" on equisetum in ten days; and experienced travellers tell me, that their horses always go faster next day after resting at night on equisetum pasture. The horses do not take to it at first; but after having a bit of equisetum put occasionally into their mouths, they soon acquire a liking for it, and prefer it to all other herbage. Near Komoka, W. Saunders.

E. hyemale, Linn. Lake Huron, Hook. Fl. Bor. Am.; St. Joachim, Abbé Provancher; London, W. S.

E. robustum, Braun. Stems much thicker than in *E. hyemale*, the ridges with one line of tubercles; sheaths shorter than broad, with a black band at base, and a less distinct one at the margin; teeth about forty, three-keeled. *E. robustum*, Braun, A. Gray. Grenadier Pond, on the Humber River near Toronto, 3d June 1862. It is difficult to decide whether this and other forms are really distinct from *E. hyemale;* certainly that species varies in size, in roughness, and in other characters. In *E. robustum* the teeth are twice as many as in *E. hyemale*, but even this is perhaps not a constant character.

E. variegatum, Weber and Mohr.; St. Joachim, Abbé Provancher.

E. scirpoides, Michaux.

E. scirpoides, *β. minor*.

E. palustre, Linn.—"Canada, from Lake Huron, Dr. Todd, Mr. Cleghorn, Mrs. Perceval, to the shores of the Arctic Sea, Dr. Richardson, Drummond, Sir John Franklin, Captain Back."—Hook. Fl. Bor. Amer.—Prófessor A. Gray speaks of "the European *E. palustre*," attributed to this country (the N. American States) by Pursh, probably incorrectly." Dr. Hooker indicates its existence, without doubt, in Arctic West America and Arctic East America. The name of the plant has occasionally appeared in Canadian lists, but I have as yet seen no Canadian specimen. It remains for Canadian or Hudson Bay botanists to trace its southern limit on the American Continent. In Europe and Asia it has no tendency to Arctic limitation.—*From the Edinburgh New Philosophical Journal.*

OBSERVATIONS ON SUPPOSED GLACIAL DRIFT IN THE LABRADOR PENINSULA, &c.

By Henry Youle Hind, M.A., F.R.G.S.

[The most important part of this paper is that which relates to the Labrador Peninsula, which we copy entire:—Eds.]

During an exploration of a part of the interior of the Labrador Peninsula in 1861, I had an opportunity of observing the extraordinary number, magnitude, and distribution of the erratics in the valley of the Moisie River and some of its tributaries, as far north as the south edge of the table-land of the Labrador Peninsula (lat. 50° 50′ N., long. 66° W.), and about 110 miles due north of the Gulf of St. Lawrence. Boulders of large dimensions, ten to twenty feet in diameter, began to be numerous at the Mountain Portage, 1460 feet above the sea, and sixty miles in an air-line from the mouth of the Moisie River. They were perched upon the summits of peaks estimated to be 1500 feet above the point of view, or nearly 3000 feet above the sea-level, and were observed to occupy the edges of cliffs, to be scattered over the slopes of mountain-ranges, and to be massed in great numbers in the intervening valleys.

At the "Burnt Portage," on the north-east branch of the Moisie, nearly 100 miles in an air-line from the Gulf of St. Lawrence, and 1850 feet above the ocean, the low gneissoid hills for many miles around were seen to be strewed with erratics wherever a lodgment for them could be found. The valleys (one to two miles broad) were not only floored with them, but they lay there in tiers, three or more deep. Close to the banks of the rivers and lakes near the "Burnt Portage," where the mosses and lichens have been destroyed by fire, very coarse sand conceals the rocks beneath; but on ascending an eminence away from the immediate banks of the river, the true character of the country becomes apparent. At the base of the gneissoid hills which limit the valley of the east branch (about three miles broad) at this point, they are observed to lie two or three deep, and, although of large dimensions, that is from five to twenty feet in diameter, they are nearly all ice or water-worn, with rounded edges, and generally polished or smoothed. These accumulations of erratics frequently form tongues, or spots, at the termination of small projecting promontories in the hill-ranges. I have several times counted three tiers of these travelled rocks where the mosses, which once covered them with a uniform mantle of green, had been burnt; and occasionally, before reaching the sandy area which is sometimes found on the banks of the river, I have been in danger of slipping through the crevices between the boulders, which were concealed by mosses, a foot and more deep, both before and after passing through the "Burnt Country," which has a length of about thirty miles where I crossed it. I extract the following note from my journal of the appearance of these travelled rocks in the "Burnt Country":—

"Huge blocks of gneiss and labradorite lie in the channel of the river, or on the gneissoid domes which here and there pierce the sandy tract through which the river flows. On the summit of the mountains, and along the crest of the hill-ranges, about a mile off on either side, they seem as if they had been dropped like hail. It is not difficult to see that many of these rock-fragments are of local origin; but others have evidently travelled far, on account of their smooth outline. From a gneissoid dome, I see that they are piled to a considerable height between hills 300 and 400 feet high; and from the comparatively sharp edges of many around me, the parent rock cannot be far distant."

On all sides of Cariboo Lake, 110 miles in an air-line from the Gulf, and 1870 feet above it, a conflagration had swept away trees, grasses, and mosses, with the exception of a point of forest which came down to the water's edge and formed the western limit of the living woods. The long lines of enormous unworn boulders, or fragments of rocks, skirting the east branch of the Moisie at this point, were no doubt lateral glacial moraines. The coarse sand in the broad valley of the river was blown into low dunes, and the surrounding hills were covered with millions of erratics. No glacial striæ were observed here, but the gneissoid hills were rounded and smoothed at their summit; and the flanks were frequently seen to present a rough surface, as if they had been recently exposed by land-slides, which were frequently observed, and the cause which produced them, namely, frozen waterfalls.

No clay or gravel was seen after passing the mouth of Coldwater River, forty miles from the Gulf, and 320 feet above it. The soil, where trees grew, was always shallow as far as observed; and although a very luxuriant vegetation existed in secluded valleys, yet it appeared to depend upon the presence of labradorite-rock or a very coarse gneissoid rock, in which flesh-colored feldspar was the prevailing ingredient.

Observers in other parts of the Labrador Peninsula have recorded the vast profusion in which erratics are distributed over its surface. There is one observer, however, well known in another branch of science, who has left a most interesting record of his journey in the Mistassinni country, between the St. Lawrence at the mouth of the Saguenay, and Rupert's River, in Hudson's Bay. André Michaux, the distinguished botanist, traversed the country between the St. Lawrence and Hudson's Bay in 1792. He passed through Lake Mistassinni; and in his manuscript notes, which were first printed in 1861, for private circulation, at Quebec, a brief description of the journey is given. "The whole Mistassinni country," says Michaux, "is cut up by thousands of lakes, and covered with enormous rocks, piled one on the top of the other, which are often carpeted with large lichens of a black color, and which increase the sombre aspect of these desert and almost uninhabitable regions. It is in the spaces between the rocks that one finds a few pines (*Pinus rupestris*), which attain an altitude of three feet; and even at this small height showed signs of decay."

The remarkable absence of erratics in the Moisie, until an altitude of about 1000 feet above the sea is attained, may be explained by the supposition that they may have been carried away by icebergs and coast-ice during a period of submergence, to the extent of about 1000 feet. I am not aware that any traces of marine shells or marine drift have been recognized, north of the Labrador Peninsula, at a greater elevation than 1000 or 1100 feet. In the valley of the St. Lawrence, marine drift has not been observed higher than 600 feet above the sea. Glacial striæ were seen on the "gneiss-terraces" at the "Level Portage," 700 to 1000 feet above the sea. The sloping sides of these terraces are polished and furrowed by glacial action. Grooves half an inch deep, and an inch or more broad, go down slope and over level continuously. It is on the edge of the highest terrace here that the first large boulders were observed.

The entire absence of clay, and the extraordinary profusion of both worn and rugged masses of rock piled one above the other in the valley of the east branch of the Moisie, as we approach the table-land, lead me to attribute their origin to local glacial action, as well as the excavation of a large part of the great valley in which the river flows. Its tributary, the Cold-water River, flows in the strike of the rocks through a gorge 2000 feet deep, excavated in the comparatively soft labradorite of the Labrador series.*

The descriptions which have recently been published† of different parts of the Labrador Peninsula not visited by me, favor the supposition that the origin of the surface-features of the areas described may be due to glacial action, similar to that observed in the valley of the Moisie River.

The remainder of the paper treats of the "Forced Arrangement of Blocks of Limestone in Boulder Clay," "The Driftless Area in Wisconsin," "Beaches and Terraces," "Anchor-ice and Excavation of Lake-basins," "Parallelism of Escarpments in America." Many interesting facts are adduced in these subjects; and the author takes strong ground in advocacy of the action of glaciers rather than of icebergs in the production of glacial striæ. He claims this view as suggested by him in 1859. His view in reference to the excavation of lake-basins is stated in the following terms. It suggests some new views; though probably all geologists will not accept the cause assigned, as the most important of those which have acted in producing this effect:

It has been frequently stated that a difficulty arises as to the *modus operandi* by which a moving glacier can excavate lake-basins. May not the manner in which stratified rocks, at least, over which a glacier may be moving, can be involved in its mass in the form of slabs or mud, constituting dirt-beds, be partially explained by the phenomena attending the formation of anchor-ice? It is

* See Sir William Logan's "Geology of Canada" (1863), on the Division of the Laurentian Rocks into "two formations":

1st. The Labrador series.

2nd. The Laurentian.

The Labrador series, I have been recently informed by Sir William Logan, has been ascertained by him to rest unconformably upon the older Laurentian, and will be distinguished by a separate color on his new Map of Canada. See also Mr. Sterry Hunt on Chemistry of Metamorphic Rocks.

† See my "Explorations in the Interior of the Labrador Peninsula." Longmans, 1863.

no uncommon occurrence for the anchors of the nets of a "seal-fishery" on the north shore of the Gulf of St. Lawrence to be frozen to the bottom at the depth of from thirty tó sixty feet; and when anchors are then raised, they bring with them frozen masses of sand. But it is in rapid rivers that the formation of anchor-ice is most remarkable, and most effective in excavating these beds. It forms on the beds of rivers above the head of a rapid, and frequently bursts up with a load of frozen mud or shingle, or slabs of rocks, which it has torn from the bottom. This phenomenon is witnessed every winter in the valley of the St. Lawrence; but it is best observed after a prolonged term of cold, when the thermometer indicates a temperature considerably below zero. Anchor-ice has only been observed, as far as my knowledge of the subject goes, in rapid currents in open water; and the sudden and apparently inexplicable rise of the St. Lawrence during extreme cold is most probably due to this cause.* It is not difficult to see how the rivers issuing from beneath the precipitous walls of glaciers, as described by Dr. Rink, may rapidly excavate deep channels by means of anchor-ice, to be widened by the subsequent operations of the glacier itself. Nor is it improbable that by this means a glacier in very cold climates may increase from the bottom upwards with a load of frozen mud and fragments of rock, particularly near its base, when that does not meet the open sea. The great lakes of North America, including Lake Winnipeg, are excavated on the edges of the fossiliferous rock-basins; and these lakes may represent the boundary of a glacial mass similar to that which now covers Greenland.—*From the Journal af the Geological Society.*

DESCRIPTION OF TWO AMERICAN SPONGES.

By Dr. J. S. Bowerbank, F.R.S., &c.

1. *Tethea hispida*, Bowerbank.

Sponge sessile. Surface strongly and thickly hispid. Oscula and pores inconspicuous? Dermis abundantly spiculous; spicula disposed at right angles to the surface, uniformly crowded together; super-fusiformi, sub-ovo-spinulate, very minute; forming a secondary series of defensive spicula. Primary series of defensive spicula super-fusiformi-acuate or sub-ovo-spinulate, very large and long. Skeleton spicula super-fusiformi-acuate and sub-

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* See "Notes on Anchor-Ice," by T. C. Keefer, C.E., Canadian Journal, new series, vol. vii, p. 173, (1862).

ovo-spinulate, large and long. Tension spicula super-fusiformi sub-ovo-spinulate, small, irregularly dispersed, numerous.

Color. Dried, light gray.

Habitat. Portland, Maine, N. America.

Dr. Dawson, McGill College, Montreal:

Examined in the dried state.

I received a small slice of this sponge from Prof. Dawson. From the curve of the surface the specimen appears to have been about an inch and a half in diameter. In its present state the hispidation of the surface is very strongly produced, and probably much exaggerated by drying; the spicula are comparatively very large and long, more so than those of the skeleton fasciculi. The secondary series of defensive spicula are of the same form as those of the interstitial membranes, but not more than half their average size. The whole of the spicula are exceedingly fusiform, the middle of the shaft being frequently twice the diameter of the base of the spiculum. The ovo-spiculate character prevails more or less in all the spicula, but is more distinctly produced in those of the interstitial membranes, and the secondary dermal defensive ones. I could not detect any gemmules in the piece of sponge sent to me.

2. *Spongilla Dawsoni*, Bowerbank.

Sponge sessile?, branching; surface smooth. Oscula and pores inconspicuous. Dermal and interstitial membranes abundantly spiculous; spicula fusiformi-acerate, entirely spined; spines numerous, short, and conical. Skeleton-spicula acerate or subfusiform-acerate. Ovaria spherical; dermal spicula numerous, disposed in flat fasciculi, or groups of spicula parallel to each other; groups irregularly dispersed; spicula acerate or subcylindrical, entirely spined; spines numerous, obtuse, and ill-defined. Sarcode aspiculous.

Color, in the dried state, emerald-green.

Hab. River St. Lawrence, Montreal, Canada (*Mr. Fowler*, and *Rev. A. Kemp*); a lake near Brockville (*Rev. A. Kemp*).

Examined in the dried state.

About two years ago I received a small fragment of this species from Dr. Dawson, who stated that it was found in the River St. Lawrence, at Montreal; but, as the fragment was destitute of gemmules and very small, there were not sufficient characters to warrant a specific description of it. In October 1859 I received from the same gentleman a further supply of fragments of this species, containing ovaria, and giving a better idea of its form than those first sent to me. The largest of the pieces sent was 1½ inch in length and 2½ lines in diameter, evidently a portion of a longer branch. At the proximal end there is a short branch, 3 lines in length and one line in diameter; and the distal end divides into two small branches of similar dimensions to the first, thus satisfactorily indicating the branching habit of the species. In several parts of this piece there are ovaries imbedded in the sponge, and there were many others in the fragments of the same species that accompanied it. The general external characters appear very like those of the European species *S. lacustris;* and from this similarity, I have very little doubt of its surface in the living state having been smooth and even, as in that species. In the European species the branches spring from a broad spreading base, about half an inch in thickness; and I think it highly probable that the American species will be found to possess the same habit. I could not detect oscula on any of the fragments in my possession.

The dermal and interstitial membranes abound with tension-spicula, and especially the dermal one, in which they seem to attain their fullest degree of development. Their normal form is fusiformi-acerate; but, from the abundant production of the spines at their terminations, they frequently appear to be cylindrical rather than acerate. They are dispersed on these tissues rather unevenly, abounding in some spots, while they are comparatively scarce in others.

The spicula of the skeleton are of about the same proportions as those of the European species. They are usually of the regular acerate form, but occasionally become subfusiform.

The spicula and their mode of arrangement in the dermis of the ovarium cannot be readily seen without the aid of treatment with hot nitric acid, in which they should be immersed for a few seconds, and the acid should then be immediately diluted with water, after which they should be dried on the glass, on which they are to be mounted in Canada balsam. The spicula in the dermis of adult ovaries are very abundant. They are similar in form and proportions to those of the dermal membrane; but, generally speaking, they are more fully produced, and the greater portion of them are subcylindrical from the profusion of spines at their apices. Their form and mode of arrangement in the ovary render them exceedingly valuable as specific characters. In some of the young and incompletely developed ovaries I could not detect a single specimen of these spicula. The only difference I could find between these spicula and those of the dermal membrane was, that the spines on those of the latter were more sharply and fully produced, while on those of the ovary they were frequently ill-defined and often only in an incipient state, but very abundant.

In the preparation of the spicula for examination, I found a few birotulate ones having the rotulæ very deeply divided. These spicula were no part of the sponge in course of description, but were undoubtedly from the gemmules of another species inhabiting the St. Lawrence.

(Note by the Editors.) The above descriptions may be taken as a first instalment of descriptions of Canadian and other American Sponges, now in the hands of Dr. Bowerbank. The first was forwarded to us in MS. by the author. The second is taken from a late paper in the Proceedings of the Zoological Society of London.

The first of the above species was dredged by Dr. Dawson at Portland. The original specimen, part of which was sent to Dr. Bowerbank, is of an oval form, an inch and a half in its longest diameter, and about a quarter of an inch thick in the centre. It is attached partly to a stone, and partly to the side of a large specimen of *Balanus porcatus*.

The second species was collected by Mr. Fowler and Rev. Mr. Kemp, and the specimens were presented by these gentlemen to the Museum of McGill University, whence the portions examined by Dr. Bowerbank were sent with a number of others by Dr. Dawson.

MISCELLANEOUS.

Hail-Storm in Pontiac.—*Extract of a Letter from Wm. King, Esq., of Bristol.*—Two days ago a very destructive hail storm occurred in this and the neighboring townships. Some singular circumstances connected with it may be noteworthy. On Monday, the 11th, about two p.m., the storm came, accompanied by thunder and lightning. Its course was from west to east, and about two miles wide. Almost all the glass in the westerly windows of the farm-houses within its range was broken; the crops of wheat, in corn, oats, potatoes, &c., greatly injured, and in some instances wholly destroyed. The pieces of ice were from half an inch to over two inches diameter, round, angular, and square; some of them had small spiculæ round their edges. A farmer told me that on his land the hail covered the ground from three to four inches deep, hard and closely packed; but the most extraordinary thing is, that a respectable farmer of undoubted veracity says he picked up a piece of hail or ice, in the centre of which was *a small green frog* dead. Deeming such a thing rather rare in meteorology, I communicate it to you. I may remark that the heaviest hail-storms occur here in the month of July.—*Bristol, July* 13, 1864.

NATURAL HISTORY SOCIETY.

Report of the Scientific Curator.

In this account of the work done since the last annual meeting, I propose to adopt a natural history order. A large case, divided into five compartments, has been erected (at a cost of $120) for the reception of the Society's collection of mammals. A few species, viz., the moose, the white whale of the St. Lawrence (*delphinapterus*) and two seals, are too bulky to be admitted into this case without much disturbing the general classification: these have accordingly been omitted. With these exceptions, the rest of the collection has been arranged as far as practicable in accordance with Prof. Baird's elaborate monograph on North American mammals. Large printed labels have been attached to each species, the nomenclature adopted being that of the author just quoted. Several new specimens have been put up; and the collection now contains eighty-nine specimens, illustrating forty-nine North American species.

The miscellaneous mammalia have been grouped in one compartment by themselves, and have been named according to the most recent authors. It would be very desirable if a small sum of money could be voted annually for the purchase of specimens of such of the wild animals of Canada as are wanting to complete our local collection. I propose in the annual report of this year to publish a list of all the Canadian species of mammals, birds, reptiles, and fishes contained in the museum, so that our friends may see what species we want. The collection of birds has been re-grouped, and a number of additional cases full of specimens have been prepared. The series of names printed by the Society some years ago is out of date, and it is proposed to substitute for them the labels issued by the Smithsonian Institute. The present arrangement of the species in small cases, and these not of uniform size, causes a great waste of room. Were each specimen mounted on a proper separate stand, as is usually done in large museums, the collection might be arranged in a much more accurate scientific order. We have now about 210 species of Canadian birds, but several species are wanting to complete our local series. A collection of the eggs of our local birds has been made; the series has been named and arranged in a glass case, with a covering of green baize, to prevent the injurious effects of light on the specimens. We have now the eggs of some fifty Canadian species carefully identified; and friends at Quebec have kindly promised to add largely to this branch of our collection during the summer. The reptiles have been arranged and named as far as our cases would admit, with the exception of several exotic snakes. Three cases of Canadian fishes have also been prepared by Mr. Hunter, containing some thirty-one species: these I have named and labelled. Two cases of miscellaneous fishes have also been prepared, and have been named so far as the limited access to proper books of reference in Canada will admit. Our collection of Canadian fishes is still very imperfect, particularly as regards the marine fishes of the gulf, which are almost unrepresented in the museum.

In the invertebrate section of the animal kingdom progress has been made as far as our material would admit. We have now 25 cases of shells, all carefully arranged and named. Of species purely Canadian we have nearly 200. Five cases are devoted to the illustration of the land and fresh water shells of the United States, and to the marine shells of the east and west coasts of the same country. The general series occupies thirteen large cases. This portion of our collection has been considerably more than doubled during the past fourteen months. The crustaceans, barnacles, sea-urchins, corals, and sponges have been named as far as possible, and arranged in one large case at the end of the gallery. Large donations of insects have been made to the Society, by Mr. Saunders and Mr. J. Ferrier; and a cabinet to hold all our specimens has been made at a cost of some $37. I am waiting for the arrival of some proper cork from England for the lining of the drawers, to work at this important branch of our collection.

I would call special attention to the large series of rocks and minerals belonging to the Society, many of which are still unpacked. Four table-cases, to hold our fossils and minerals, would cost us from 100 to 120 dollars, and this is an improvement which I think should be our first object when the state of our funds will permit. I think it is no exaggeration to say that we have some 3000 or 4000 specimens of rocks, minerals, and fossils that we have no means of exhibiting, The only proper case we have contains some 1800 specimens. Of these I have carefully classified and labelled a little over 1200. Our collection of fossils I have partially arranged and named, and have placed them temporarily in the drawers under the mineral cabinet. In acknowledgment of the liberality of the Geol. Survey, the council of the N. H. S. have authorized me to pack up and distribute five series of the duplicate shells, sea-urchins, &c., belonging to the Survey, to the following Societies: Laval University, and the Museum of the Literary and Historical Society, Quebec; McGill College, Montreal; Queen's College, Kingston; and University College, Toronto. I have accordingly selected, named, and forwarded these sets to the afore-mentioned institutions; and among the results proceeding from this, may be mentioned a valuable donation of books from the Literary and Historical Society of Quebec, and the acquisition of several interesting additions to the Museum from McGill College in this city, and from the Laval University of Quebec. Since the date of my first connection with the Society, some 2000 specimens have been added to the Museum, and it is hoped that satisfactory progress has been made during the past year in the work of arrangement and classification. Dr. Smallwood having adverted to the course of lectures I had the pleasure of giving during the past winter, further allusion to them is unnecessary.

As Recording Secretary to the Society, it has been my duty to issue notice of council meetings, and to prepare and direct circulars calling the usual monthly meetings, to keep the minutes of all ordinary and special meetings, to prepare proper accounts of our monthly proceedings for the press, and for the Naturalist, to return thanks for donations, to issue diplomas and notices of election, and to transact many little items of general business for the Society. Finally, as an ex-officio member of the editing committee of the Naturalist, I have endeavored to do what I could for the Journal, whether directly or indirectly.

J. F. WHITEAVES, F.G.S., &c.,
Rec. Secretary and Scientific Curator, N. H. S.

Mr. Jas. Ferrier, jun., then presented his Report as Treasurer of the Society, which will be found on the other side.

It was moved by the Right Rev. the Lord Bishop, seconded by Stanley C. Bagg, and unanimously resolved: "That the reports just read be adopted, and printed for distribution among the members."

A vote of thanks to the officers of the past year was moved by Dr. David, seconded by L. A. H. Latour.

The following gentlemen were elected as office-bearers during the coming year, as follows:

OFFICERS FOR 1864-65.

President.—Principal Dawson, LL.D., F.R.S., &c.

Vice-Presidents.—Rev. A. De Sola, LL.D.; Sir W. E. Logan, LL.D., F.R.S., &c.; E. Billings, F.G.S.; Dr. T. Sterry Hunt, M.A., F.R,S., &c.; W. H. A. Davies; The Right Rev. the Lord Bishop; C. Smallwood, M.D., LL.D.; Rev. A. F. Kemp, M.A.; John Leeming.

Treasurer.—Jas. Ferrier, jun.

Cor. Secretary.—Prof. P. J. Darey, M.A.

Rec. Secretary and Scientific Curator.—J. F. Whiteaves, F.G.S., &c.

Librarian.—Stanley C. Bagg.

Council.—A. Rimmer, G. Barnston, E. Murphy, Dr. Hingston, L. A. H. Latour, D. A. P. Watt, C. Robb, J. H. Joseph, and Dr. David.

Library Committee.—Messrs. J. C. Becket, Prof. Cornish, Dr. Fenwick, Dr. David, and Dr. Mackay.

Editing Committee of the "Canadian Naturalist."—D. A. Poe Watt, Acting Editor; Dr. Dawson; Dr. Hunt; E. Billings; Rev. A. F. Kemp, M.A.; Prof. Robins, B.A.; Dr. Smallwood; and the Corresponding and Recording Secretaries.

THE NATURAL HISTORY SOCIETY OF MONTREAL IN ACCOUNT WITH JAMES FERRIER, JUN., TREASURER.

Dr.

1864. May 1.	RECAPITULATION.	$
To Cash paid,	Salary to J. F. Whiteaves	$350 00
" "	" " W. Hunter (and vote $25)	225 00
" "	Interest	208 00
" "	For "Naturalist" sent free	195 24
" "	Furniture, cases, &c	191 51
	Printing	151 69
	Furnace	133 14
	Wood and coals	144 63
	Books and binding	131 57
	Sundry petty charges, repairs, &c	121 65
	Gas accounts	61 08
	Water "	40 62
	Commission to Mr. McCormick	57 85
	City taxes	45 10
	Insurance	40 00
	P. O. acct	5 80
		$2102 88

Cr.

1864. May 1.	RECAPITULATION.	$
By Cash	received Government grant	$750 00
"	Member's yearly subscriptions	864 00
"	Proceeds Conversazione	66 75
"	" Museum entrance-fees	33 00
"	For gas used by Literary Society	20 60
"	Balance in Treasurer's hands	353 10
"	Received from, and due the Treasurer, May 1, 1864	15 43
		$2102 88

Examined and Vouchers compared and found correct.
Montreal, 1st May, 1864.

J. H. JOSEPH,
W. H. A. DAVIES, } Auditors.

STATEMENT OF LIABILITIES OF THE NATURAL HISTORY SOCIETY, MAY 1ST, 1864.

Mortgage on Society's Building held by Scottish Provincial Insurance Co	$2000 00	
" in favor of Wm. Watson, Esq	400 00	$2400 00

List of Donations to the Museum.

N.B.—The dates refer to the meetings of the Society at which the specimens were presented.

Donors' Names.	Donations.
	July 1st, 1863.
G. Barnston, Esq.......	Stuffed specimen of the smaller, or "pulling-down" otter. (*Lutra destructor*, Barnston.)
	Eggs of thirteen species of birds from New Brunswick.
John Leeming, Esq.....	Egg-capsule of Pyrula. (*A marine univalve shell.*)
	12 species of marine shells from Jamaica.
J. F. Whiteaves, Esq....	9 species of foreign shells.
Jas. Thompson, Esq....	The mud or beaver fish. Amia ocellicauda, Richardson; (*Amia calva*, Linnæus?) from Sorel.
H. Taylor, Esq.........	Red snake.
Mrs. H. Bailey.........	Specimen of the granulated (?) salamander. (*Salamandra granulata?* Holbrook).
Jas. Ferrier, jun., Esq...	Abnormal growth of spruce from the White Mountains, with specimens of quartzite in which it was imbedded.
Mr. W. Hunter..........	Dendroica coronata? Gray, male. (*Yellow-crowned wood-warbler.*)
	Troglodytes hyemalis, Viellot, male. (*Winter-wren.*)
	Certhia Americana, Bonaparte. (*American creeper.*)
	Chrysomitris pinus, Bonaparte. (*Pine-finch.*)
	Cyanospiza cyanea, Baird. (*Indigo-bird.*)
Prof. P. J. Darey.......	Tree-Frog. (*Hyla versicolor*, Leconte.)
	September 28th, 1863.
Jas. Ferrier, jun., Esq...	3 cases of miscellaneous insects.
	1 chameleon. (*Chamæleo vulgaris?*)
	Large block of crystals of calc-spar.
W. Saunders, Esq., London, C. W...........	Collection of Canadian insects (*in five cases*), which took the first prize at the Provincial Exhibition of 1863, and of which the following is an estimate :
	Lepidoptera, (*Butterflies and Moths*,) 78 species.
	Coleoptera, (*Beetles*,) 294 "
	Hymenoptera, (*Bees, wasps, &c.*,) 15 "
	Diptera, (*Flies*,) 3 "
	Neuroptera, (*Dragon-flies, &c.*,) 6 "
	Hemiptera, 4 "
	Orthoptera, (*Crickets, locusts, &c.*,) 5 "
	(In all nearly 400 species of Canadian in-

Donors' Names.	Donations.
	September 28th, 1863. (*Continued.*)
	sects, beautifully prepared and carefully named.)
Dr. Wolff, Quebec......	5 species of corals.
Mr. J. F. Wolff, Quebec..	Egg of eider duck (*Somateria mollissima, Leach,*) from Hare Island.
Dr. Douglas, Quebec....	Sea-urchin. (*Palæasterina*—?) from the Eocene limestone at the base of the great pyramid at Ghizeh.
Mr. Jos. Hartley, (Park Farm, near Brantford, C. W.)	5 species of Devonian fossils, from Canada West.
R. J. Fowler, Esq.......	4 Echinocyamus pusillus, (*A small echinoderm,*) and 4 Trochus Magus, (*A marine shell,*) both from Britain.
	1 specimen of the violet salamander. (*Salamandra subviolacea*, Barton.)
	Sponge. (Halichondra?) from Portland, Me.
John Leeming, Esq.....	Specimen of the violet salamander. (*Salamandra subviolacea,*) and do. of another species of Salamandra.
Jas. Sherar, Esq.........	Two species of fossils (*Turritella carinata?* and an *Ostræa*), from the Potomac.
Jno. Swanston, Esq.....	Dress worn byone of the Loucheau or "Squint-eyed" Indians, from the McKenzie River.
G. Barnston, Esq.......	The red throated diver. (*Colymbus Septentrionalis*, Linnæus.)
Principal Dawson......	2 Species of marine shells. (*Myadora ovata*, Reeve, N. S. Wales; and *Donax anatinus*, Britain.)
J. F. Whiteaves, Esq....	4 eggs of the chipping-sparrow. (*Spizella socialis*, Bonaparte.)
	6 species of fresh-water shells from the Southern States.
W. L. Doutney, Esq....	Specimen of the chipmunk. (*Tamias striatus*, Linnæus.)
Captain Jno. McMurtchie	3 scorpions from the West Indies.
Mr. W. Hunter.........	The red bat. (*Vespertilio Noveboracensis*, Linn.)
	The swamp sparrow. (*Melospiza palustris*, Baird)
	The Philadelphian flycatcher. (*Vireo Philadelphicus*, Cassin.)
David Moss, Esq	Facsimile of *London Times* of October 3rd, 1798, containing despatches announcing the victory of the Nile.
Mrs. Edwin Atwater....	A home-made wedding-apron, spun, woven, and embroidered by Mrs. Almy, about the year 1650.
————..........	Capelin (*Mallotus villosus*), in a drift nodule from the Ottawa district.

DONORS' NAMES.	DONATIONS.
	October 26th, 1863.
Principal Dawson......	The banded pipe-fish, (*Syngnathus fasciatus*, DeKay) from Nova Scotia, also an exotic species of Syngnathus.
	Two corallines from Florida. (*Leptogorgia virgata*, and *Ziphigorgia anceps*, both of Edwards and Haime.)
G. Barnston, Esq.......	Star fish, (*Ophiura Egertoni*,) from the Lias of Lyme Regis, England.
Mr. W. Hunter.........	8 specimens of native copper, from the Lake Superior district.
	1 example of iron pyrites, in conglomerate from Massachusetts.
	Meadow mouse. (*Arvicola riparia*, Ord.)
John Gilmour, Esq., Quebec..................	Head of the common or woodland caribou, (*Rangifer Caribou*, Audubon and Bachman.)
Jas. Ferrier, jun., Esq...	2 sea-gulls, in immature plumage, species undetermined.
	November 30th, 1863.
Jas. Ferrier, jun., Esq...	1 specimen of the hooded merganser. (*Lophodytes cucullatus*, Reich.)
Rev. O. Brunet, Laval University, Quebec...	2 species of exotic starfishes.
	8 " of foreign shells.
J. F. Whiteaves, Esq ...	2 species of foreign shells.
	21 fossils (named), from the Trenton limestone, near Quebec.
Mr. W. Hunter.........	Specimen of the chipmunk or striped ground-squirrel. (*Tamias striatus*, Linnæus.)
Principal Dawson......	7 "cone in cone" concretions from the coal fields of Glace Bay, Cape Breton.
	December 28th, 1863.
C. Robb, Esq., C. E.....	Star-nosed mole. (*Condylura cristata*, Linnæus.)
A. Rimmer, Esq........	The mole shrew. (*Blarina talpoides*, Gray.)
Captain Noble..........	Snowy owl. (*Nyctea nivea*, Gray.)
Jno. Brown, Esq., Hamilton, C. W............	The double-crested cormorant. (*Graculus dilophus*, Gray.)
M. Cochrane, Esq.......	Specimen of the spotted Menobranchus, (*Menobranchus lateralis*, Say) in spirits.
W. Learmont, Esq......	Cairngorm stone, cut and polished.
	Jan. 25th, 1864.
Rev. M. De Villeneuve..	8 species of Chinese marine shells.
Rev. M. Billion.........	1 example of Andonta implicata, Say. (*A rather scarce Lower Canadian fresh-water bivalve shell.*)

Donors' Names.	Donations.
	Jan. 25th, 1864. (*Continued.*)
Andrew Allan, Esq.....	Star-Fish, (*Astrophyton —?*) from the Gulf of St. Lawrence.
H. G. Vennor, Esq......	Two specimens of the "drinker" moth, (*Gonoptera libatrix,*) from a cave at the Cote St. Michel, near Montreal.
	February 29th, 1864.
Prof. Miles, Lennoxville.	2 Specimens of gutta percha in its crude state, of qualities No. 1 and 2.
	Fibres from the bark of the Spanish aloe, (*Agave,*) as extracted by machinery.
	Another example of aloe fibre.
	Specimen of Cingalese aloe fibre, with piece of cord made from the same and reddened by vegetable juices.
	2 examples of raw mohair, as it comes from the animal,—of two intermediate qualities.
	Another sample of mohair.
	Specimen of pure mohair "top," combed in preparation for manufacture.
	Example of yarn spun from pure mohair "top."
	2 specimens of down of the silk cotton tree. (*Eriodendron anfractuosum.*)
	Prepared Sarracenia purpurea, (*The pitcher-plant,*) the Indian remedy for small-pox, as used by the Micmacs; from Nova Scotia.
	Samples of Mr. Harben's proposed substitute for cotton, the fibrous alva.
	Specimen of a Javan vegetable fibre proposed as a substitute for cotton, but as prepared for manufacture by Messrs. Marshall & Dalmer of London, (England,) found to answer better in admixture with silk.
Principal Dawson......	10 specimens of fossil plants (named), from the coal measures of Nova Scotia.
Mr. W. Hunter.........	Small brown weasel. (*Putorius cigognanii*, Bonaparte.
	Hairy woodpecker, variety. (*Picus villosus*, Linnæus.)
	Bohemian chatterer. (*Ampelis garrulus*, Linnæus.)
	March 28th, 1864.
Jas. Ferrier, jun., Esq...	1 stuffed specimen of the goshawk, female, (*Astur atricapillus*, Bonaparte.)

Donors' Names.	Donations.
	April 25th, 1864.
Mr. W. Hunter.........	Fine example of the woodchuck or ground-hog, (*Arctomys monax*, Gmelin,) from Brockville, C. W.
	The downy woodpecker. (*Picus pubescens*, Linnæus.)
Mrs. H. Parkinson......	A small collection of marine shells, bryozoa, annelida, and sea-weeds, from Little Metis Bay, Gaspé.
	May 30th, 1864.
A. Ramsay, Fsq........	The snow-goose. (*Anser hyperboreus*, Pallas,) shot at Nun's Island.
Jas. Ferrier, jun., Esq...	The turnstone. (*Strepsilas interpres*, Illiger.)
	Curious Japanese mirror and case.
Mr. W. Hunter.........	The yellow-bellied woodpecker. (*Centurus flaviventris*, Swainson.)
	The golden-winged woodpecker. (*Colaptes auratus*, Swainson.)
	Two robins, male and female. (*Turdus migratorius*, Linnæus.)
	The blue yellow-backed warbler. (*Parula Americana*, Bonaparte.)
Mrs. McCulloch........	138 skins of Canadian birds.
	5 " Foreign "
	20 mammals, (mostly however duplicate specimens).
E. E. Shelton, Esq......	4 Indian pipes, from an excavation in Hospital street, Montreal.
Jas. Claxton, Esq......	8 specimens of minerals, viz., quartz, and quartz with pyrites, calc-spar and sulphate of barytes;—from Devon and Cornwall, England.

J. F. Whiteaves, F. G. S., &c.,

Scientific Curator & Rec. Secretary N. H. S.

The Canadian Naturalist.

The *Canadian Naturalist* is sent to the following Institutions and Societies:

CANADA, ETC.

University College,........................Toronto.
Trinity College,............................Toronto.
Canadian Institute,........................Toronto.
Knox's College, ...Toronto.
Victoria College,...........................Cobourg.
Queen's College,............................Kingston.
McGill College,.............................Montreal.
Bishop's College,...........................Lennoxville.
Laval University ....Quebec.
Literary and Historical Society,.........Quebec.
Natural History Society, ...St. John, N. B.

UNITED STATES.

Harvard College,...........................Cambridge, Mass.
Amherst College, ...Amherst, Mass.
Yale College,.. ....New Haven, Conn.
Natural History Society,..................Boston, Mass.
State Library, ...Albany, New York.
Albany Institute,...........................Albany, New York.
Essex Institute,............................Salem, Mass.
Lyceum of Natural History,.............New York.
Astor Library,..............................New York.
Academy of Natural Sciences,.. ....Philadelphia.
Franklin Institute,.........................Philadelphia.
Smithsonian Institute,....................Washington.
Academy of Science,......................St. Louis, Missouri.
University of Nashville,..................Tennessee.
Natural History Society...................Portland, Maine.

GREAT BRITAIN.

Geological Society,.........................London.
Linnæan Society,...........................London.
Royal Society,..............................London.
Royal Geographical Society,..............London.
British Museum Library,..................London.
University College,........................London.

Society of Arts,...... ....London.
Geological Survey of Great Britain,....London.
Natural History Society, Dawson St....Dublin.
Royal Dublin Society,......................Dublin.
Literary and Philosophical Society,.....Manchester.
Natural History Society, ...Newcastle-upon-Tyne.
Bodleian Library,...........................Oxford.
University Library,........................Cambridge.
University Library, ...Edinburgh, Scotland.
University Library,.........................Glasgow, Scotland.
University Library, ...St. Andrew's, Scotland.
College Library,............................Maynooth, Ireland.
Queen's College,............................Cork, Ireland.
Queen's College, ...Belfast, Ireland.

CONTINENT OF EUROPE.

Société Géologique de France, ...Paris, France,
Académie des Sciences, ...Paris, France.
Académie des Sciences, ...Bologna, do.
Academia Car. Leop.,.......................Jena, Saxe Weimar.
Imper. Geological Institute,...............Vienna, Austria.
Deutsches Geolog. Gesellschafft,..........Berlin, Prussia.
Société Hollandaise des Sciences,........Haarlem, Holland.
Konigl. Sachs. Gesellschaft der Wissenschaften,............................Leipzig, Saxony.
Société Impériale des Naturalistes,......Moscow, Russia.
Konigl. Bayerischen Akademie der Wissenschaften,.........................Munich, Bavaria.
Stockholm Biksbibliokeket, ...Stockholm, Sweden.
Upsala University,.........................Upsala, Sweden.
Academy of Sciences,.......................Stockholm, Sweden,
Christiania University,.....................Christiania, Norway.
Royal Library,...............................Copenhagen, Denmark.
St. Petersburg, Bibliothèque Impériale,St. Petersburg, Russia.
Dorpat University,.........................Dorpat, Russia.
Kasan University,..........................Kasan, Russia.
Helsingfors University,....................Helsingfors, Russia.
Amsterdam Stadsch Bibliotheck,........Amsterdam, Holland.
Leyden Batavian Academy,..............Leyden, Holland.
Gröningen University,.....................Gröningen, Holland.

Bonn University,..........................Bonn, Prussia.
Breslau University, ...Breslau, Prussia.
Freiberg Royal Acad.,......................Freiberg, Saxony.

And to the following Periodicals:—

CANADA.

Canada Medical Journal,..................Montreal.
Journal of the Board of Arts,............Toronto.

UNITED STATES.

Silliman's Journal,.........................New Haven.

GREAT BRITAIN.

Zoologist, ...1 Paternoster Row.
Intellectual Observer, ...5 Paternoster Row.
Technologist, ...23 Paternoster Row.
Geological Magazine,.......................39 Paternoster Row.
Popular Science Review,...................192 Piccadilly.
Seeman's Journal of Botany, ...192 Piccadilly.
Journal of Science, ...11 New Burlington St.
Natural History Review,...................14 Henrietta Street, Covent Garden.
Phytologist.................................28 Upper Manor St.

CONTINENT OF EUROPE.

Annales des Sciences Naturelles,.........Paris, France.
Allgemeine Deutsches Naturh. Zeitung,Dresden, Saxony.
Archiv. fur Naturgeschichte by Weigman,.................................Berlin, Prussia.
Leopoldoia,...................................Jena, Saxe Weimar.
Leonhard und Brohn Jahrbuch,.........Stutgardt, Wurtemburg.

Published, Montreal, September 15, 1864.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ N. Longitude, 4h. 54m. 11s. W. of Greenwich. Height above level of the Sea 182 feet. For the month of March, 1864.

BY CHARLES SMALLWOOD, M.D., LL.D.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F. Highest	Lowest.	Mean.	Reading of Thermometer. Max.	Min.	Mean	Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Inches.	Inches.	Inches.												
1	29.943	29.770	29.868	32.0	16.0	25.9	.135	.834	W	87.61	8.0	....	....	1.6	
2	.900	.619	.777	34.1	18.9	28.4	.131	.887	W by N	115.18	6.3	....	Inapp	3.0	Snow.
3	30.042	.920	30 001	34.0	8.9	24.5	.138	.867	W by N	149.88	0.0	....	....	1.3	
4	29.551	.483	29.510	56 7	21 1	40.2	.251	.826	S W	65.63	0 6	....	....	1.3	
5	.508	.451	.480	40.1	34.6	37.4	.212	.878	N E	280.23	8.6	Inapp	....	3.6	Rain.
6	.700	.541	.496	40.2	31.9	36.5	.206	.869	S W	103.00	10.0	0.170	....	3.3	Rain.
7	.501	.411	.501	34.9	32.0	33.0	.188	.890	S W	290.82	10.0	....	2.34	5.0	Snow.
8	.721	.523	.632	37.3	25.1	31.3	.173	.887	S W	104.59	6.3	....	6 10	4.0	Snow.
9	.985	.773	.885	40.0	18.2	29.3	.155	.819	W	146.61	0.6	....	....	1.6	Aurora Bor.
10	.862	.722	.792	42.4	22.4	30.7	.171	.863	W	95.56	3.6	....	....	1.6	
11	.482	.268	.368	48.3	31.1	39.9	.246	.939	N E	98.64	8.6	Inapp	Inapp	3.3	Rain.
12	.601	.179	.428	42.2	31.9	38.7	.226	.886	W	152.25	8.6	0.849	0.849	3.6	Rain.
13	.726	.700	.717	48.2	31.4	36.6	.209	.860	W	204.40	3.3	....	....	3.3	
14	.804	.709	.736	44.2	15.0	28.7	.160	.829	W	208.00	1.0	....	....	2.0	
15	.784	.761	.776	37.2	10 2	24.8	.105	.861	W by N	177.04	8.6	....	....	1.3	
16	.614	.610	.612	34.9	16.1	26.4	.146	.872	W	40.49	3.6	....	....	2.0	
17	.678	.650	.666	35.0	14.1	27.1	.149	.868	N E	120.34	7.6	Inapp	....	2.0	Rain. L. Halo
18	.425	.352	.381	42.3	27.9	34.8	.197	.891	S W	77.01	8.6	....	....	2.3	
19	.700	.530	.636	29.1	11.2	21.7	.122	.882	W	379.14	1.3	.025	....	2.3	Rain.
20	.792	.579	.674	28.4	12.4	19.4	.116	.881	N E	162.00	6.6	....	Inapp	2.6	Snow.
21	30.046	.837	.960	30.8	2.1	15.9	.102	.869	W	89.02	3.3	....	....	1.3	
22	.295	30.129	30.189	84.4	5.9	19.1	.116	.890	N E	163.50	3.3	....	Inapp	2.6	Snow.
23	.021	29.840	29.950	35.2	3.5	22.3	.127	.840	S W	133.80	4.0	....	....	1.3	
24	29.802	.697	.756	52.3	18.4	36.8	.222	.865	W	781.40	0.6	....	....	2.3	
25	.900	.741	.820	49 9	20.4	35.7	.216	.890	N E	105.40	0.0	....	....	2.6	
26	.900	.769	.845	42.3	28.4	36.5	.212	.909	N E	152.19	3.3	Inapp	....	2.6	
27	30.046	.961	.995	47.0	36.4	43.0	.267	.913	N E	124.00	10.0	....	....	3.3	
28	.117	30.052	30.089	53.1	24.2	37.8	.233	.893	N E	167.41	0.0	....	....	2.0	Aurora Bor.
29	29.973	29.850	29.911	54.7	21.4	38.3	.233	.866	N E	244.20	6.4	....	....	2.6	
30	.691	.669	.669	37.4	29.9	35.2	.198	.898	N E	294.56	10.0	0.191	....	2.6	Rain.
31	.690	.549	.620	46.4	31.5	39.1	.234	.909	N E	235.56	8.6	....	....	3.0	

Remarks for the Month.

Barometer... { Highest, the 22nd day, 30.295 inches. / Lowest, the 12th day, 29.197 " / Monthly Mean, 29.824 " / Monthly Range, 1.098 " }

Thermometer { Highest, the 29th day, 54°7. / Lowest, the 21st day, 2°1. / Monthly Mean, 32°07. / Monthly Range, 52°6. }

Greatest intensity of the Sun's rays, 74°7.
Lowest point of Terrestrial radiation, —7°0.
Mean of Humidity, .880.
Rain fell on 8 days, amounting to 1.235 inches.
Snow fell on 7 days, amounting to 8.93 inches.
Most prevalent wind, N. E.
Least prevalent wind, S. W.
Most windy day the 24th day, mean miles per hour, 22.14.
Least windy day the 16th day, mean miles per hour, 1.68.
Aurora Borealis visible 2 nights.
Zodiacal light, bright.
Lunar Halo, 17th day.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ *N. Longitude,* 4*h.* 54*m.* 11*s. W. of Greenwich. Height above the level of the Sea* 182 *feet. For the month of April,* 1864.

BY CHARLES SMALLWOOD, M.D., LL.D.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F.			Reading of Thermometer.			Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Highest	Lowest.	Mean.	Max.	Min.	Mean									
	Inches.	Inches.	Inches.												
1	29.710	29.650	29.687	56.8	29.9	41.0	.263	.913	N E	265.85	7.6	Inapp	....	3.0	Rain.
2	.720	.673	.703	49.7	31.7	40.5	.245	.915	N E	219.44	8.0	0.114	....	4.0	Rain.
3	.942	.882	.908	51.1	34.3	41.0	.244	.894	N E	114.10	3.3	....	....	2.6	Aurora Bor.
4	.949	.936	.941	61.2	27.1	44.0	.284	.862	N E	115.10	1.8	....	....	1.3	Aurora Bor.
5	.969	.902	.940	51.4	25.0	40.4	.246	.884	N	189.81	0.0	....	....	1.6	Aurora Bor.
6	30.047	.998	30.028	51.1	32.0	48.9	.340	.876	W by S	85.19	1.3	....	....	2.3	
7	.064	30.021	.045	59.6	35.1	52.6	.379	.881	N	66.41	0.0	....	....	2.0	
8	.035	.010	.019	59.8	34.1	43.6	.271	.873	N	127.39	3.3	....	....	1.3	
9	.120	.000	.047	58.8	28.9	43.2	.271	.874	N	265.41	1.3	....	....	1.0	
10	29.932	29.869	29.899	40.1	37.4	39.6	.228	.912	N E	194.40	10.0	Inapp	Inapp	3.3	Rain—Snow.
11	.899	.749	.827	40.6	39.9	37.6	.216	.907	N E	297.18	10.0	0.213	1.90	4.0	Rain—Snow.
12	.920	.825	.877	40.1	32.4	36.8	.212	.922	N E	123.73	10.0	0.051	0.20	2.6	Rain—Snow.
13	.825	.804	.816	47.4	34.2	39.4	.229	.899	N E	136.00	10.0	....	....	2.6	
14	.761	.770	.767	46.1	31.1	40.2	.238	.888	N E	122.24	10.0	....	....	2.8	
15	.629	.601	.628	59.0	34.1	45.3	.306	.915	W	320.04	8.6	....	....	1.6	
16	.474	.450	.458	50.1	34.4	43.1	.268	.904	W	154.05	6.6	....	....	3.0	Snow.
17	.599	.421	.494	46.3	34.2	40.4	.242	.898	W	110.20	8.0	....	Inapp	3.0	Snow.
18	.851	.625	.739	45.7	26.6	37.7	.215	.888	W	133.01	10.0	Inapp	Inapp	3.8	Rain—Snow.
19	.904	.875	.896	64.6	29.4	46.2	.305	.867	N E	199.86	4.0	....	Inapp	3.0	
20	.883	.800	.851	52.4	29.2	43.4	.281	.898	N E by E	60.95	6.6	....	....	2.3	Solar Halo—
21	.913	.820	.861	68.2	34.7	51.8	.340	.866	N E	124.07	0.0	....	....	1.2	Lunar Halo
22	30.011	.982	.975	75.0	32.0	52.0	.369	.815	W by S	51.42	0.0	....	....	1.0	
23	29.851	.780	.814	44.3	39.6	41.6	.257	.920	S W	244.84	10.0	0.110	....	3.0	Rain.
24	30.041	30.024	30.032	66.0	38.4	51.3	.361	.864	W	309.72	0.0	....	....	1.3	Bril. Au. Bor.
25	29.900	29.854	29.875	58.8	32.4	49.7	.315	.833	N N E	219.22	3.6	0.132	....	1.3	Rain.
26	.769	.539	.616	55.0	46.0	50.4	.345	.865	N E	125.14	6.6	0.830	....	3.0	Rain Thund'r
27	.614	.545	.585	53.3	46.9	50.1	.319	.869	N E	115.68	10.0	0.462	....	3.3	Rain.
28	30.035	.769	.911	42.2	33.1	38.8	.231	.909	W	151.54	10.0	0.148	....	2.6	Rain.
29	.040	.992	30.022	60.3	38.4	47.7	.311	.869	W by N	114.24	3.6	Inapp	....	2.0	Rain.
30	29.906	.900	29.868	66.4	34.4	53.4	.361	.884	N by W	151.92	3.3	....	......	2.3	

Remarks for the Month.

Barometer....
- Highest, the 9th day, 30.120 inches.
- Lowest, the 17th day, 29.421 "
- Monthly Mean, 29.765 "
- Monthly Range, 0.699 "

Thermometer
- Highest, the 22nd day, 75°0.
- Lowest, the 5th day, –25°0.
- Monthly Mean, 44°37.
- Monthly Range, 50°0.

Greatest intensity of the Sun's rays, 79°0.
Lowest point of Terrestrial radiation, –20°4.
Mean Humidity .883.
Rain fell on 12 days, amounting to 2.060 inches.
Snow fell on 6 days, amounting to 2.10 inches.
Most prevalent wind, N. E.
Least prevalent wind, S. W.
Most windy day the 15th day, mean miles per hour, 13.33.
Least windy day the 22nd day, mean miles per hour, 2.14.
Aurora Borealis visible on 4 nights.
Solar Halo on the 19th day.
Lunar Halo on the 19th day.
Thunder on the 26th day.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ N. Longitude, 4h. 54m. 11s. W. of Greenwich. Height above level of the Sea 182 feet. For the month of May, 1864.

BY CHARLES SMALLWOOD, M.D., LL.D., D.C.L.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F. Highest	Lowest.	Mean.	Reading of Thermometer. Max.	Min.	Mean	Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Inches.	Inches.	Inches.												
1	29.642	29.574	29.613	51.0	43.0	48.8	.326	.910	N	118.00	6.6	0.063	....	2.3	Rain.
2	.671	.606	.640	67.8	44.1	55.4	.414	.903	S W	100.40	3.3	....	....	1.6	
3	.568	.530	.549	67.4	40.2	44.6	.279	.891	N E	176.96	10.0	0.472	....	2.6	Rain.
4	.810	.587	.692	54 3	34.3	49.8	.279	.844	N by W	285.26	6 6	0.686	....	3.3	Rain.
5	.872	.800	.848	70.1	44.7	53.8	.432	.853	W	109.28	6.3	Inapp	....	2.3	Rain.
6	.842	.621	.721	56.9	40.4	48.5	.310	.851	N E	186.05	10.0	0 221	....	3.0	Rain.
7	.836	.799	.811	59.9	37.0	50.7	.340	.880	N E	220.56	9.6	0.220	....	3.2	Rain.
8	.697	.612	.666	54.3	45.6	48.9	.314	.882	N E	70.41	10.0	0.163	....	2.0	Rain.
9	.579	.469	.522	72.2	48.1	61.5	.484	.873	N N E	81.39	6.6	....	....	3.3	
10	.600	.403	.505	71.4	47.2	59.6	.482	.900	S by W	72.96	10.0	0.030	....	2.0	Rain.
11	.784	.764	.773	53.7	35.0	46.6	.281	.927	N E	250.54	8·0	0.104	....	3.0	
12	.750	.598	.687	50 2	42.0	47.2	.311	.912	N E	143.65	10.0	0.202	....	3.0	Rain Hail.
13	.805	.721	.768	71.2	46.0	60 9	.516	.926	N E	143.61	8.6	0.792	....	2.0	Rain.
14	.971	.817	.970	80.2	59.2	69.4	.660	.904	S W	63.62	6.0	0.014	....	2.2	Rain.
15	.930	.919	.926	85.4	60.9	72.1	.706	.890	N E	134.00	4.0	Inapp	....	1.3	Rain.
16	.867	.802	.847	84 7	58.1	71.3	.675	.861	N E	147.10	3.3	....	....	1.3	
17	.645	.637	.641	84.7	61.1	70.0	.628	.838	N E	94.71	1.3	....	....	1.0	
18	.726	.717	.720	79.2	51.0	66.8	.591	.852	N E	198.61	4.0	....	....	1.0	
19	.805	.797	.800	74.7	48.2	64.4	.495	.838	S W	142.04	8.3	Inapp	....	1.0	Rain.
20	.638	.619	.627	64.2	50.4	61.0	.452	.843	N E	131.80	10.0	Inapp	....	1.3	Rain.
21	.383	.378	.380	70.1	45 7	62.3	.496	.867	N E	62.59	8.3	0.291	....	1.6	Rain.
22	.737	.622	.679	72.2	50 0	61.0	.405	.757	N E	106.40	2.0	Inapp	....	1.3	Rain.
23	.668	.647	.659	63.0	43.0	56.8	.366	.787	W	180.40	6.0	0.442	....	1.3	Rain.
24	.598	.594	.596	51.0	43.1	48.8	.338	.931	N E	159.36	10.0	0 242	....	2.6	Rain.
25	.700	.589	.646	58.2	43.4	55.8	.419	.929	N E	220.78	6.0	0.240	....	2.3	Rain.
26	.597	.502	.546	78.6	49.0	69.4	.659	.894	N E	117.41	10.0	....	....	3.6	
27	.500	.354	.418	80.1	53.0	69.8	.634	.871	N W	104.19	6 6	0.420	....	3.3	Rain.
28	.700	.627	.673	69.5	50.9	59.2	.460	.884	N by W	189.28	2.0	Inapp	....	1.3	Rain.
29	.832	.659	.747	74.0	49.6	60.5	.482	.876	N E	108.00	4 6	....	....	1.0	
30	.662	.572	.625	65.2	43.4	60.1	.489	.930	N E	120.00	6.6	0.170	....	2.0	Rain.
31	.571	.449	.512	72.3	50.1	68.9	.641	.871	W	72.70	10.0	0.051	....	2.0	Rain.

Remarks for the Month.

Barometer .. { Highest, the 14th day, 29.971 inches. Lowest, the 27th day, 29.354 " Monthly Mean, 29.703 " Monthly Range, 0.627 "

Thermometer { Highest, the 15th day 85° 4. Lowest, the 4th day, 34° 3. Monthly Mean, 61.79. Monthly Range, 51° 1.

Greatest intensity of the Sun's rays, 113° 0.
Lowest point of Terrestrial radiation, 34° 7.
Mean of Humidity, .879.
Rain fell on 24 days, amounting to 4.823 inches, it was accompanied by Thunder on 1 day and Hail on 1 day.
Most prevalent wind, N. E.
Least prevalent wind, S. by W.
Most windy day the 4th day. mean miles per hour, 11.88.
Least windy day, the 21st day, mean miles per hour, 1.77.
Aurora Borealis visible on 2 nights.
Lunar Halo visible on 1 night.
Amount of Evaporation 1.81 inches.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ *N. Longitude, 4h. 54m. 11s. W. of Greenwich. Height above the level of the Sea* 182 *feet. For the month of June,* 1864.

BY CHARLES SMALLWOOD, M.D., LL.D., D.C.L.

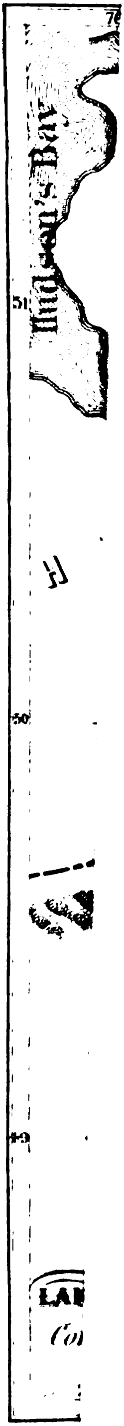
Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F.			Reading of Thermometer.			Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Highest	Lowest.	Mean.	Max.	Min.	Mean									
	Inches.	Inches.	Inches.												
1	9.714	29.661	29.688	74.2	53.0	66.4	.539	.842	S W	189.20	7.6	Inapp	....	1.3	Rain.
2	.724	.714	.719	83.0	49.0	64.5	.487	.792	N E	91.02	1.3	....	....	1.6	
3	.591	.574	.581	66.4	44.7	57.5	.388	.799	W	148.89	3.3	0.080	....	1.3	Rain.
4	.701	.669	.681	85.1	46.0	69.3	.618	.881	W	75.52	0.0	....	....	1.0	
5	.800	.601	.721	83.8	64.2	73.0	.614	.792	W	209.67	3.3	....	....	1.3	
6	.674	.354	.467	88.4	55.0	74.7	.625	.735	W	200.04	4.6	....	....	1.0	
7	.392	.350	.366	85.0	43.0	63 4	.463	.771	W	201.57	0.0	....	....	1.0	
8	.754	.420	.652	65.2	43.0	62.1	.424	.760	W	92.36	10.0	....	....	1.3	
9	.214	.106	.158	60.1	46.0	55.1	.384	.818	W	204.47	10.0	0.472	....	1.3	Rain.
10	.500	.350	.405	69.0	55.2	56.7	.321	.660	W	351.39	4.0	....	....	1.0	
11	.800	.651	.716	72.1	55.4	60.6	.331	.670	W	119.16	5.6	....	....	1.0	
12	.380	.814	.855	73.4	48.0	61.1	.394	.729	N E	234.30	2.6	....	....	1.0	
13	.392	.874	.886	89.4	44.2	73.1	.583	.706	W	103.06	0.0	Inapp	....	1.0	Rain.
14	.792	.741	.759	91.0	52.7	73.1	.583	.706	W	138.50	0.0	....	....	0.6	
15	.706	.692	.698	91.4	55.9	76.4	.682	.743	W	14.51	2.0	....	....	0.0	
16	.614	.602	.606	92.0	59.0	79.3	.702	.697	N E	244.78	0.0	....	....	0.0	
17	.800	.714	.758	94.7	60.0	78.8	.659	.660	N E	246.13	0.0	....	....	0.1	
18	.830	.814	.819	96.7	60.5	83.5	.770	.678	S W	91.55	0.0	....	....	0.1	
19	.819	.816	.813	96.2	66.4	83.9	.772	.666	S W	192.20	0.0	....	....	0.0	
20	.852	.850	.851	89.2	68.4	77.7	.687	.778	S W	285.09	0.0	....	....	0.6	
21	30.045	30.011	30.029	89.8	59 2	77.1	.706	.784	N E	207.09	0.0	....	....	0.6	
22	29.927	29.794	29.878	92.4	69.3	80.5	.769	.709	S W	173.41	0.0	....	...	0.8	
23	.784	.633	.716	76.9	66.0	78.7	.652	.797	N E	235.70	3.3	....	....	0.5	
24	.759	.654	.723	77.0	59.0	78.4	.636	.784	S W	217.83	0.0	....	......	0.8	
25	.509	.500	.505	90.2	68.2	79.9	.757	.749	W S W	156.07	0.0	....	....	0.1	
26	.477	.344	.423	92.3	71.1	78.9	.739	.754	W S W	114.92	2.6	0.374	....	0.1	Rain.
27	.821	.605	.680	80.0	59.0	67.0	.561	.822	N E	218.90	3.8	Inapp	....	1.0	Rain.
28	.947	.937	.940	80.4	52.2	67.1	.535	.770	W N W	214.61	10.0	....	....	0.6	
29	.984	.926	.929	91.0	54.0	74.0	.678	.779	W	427.80	0.0	....	.. .	0.0	
30	.718	.617	.674	82.	54.2	73.8	.656	.794	W	284.20	1.8	....	....	0.6	

Remarks for the Month.

Barometer ... { Highest, the 21st day, 30.045 inches.
Lowest, the 9th day, 29.106 "
Monthly Mean, 29.708. "
Monthly Range, 0.939. "

Thermometer { Highest, the 18th day, 96° 7.
Lowest, the 10th day, 35° 2.
Monthly Mean, 70.01.
Monthly Range, 61° 5.

Greatest intensity of the Sun's rays, 118° 4.
Lowest point of Terrestrial radiation, 33° 4.
Mean of Humidity, .703.
Rain fell on 6 days amounting to 0.876 inches.
Most prevalent wind, W.
Least prevalent wind, S. W.
Most windy day, the 29th day, mean miles per hour, 17.82.
Least windy day, the 15th day, mean miles per hour, 0.60.
Amount of Evaporation, 247 inches. 2.47.
Aurora Borealis visible on 2 nights.


Hudson's Bay

THE

CANADIAN NATURALIST.

SECOND SERIES.

MICHAUX AND HIS JOURNEY IN CANADA.

By the ABBÉ OVIDE BRUNET, Professor of Botany at the Laval University, Quebec.*

It is well known to botanists, that the *Flora Boreali-Americana* of Michaux often fails to indicate the precise localities of the plants there first described, and that, in consequence, many of these plants are either still unknown to collectors, or excessively rare. In the hope of being able to determine the localities of those plants which this author has noticed as occurring in Canada, I attempted several years since to trace the steps in his journey to the Saguenay, and to Hudson's Bay. At that time however, the only materials at my disposal were the *Flora*, and some scattered notes in the works of his son. I had not then seen his Herbarium, which is rich in notes of localities; and the manuscript journal of his journey, in the library of the American Philosophical Society in Philadelphia, was unknown to me. Since that time however, I have been able to consult the original collections of Michaux, which are in part at the Jardin des Plantes of Paris, and in part in thé museum of Mr. Benjamin Delessert of that city. The American Philosophical Society has moreover permitted me to copy the manuscript journal, for which favor I take this occasion of expressing my thanks.

* TRANSLATOR'S NOTE.—This interesting paper was printed a few months since, in French, by Mr. Brunet, for private distribution only. I have accordingly translated it for publication in the *Canadian Naturalist*, suppressing some unessential portions, with the approbation of the author; who has added to it a map of the region from Lake St. John to Hudson's Bay. A MS. map by the Jesuit Laure, who was a missionary in Canada during the early part of the last century, is the chief authority for the region beyond Lake St. John, though other old French maps were consulted. The map of Laure is in the library of the Canadian Parliament.—T. S. H.

In the following pages, which I have prepared with the aid of the materials thus placed at my disposal, I shall give a list of the most interesting plants found by our botanist in the various localities visited during his Canadian journey; while for the more common species, I shall only notice the most northern points at which they were observed. There will be found in these pages, notices of more than one hundred and sixty plants observed by Michaux in localities not mentioned in his Flora. These indications, it is to be hoped, will not be devoid of interest to collectors, and to students of geographical botany; while in addition will be found some interesting details from the journal of Michaux on the characters of a portion of that almost unknown region which forms the water-shed between the St. Lawrence and Hudson's Bay.

André Michaux, the early years of whose life were devoted to agriculture, soon conceived a plan for visiting foreign countries with the object of studying their plants, and, if possible, introducing them into France. As a preparation for this, he came to Paris in 1779, and studied botany for two years under Bernard de Jussieu. After having in the pursuance of his plan visited England, and crossed the Pyrenees into Spain, he visited Persia, from whence he brought great collections of plants and seeds. The French government, desirous of introducing into France some of the trees of North America, then decided on sending Michaux to this continent; where his orders were to travel through the United States, and collect both trees and seeds, which were to be sent to France. In pursuance of this mission, he sailed on the 25th of August 1785, and reached New York the 1st of October, accompanied by a gardener. Although his journey had for its chief object the introduction of forest-trees, Michaux had received orders to send also such shrubs and plants as might serve to ornament the king's gardens.

He at first made New York his head-quarters, from which he visited New Jersey, Pennsylvania, and Maryland, and he established a nursery in New Jersey, with a view of raising young trees which should be of better growth than those found in the forests. In the year following, Michaux sent to Paris twelve boxes of seeds, and several thousand young trees. After a time he removed to Charleston, South Carolina, and there established a second nursery, which soon obtained great dimensions from the immense collections of trees and shrubs, the fruit of more than sixty journeys in various parts of the interior. The manuscript notes of Michaux, however, give us no details of these excursions up to the month of April 1787, when he made his first journey to the Alleghanies, going up the Savannah River to its head, and thence gaining the heights of the mountain region. Having made friends with some of the Indians, he then ascended with them one of the tributaries of the Savannah, and reached a branch of the Tennessee on the other side of the mountains. This was the limit of his voyage, and he then returned to Charleston on the first of July, after a voyage of 300 leagues in South Carolina and Georgia. His manuscript notes of this journey contain many observations on the plants met with, and precise indications of their localities. In 1788 and 1789 he visited, successively, Florida, the Lucayan islands, and Virginia, passing through the mountain region of North Carolina. He returned to Charleston from this last excursion in September 1789, but revisited the region in the course of the following winter, accompanied by his son, reaching Charleston again in the spring of 1790, where he remained until April 1791. His notes during this year are wanting.

Michaux had now spent six years in America, his pecuniary resources were nearly exhausted, and he feared to be obliged to return to France without having completed his plans on this continent. He had long desired to add to his studies upon the American Flora, some researches on the geographical distribution of the forest trees, and to determine the native region of each, which he regarded as that in which the plant attains its greatest size and strength. The tulip-tree (*Liriodendron tulipifera*), for example, appears in Western Canada with a maximum height of sixty feet, and a diameter of three feet; while westward, and especially in Kentucky, where it forms by itself vast forests, it reaches a height of one hundred and forty feet, and a diameter of seven or eight feet. To the northward, on the contrary, it becomes rarer and smaller, and Michaux was hence led to regard this tree as a native of Kentucky. In accordance with these views, he resolved to study the topography of the North American trees. He had already extended his travels southward to Florida, but another journey, longer and more difficult, but still more important to his investigations, yet remained to be accomplished,—a visit to Canada and northward as far as Hudson's Bay. This project he attempted in 1792. Leaving Charleston in April, he proceeded northward by land, and, as we learn from his manuscript notes, went first directly to New York, thence to New Haven, and finally to Albany, where he arrived on the 14th June. On the 18th we find him at Saratoga, and on the 20th he embarked on Lake Champlain at Whitehall. The remainder of this month was employed in examining the vegetation on the shores of the lake, which he crossed several times. In his Flora, mention is made of a great number of plants which he found in this region.* On the 30th of June, Michaux reached Montreal, where he spent ten days in collecting the plants of the environs. On the 1st of July, he tells us he botanized on the mountain. "On the 3rd, in the country and the low meadows," and "on Sunday the 8th, in the wood of Lachine, for a league along the river-side." In these excursions he collected the following plants, which are marked in his herbarium as having been collected about Montreal:

Scirpus spathaceus, Michx.; *Elodea Canadensis*, Michx.; *Poa compressa*, Linn.; *Scutellaria parvula*, Michx.; *Oxalis corniculata*, Linn.; *Hypericum macrocarpum*, Michx.; *Acalypha Virginica*, Linn.; *Zanthoxylum fraxineum*, Willd.

On the 11th June Michaux left for Quebec; but adverse winds obliged him to put in at Sorel and at Batiscan, where he made collections. In the latter locality he found *Scheuchzeria palustris*, Linn.; *Triglochin maritimum*, Linn.; *Drosera longifolia*, Linn.

He reached Quebec on the 16th July, and remained there a fortnight, in which time he made several excursions in the environs, visiting the Falls of Montmorency, Lorette (probably La Jeune Lorette), and botanized in the forest on the right bank of the river St. Charles. As the season was advancing, he now made arrangements for his journey to Hudson's Bay. Engaging as an interpreter a young half-breed, who had been three years with the Indians, he started for the Saguenay. The following extracts from his notes will show his route:

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* It would be superfluous to furnish lists of plants whose names and localities are found in the *Flora* of Michaux. When therefore in this narrative I give a list of plants found by our botanist in any locality, it will be understood to include only those which have not been mentioned in his *Flora* as there occurring; but which are given in his Herbarium, or in his manuscript notes as having been found in that locality. For the convenience of reference, however, I give in the following manner, the pages where the plants not here named will be found mentioned:

Flora Boreali-Americana, in Canada, ad ripas lacus *Champlain*, vol. i, fol. 47, 75, 136, 153, 304; vol. ii, fol. 28, 198, 227, 245.

"Left Quebec July 31, sailing by Cape Tourmente and Cape Brulé, which are distant twelve and fourteen leagues from Quebec. Saw upon the mountains *Juniperus communis*, *Thuja*, *Abies balsamea*, *A. alba*, *Epigœa repens*, *Linnœa borealis*, etc., etc. ....That night lay off Bay St. Paul.........August 1st. The wind changed and rain fell; botanized on the mountains......... August 2nd. Arrived at Malbaie, and left there on the 4th, reaching the mouth of the Saguenay, where I passed the night. On the morning of Sunday the 5th reached Tadoussac, forty-six leagues from Quebec."

The plants collected by Michaux at Malbaie were as follows:

Hippuris vulgaris, Linn.; *Salicornia herbacea*, Linn.; *Pulmonaria parviflora*, Michx.; *Ligusticum Scoticum*, Linn.; *Salsola salsa ?* Michx.; *Polygonum cilinode*, Michx.; *Potentilla hirsuta*, Michx.; *Astragalus secundus*, Michx.;* *Medicago lupulina*, Linn.; *Pteris gracilis*, Michx.

A little lower down on the shores of the St. Lawerence he gathered *Salicornia herbacea*, Linn.; *Arundo arenaria*, Linn.; *Glaux maritima*, Linn.; *Salsola salsa ?* Michx.; *Atriplex patula*, Linn.; *Rumex verticillatus*, Linn.; *Arenaria rubra*, Linn., (= *Spergularia rubra*, Pers.); *Potentilla hirsuta*, Michx.; *Empetrum nigrum*, Linn.

The picturesque little village of Tadoussac is built upon a point of rock at the entrance to the Saguenay, and was a post of the Hudson's Bay Company. Here Michaux bought two bark-canoes, and engaged three Indians; here also, as we learn from his Flora and his Herbarium, he collected the following plants: *Ligusticum Scoticum*, Linn.; *L. actœifolium*, Michx.; *Gentiana acuta*, Michx.; *Epilobium tetragonum*, Linn.; *Vaccinium Vitis-Idœa*, Linn.; *Potentilla hirsuta*, Michx.; *Ilex Canadensis*, Michx. †

He was soon however on his way up the Saguenay, which for a distance of twenty-seven miles flows between immense walls of gneiss, often extremely bold and picturesque. The banks are almost destitute of vegetation, except in the fissures of the rocks, where a few stunted pines and spruces, wild gooseberries and blueberries laden with fruit, and a juniper (*Juniperus sabina*), form

* See note† on page 331.

† Flora Boreali-Americana, ad ripas fluminis *S. Laurentii*, juxta Tadoussac, vol. i, fol. 166, 177; in fluminis *S. Laurentii* aquis affluente mare subsalsis, vol. i, fol. 1, 67, 95, 102, 132.

a green tapestry hanging on the embankments, which rise sometimes a height of 1100 feet.*

As we approach Ha! ha! Bay the shores become lower, and the great pine forests which form the wealth of this region are seen. At Chicoutimi, where the river ceases to be navigable for large vessels, it spreads into a wide basin which receives a cascade of forty feet in height. Michaux reached this spot on the 11th of August.

Chicoutimi, which signifies *deep water*, was then a little village at the junction of the river of this name with the Saguenay. Upon a point which projects into the basin was a small chapel about twenty-five feet long, built by the Jesuits, and having within a single altar and a few pictures, while outside was seen the tomb of Père Coquart, the last of the Jesuits, who, with the Père Labrosse, had first preached the Gospel to the natives. Michaux, in the manuscript notes which he left to his son, thus speaks of this chapel: "On my way to Hudson's Bay I reached in the month of August the Lake Chicoutimi, near the 48th degree of latitude, and there found the church erected in 1728 (as indicated by the date placed over the principal entrance) by the Jesuit fathers for the natives of the vicinity. This building, made of squared timbers of white cedar (*Thuja occidentalis*) placed upon each other, was in good preservation; and although these beams had never been covered either within or without, the wood at the depth of half a line was not the least altered after a lapse of more than sixty years."† This little chapel was still standing in 1857.

The route to Lake St. John was then much more difficult than that which is now followed. Michaux went up the river Chicoutimi in a canoe and then passed through Lake Kinogomi, from which, by a portage of half a mile, he reached Lake Kinogomichiche; this discharges itself by a slow and tortuous stream into Belle River, which falls into Lake St. John, which our traveller reached after a journey of six days from Chicoutimi, gathering the following plants in his way:

Scirpus spathaceus, Michx.; *Swertia corniculata*, Linn.; *Prinos verticillatus*, Linn.; *Gentiana pneumonanthe*, Linn.; *Drosera rotundifolia*, Linn.; *Triglochin palustre*, Linn.; *Juncus fluitans*, Michx.; *Mitella diphylla*, Linn.; *Sparganium natans*, Michx.;

* Flora Boreali-Americana, in saxosis ad amnem *Saguenay*, vol. i, fol. 3. vol. ii. fol. 246.

† Michaux fils, Arbres Forestiers, vol. iii, p. 34.

Nymphœa lutea, β. Kalmiana, Linn.; *Spergulastrum lanceolatum*, Michx., (=*Stellaria borealis*, Bigelow); *Alnus crispa*, Michx.; *A. glauca*, Michx.; *Lobelia Dortmanna*, Linn.

Lake St. John lies between latitude 48° 23′ and 48° 42′, and between longitude 71° 29′ and 72° 9′, its greatest length being sixteen leagues; it is more than thirty leagues to the north of Quebec. Michaux went entirely around it, and collected a great number of plants;* but in pursuance of his plan of studying the trees, he also penetrated into the surrounding forests, which abound in valuable timber-trees, details with regard to the nature and distribution of which, will be given further on.

It was on the 16th August that our botanist reached this lake, but, delayed by an adverse wind, he spent the next day at the mouth of Belle River, where he found *Lycopus Virginicus*, Linn.; *Circœa Canadensis*, Linn.; *Bromus Canadensis*, Michx.; *Arundo arenaria*, Linn.; *Galium Claytonii*, Michx.; *G. asprellum*, Michx.; *Cornus alternifolia*, Linn.; *Polygonum amphibium*, Linn.; *Cerasus pumila*, Michx.; *Lathyrus palustris*, Linn.; *Astragalus secundus*,† Michx.; *Hedysarum alpinum*, Michx.; *Aster amygdalinus*, Michx.; *A. cordifolius*, Linn.; *Solidago flexicaulis*, Linn.; *S. aspera*, Ait.; *Senecio pauperculus*, Michx.; *Artemisia Canadensis*, Michx.; *Lobelia Kalmii*, Linn.; *Eriocaulon pellucidum*, Michx.; *Calla palustris*, Linn.; *Salix cordata*, Michx.; *Ilex Canadensis*, Michx.; *Vitis riparia*, Michx.

Of the *Vitis* just named, Michaux has in his Herbarium the following notes: "Called beach-vine (*vigne des battures*) by the French voyageurs on the Ohio and Mississippi, because it grows upon the rocks and sands which are exposed to the annual floods. ....This species is never found to the east of the Alleghany Mountains."

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* Flora Boreali-Americana, in lacu vel juxta lacum *S. Joannis*, vol. i, fol. 240, vol. ii, fol. 205, 220, 225.

† Prof. Asa Gray had for some time supposed the *Astragalus secundus* of Michaux to be the *Phaca astragalina*, D. C., (*Astragalus alpinus*, Linn.,) when in 1861, I re-discovered the plant at Lake St. John, where Michaux had first found it, and sent specimens of it to Prof. Gray, which fully confirmed his opinion that it is but another form of *A. alpinus*, Linn. But whence this difference of form? Last year, at the Island of Orleans, where this species is abundant, I found the two varieties in the same locality; and I was able to observe that when it grows on exposed rocks the plant has the ordinary form of *Phaca astragalina;* while on the contrary, when sheltered by a growth of taller plants, it assumes the slender and elongated form of the plant of Michaux.

Among the rivers which fall into Lake St. John is the Mistassini, called also R. des Sables, from the great quantity of sand which it brings down. By this river, which has a length of about 150 miles, the Indians known by the name of Mistassins, and living around the great lake of that name, were accustomed to descend at Pointe Bleue, the most northern trading-post in this region, where they sold their furs. They still come down every year in the month of June for the purpose of trade, and also to meet the missionary who pays them an annual visit. It was by this river that Michaux proposed to pass to Hudson's Bay. Leaving the post at Pointe Bleue on the 21st August, he reached in a few hours the river Mistassini. The waters were shallow, and for five or six leagues flowed through banks of moving sands, which were sometimes more than half a league long. The lands on either side were low and fertile, no mountains were visible, and the trees were chiefly elms, ashes, and pines, of a good growth.* At the end of about eighteen leagues Michaux arrived at a beautiful waterfall about eighty feet in height, and on the evening of the 22nd August encamped on the borders of the basin below.

This point which was known as Larges Rapides, Michaux observed as the northern limit of *Potentilla tridentata*, while *Gaultheria procumbens*† disappeared ten leagues above Lake St. John, although Hooker, in his *Flora Boreali-Americana*, has indicated Quebec as its northern limit.

The 23rd being a day of rain, Michaux remained in camp; but the three following days he continued the ascent of the river, which became narrower, and so rapid that the canoes could only be propelled by means of poles. At length he reached the portage called *Monte-à-peine*, where he was obliged to make a difficult and even dangerous ascent of a hill eight or nine hundred feet in height. From the summit he looked down into an immense valley, traversed by green hills which resembled great waves in an ocean of verdure. A single small river alone broke the monotony of this landscape; to it the travellers directed their steps, and soon reached a stream which was only about eighteen feet wide. During

* Flora, in Canada ad amnem *Mistassini*, vol. i, fol. 34, 61, 110.

† Some botanists have ventured to change the name of this plant to *Gautiera;* but the true orthography of the name of its discoverer is Gauthier, as appears from the registers of Notre Dame de Quebec (Register of Aug. 26, 1751). It would besides be undesirable to change a name consecrated like this by long use.

the portage the following plants were met with: *Vaccinium cæspitosum*, Michx.; *Epigœa repens*, Linn.; *Arbutus Uva-ursi*, Linn.; *Lycopodium inundatum*, Linn.; *L. Selaginoides*, Linn.; *Botrypus lunaroides*, Michx.

The little river on which they now embarked was generally deep enough for their canoes, but the navigation was often interrupted by the dams constructed by the beavers, whose cabins were seen on the shores. This stream led them to Swan Lake (Lac des Cygnes), which they reached in the afternoon of the 29th August. This picturesque little lake, which is about forty-five leagues from Lake St. John, is very irregular in form, in some parts having a breadth of two leagues, and at others being very narrow. The shores are generally low, with occasional hills covered by stunted trees. Around the shores of this lake Michaux found the following plants: *Avena striata*, Michx.; *Arundo Canadensis*, Michx.; *Xylosteum villosum*, Michx.; *Juncus melanocarpus*, Michx.; *Vaccinium Vitis-Idœa*, Linn.; *Epigœa repens*, Linn.; *Epilobium oliganthum*, Michx.; *Potentilla fruticosa*, Linn.; *Aster uniflorus*, Michx.; *Carex lenticularis*, Michx.; *Abies balsamifera*, Michx.; *A. denticulata*, Michx.; *Betula glandulosa*, Michx.

He remarks that *Avena striata* is the only gramineous plant observed by him in this vicinity, and also that Swan Lake appears to be the most northern limit of *Vaccinium Vitis-Idœa*.

Lake Mistassini is about 100 leagues from Lake St. John, and Michaux had already traversed about half the distance, but the most difficult part remained. He had to cross a dismal wilderness, where the vegetation consists only of a small number of stunted and depauperated species. "The trees which predominate in the forests, a few degrees to the southward, have here almost entirely disappeared, from the severity of the winters and the sterility of the soil. All this region is traversed by thousands of lakes, and covered with enormous rocks piled upon one another, and generally covered with huge black lichens, which add to the gloomy aspect of this desert and almost uninhabitable country. Between these rocks are seen here and there some specimens of a stunted pine (*Pinus rupestris*), which at the height of three feet is seen bearing fruit, and having all the marks of decrepid old age. One hundred and fifty miles to the southward this pine attains a height of eight or ten feet, and presents a much more vigorous growth."*

* Michaux fils, Arbres Forestiers, vol. i, page 49.

Of this region, between Swan Lake and Lake Mistassini, Michaux remarks in his journal, that it evidently occupies the height of land, since the waters of the latter lake fall northward into Hudson's Bay, while those of Swan Lake through the river Mistassini reach Lake St. John and the St. Lawrence. We cannot give a better notion of the climate and vegetation of this elevated and semi-arctic region, than by the following extracts from the manuscript journal of Michaux:

"August 30th. We have passed through three lakes, which lie among low hills, and are connected by short streams. The whole of this region is cut up into mountains and hills; the low places between which are filled with water, forming innumerable lakes, which for the most part have no names among the Indians who hunt in this country. Wide intervals are often covered with *Sphagnum*, in which the traveller sinks to his knees, and which even in the dry weather is always saturated with water. In the course of the day we have made three portages, and have travelled three or four leagues only, on account of the difficulty of crossing these marshes.

"These marshes abound in *Kalmia glauca*, *Andromeda polyfolia*, *Sarracenia purpurea*, and *Vaccinium Oxycoccus*. In the drier parts are *Andromeda calyculata*, *Ledum palustre*, *Kalmia angustifolia*, *Epigæa repens*, and *Pinus rubra*. *Abies balsamifera* may be said to cease at Swan Lake: I saw only three specimens of it to day in the form of little shrubs. All the plants here seem like decrepid pigmies on account of the sterility and the severity of the cold.

"August 31st. We paddled for an hour; and then came to a portage. The cold was excessive, the sky cloudy for the last two days, and the rain like melted snow. When we stopped for breakfast, the cold took away our appetites, and the Indians, who were drenched with water, trembled with cold.

"September 1st. The rain prevented our travelling, and one of our Indians was sick. In the afternoon the weather was clearer, and we went on notwithstanding the rain. All night we had rain with thunder and lightning. We made six leagues, passing through a lake and along streams scarcely wider than a canoe.

"September 2nd. Sunday. The weather was very thick in the morning, and a half-melted snow fell; the cold became less severe, but we had a portage of three quarters of a league across a marsh. Despite showers of hail, which lasted all day, we kept on, for the

Indians, like myself, were most anxious to reach Lake Mistassini before the snow and cold should augment. We crossed three lakes, and travelled about ten leagues.

"September 3rd. Ice formed about a line in thickness. After midnight a white frost was seen on the vegetation around our camp, and there was promise of a fine day; but about seven in the morning the air became thick, and we had alternations of snow, rain, hail, and sunshine. * * * At eleven o'clock we reached a great river flowing northward, and with a favoring current we made eighteen or twenty leagues to-day. The soil appeared to grow better.

"September 4th. We were obliged to make three portages, on account of rocky rapids, and at a quarter past ten reached Lake Mistassini."

The following plants, in addition to these already mentioned, were met with in crossing the height of land: *Scirpus eriophorum*, Michx.; *Cinna arundinacea*, Linn.; *Avena striata*, Michx.; *Symphoricarpos racemosus*, Michx.; *Gentiana pneumonanthe*, Linn.; *Juncus melanocarpus*, Michx.; *Triglochin maritimum*, Linn.; *Alisma plantago*, Linn.; *Vaccinium oxycoccus*, Michx.; *V. cæspitosum*, Michx.; *V. myrtilloides*, Michx. (*V. Pennsylvanicum*, Lam.); *Mentha borealis*, Michx.; *Pinus inops?* Ait.; *Lycopodium Selaginoides*, Linn.

Of the great Mistassin Lake but little is known; the sketch of it given in the accompanying map represents its size and shape as far as can be gathered from the missionaries and Indian traders. Rupert's River, by which it empties into James's Bay, is described as being from fifty to sixty leagues in length, and larger than the Saguenay. Its name, and that of the natives of its shores, is derived from the Indian word *mistassini*, by which they designate a huge rock which hangs over the lake near its outlet, and is regarded as the abode of a Manitou or Great Spirit, who is an object of religious worship. When crossing the lake they are said to keep their eyes turned away from this rock lest he in his ire should excite a tempest. Near the lake, on a small river which flows into it, is said to be a rude cavern in marble, which the Indians call the house of the Great Spirit. The notes of Michaux add but little to our knowledge of this lake. He tells us, however, that the shores are low, and the hills remote, and adds that "the waters of the lake are discharged by rivers to the north and northwest, which fall into Hudson's Bay, the journey to which, from the lake requires, according to the Indians, four days, although, on account of the rapids, it requires ten days to return."

Michaux reached Lake Mistassini on the 4th of September, and, after paddling along it for ten or twelve leagues, encamped on a long peninsula on the west side of the lake. The next morning he began to collect plants, of which he gives the following names, exclusive of those mentioned in his *Flora* as occurring in this region:*

Lycopus Virginicus, Linn.; *Scirpus sylvaticus*, Linn.; *S. eriophorum*, Michx.; *Phalaris arundinacea*, Linn.; *Cornus Canadensis*, Linn.; *C. stolonifera*, Michx.; *Potamogeton perfoliatum*, Linn.; *Linnæa borealis*, Gronov.; *Ulmus fulva*, Michx.; *Streptopus distortus*, Michx; *Convallaria stellata*, Linn.; *Triglochin maritimum*, Linn.; *Epilobium angustifolium*, Linn.; *Vaccinium oxycoccus*, Linn.; *V. hispidulum*, Linn.; *V. uliginosum*, Linn.; *Pyrola secunda*, Linn.; *Epigæa repens*, Linn.; *Spergulastrum lanceolatum*, Michx.; *Cerasus borealis*, Michx.; *Sorbus aucuparia*, Linn., (*Pyrus Americana*, D. C.); *Geum rivale*, Linn.; *Potentilla fruticosa*, Linn.; *Rubus occidentalis*, Linn.; *R. arcticus*, Linn.; *Prunella vulgaris*, Linn.; *Rhinanthus Crista-galli*, Linn.; *Sisyrinchium Bermudiana*, Linn.; *Geranium Carolinianum*, Linn.; *Bartsia pallida*, Linn.; *Hedysarum alpinum*, Michx.; *Hieracium scabrum*, Michx.; *H. Canadense*, Michx.; *Aster macrophyllus*, Linn.; *Solidago aspera*, Ait.; *Senecio aureus*, Linn.; *Lobelia Dortmanna*,† Linn.; *Carex flava*, Linn.; *Betula papyrifera*, Michx.; *Sparganium angustifolium*, Michx.; *Abies alba*, Michx.; *A. balsamifera*, Michx.; *A. denticulata*, Michx.; *Pinus inops* ?‡ Ait.; *Salix incana*, Michx; *Acer montanum*, Ait.; *Osmunda regalis*, Linn.

Having made his collections, and reached the other side of the lake, Michaux proceeded on his journey; chosing for this purpose, among the discharges of the lake, a large and fine river falling into Hudson's Bay, and known as the Rivière des Goëlands (Gull

* Flora Boreali-Americana, ad sinum *Hudsonis* et juxta lacus, *Mistassini*, vol. i, fol. 5, 11, 14, 61, 64, 111, 124, 191, 223; vol. ii, fol. 2, 115, 121, 123, 153, 154, 171, 172, 173, 175, 180, 283.

† The *Lobelia Dortmanna* is a rare species in Canada: I have as yet found it in but two localities, Lake Kenogami and Lake St. Joachim.

‡ The *Pinus inops* here mentioned is the *P. Banksiana*, Lamb., *P. rupestris*, Michx. fils., already mentioned on page 333. It may be here remarked, however, that it attains in some localities a height of thirty feet.

River), which is very probably that designated in the maps as Rupert's River. He followed this for some distance, and camped on the night of September 5th, near the Atchoukue or Seal River. The next day a cold fog was succeeded by rain and snow, and compelled him to stop. The Indians, fearing the rigors of the season, refused to go further, assuring him that if the snow continued it would be impossible for them to return. It was therefore decided that they should immediately retrace their way to Lake Mistassini, where they arrived that night. Along the banks of the Gull River the following plants were collected:—*Xylosteum villosum*, Michx.; *Primula Mistassinica*, Michx.; *Ledum latifolium*, Ait.; *Rubus Chamæmorus*, Linn.; *Aster uniflorus*, Michx.; *Carex Richardi*, Thuill.; *Betula nana*, Linn.; *Myriophyllum spicatum*, Linn.; *Salix incana*, Michx.; *Myrica Gale*, Linn.; *Lycopodium annotinum*, Linn.

Michaux left Lake Mistassini on the 7th of September. His journey back, although difficult, was rapid; and from the height of land the descending currents of the rivers, now swollen, enabled the travellers to pass down in their canoes over most of the rapids where they had made portages in ascending. On the 9th of September he passed Swan Lake and camped at Monte-à-Peine, and on the 10th reached the river Mistassini, and camped at night "four leagues below the Larges Rapides, near the first Weymouth pines (*Pinus strobus*) which we met on our way downwards." On the 12th, Michaux reached Lake St. John, and two days later left for Quebec; from which he returned, by way of Montreal and Lake Champlain, to Philadelphia, where he arrived on the 8th of December, 1792.

"REMINISCENCES OF AMHERST COLLEGE."

By Edward Hitchcock, D.D., LL.D.*

This is a book which should be read by all our young naturalists, and by all connected with our colleges and schools. It shows what can be done for natural science, education, and Christianity by the earnest labors of a self-denying man, even under the disadvantages of poverty, want of educational privileges, and bodily weakness; and is full of suggestive hints as to the best means of overcoming the difficulties which beset the pursuit of science and education in this country.

* Northampton, Mass., U. S.: Published by Bridgman & Childs, 1863.

Its interest as a narrative and as a study of human nature is also great. Mixed with some pardonable egotisms, it brings before us a vivid picture of the genuine old New England puritan character, in its energy, its stubborn endurance, its rigid honesty and integrity, its horror of debt and dependence, and its quiet enthusiasm,—qualities which, it is to be feared, have somewhat died out in more recent times, and which certainly require culture among the young men of Canada.

We purpose, in the present notice, to give a few extracts illustrative of the early life and character of Dr. Hitchcock, and of his efforts in behalf of natural history, and especially of the museum of Amherst College.

The following extracts refer to the difficulties of his early life:

"One of these circumstances was the comparative poverty of my early condition. It was not absolute poverty, for my father moved among the most respectable of the people of Deerfield, where I was born, and was honored among them especially by being chosen deacon of the Orthodox church, of which he was long one of the strongest pillars. But he had to struggle hard with a trade not very lucrative, to feed, clothe, and educate a large family. He had commenced his family career during the Revolutionary War, in which he had been twice engaged as a soldier, as was his father, who fell a sacrifice to the diseases of the camp. The debts which he contracted when Continental Notes were almost the only money, hung like an incubus upon him nearly all his life, and he was relieved only when his sons were old enough to aid him. But he was highly intellectual in his habits, and studied theology especially, with much success." [Towards the close of his life, as but few sympathized with him in his religious views, the church with which he was connected having passed into other hands, he committed many of his thoughts to writing, and some of the essays and sermons which he left "would do no discredit to educated clergymen."]

"It cannot be doubted that such a father would do all he could for the education of his children. We were first carried thoroughly through the primary school, and then had the advantages of a good academy, as much as we could find time and means to improve. But he could go no farther with any of us—he had three sons. And nothing was before me but a life of manual labor. But as I had a great aversion to being apprenticed to a tradesman, he did not attempt even to teach me his own trade, that of a hatter. Farming was the only resort, and I worked on the farm—not on my father's, for he had none—but on land hired by my brother—I know not how many years. I liked the employment; but, as I shall state more particularly in a few moments, I had acquired a strong relish for scientific pursuits, and I seized upon every moment I could secure—especially rainy days and evenings—for those studies. I was treated very leniently by my father and brother, who probably did not know what to do with me, but saw plainly that I should not become distinguished as a farmer. My literary taste was also greatly encouraged by a few companions in Deerfield with whom I united in a society, whose weekly meetings we kept up for years, which had a department for debate, and another for philosophical discussion. I always regarded this as one of the most important means of mental discipline that I ever enjoyed.

"But perhaps the most important lesson taught me by my straitened circumstances was habits of rigid economy. I learnt that these were more important than a large income. I learnt the value of money, and that the use of it is one of those talents for which we must give an account. It has made me ever since opposed to any useless expenditure of money in clothing, food, furniture, servants, equipage, journeyings, &c. I have been opposed to large salaries; and am confident, that, if the truth were known, our public institutions, literary, political, and religious, have the greatest real prosperity when their officers' salaries are low; for the temptation to extravagance with an increase of means is well nigh irresistible. I have always felt it to be an imperious duty for the officers of a literary institution, which contains indigent young men, to set an example in plainness in dress, equipage, and living, that they might be encouraged. In respect to books, apparatus, and specimens, and even objects to improve the taste, such as paintings, statuary, and articles of *vertu*, I would counsel as large an expenditure as possible, for that is true economy; and to get large sums for these and benevolent objects is the great purpose of economy in personal expenses. But I have ever found men more ready to call your economy parsimoniousness, than to inquire into the liberality of your benefactions for worthy objects.

"For the formation of a taste for science I was doubtless indebted to my uncle, Major-General Epaphras Hoyt, of Deerfield, a near neighbor. He gave the most attention to military science, on which he published some valuable works, and to which I devoted myself with considerable interest, especially to fortification, when from fifteen to eighteen years of age. But he was also deeply interested in astronomy and natural philosophy, and these branches became my favorites. The great comet of 1811, and access to some good instruments for observing it, belonging to Deerfield Academy, gave me a decided bias for astronomy. From the 7th of September, 1811, to the 17th of December, corresponding to the appearance and disappearance of the comet, I was engaged in making observations, not only on the comet's distances from stars, but on the latitute and longitude by lunar distances and eclipses of the sun and moon, and on the variation of the magnetic needle. I gave myself to this labor so assiduously that my health failed, and I well remember that when my physician was consulted he said, 'I see what your difficulty is: you have got the comet's tail in your stomach.' To reduce my numerous observations cost me several more months of study, so imperfect were the means of calculation in my hands. Yet I have sometimes thought, when looking over my record of these observations and the results, that they might almost be worth publication, although much inferior to similar works in the observatories of the present day. Indeed, General Hoyt, under whose direction I labored, and who often aided me in observations, communicated some of them to the American Academy of Arts and Sciences, and they were published by that society. But I experienced great benefit from the work, in the mental discipline it required, and I acquired a strong love for theoretical and practical astronomy. I became, in fact, such an enthusiast in this respect, that I could cheerfully forego every ordinary source of pleasure sought after by young men, in order to gratify this scientific passion.

"But I was destined to a sad disappointment in this, my first scientific love. I had for a considerable time been engaged in the study of Latin and Greek, in the hope of entering the University at Cambridge in advanced standing, and using my eyes upon Greek during an attack of the mumps, a sudden weakness of the eyes came on which compelled me to suspend nearly all study and to change the whole course of my life, abandoning a college course as impracticable, and, for a time, nearly all hope of pursuing science or literature as a profession. I have now struggled with this affliction fifty years; and though for some time past, through the kindness of Providence, it has been much mitigated, it has seemed to be a very serious obstacle to my literary pursuits, and it certainly has produced much suffering. I am not sure, however, but it has been a merciful check upon my disposition to over-work, and thereby has tended to lengthen out my life and ability to labor. If so, how thankful I ought to be for it!

"But Providence had better things in store for me in a variety of respects, to which this trying failure of my eyes and blasting of my plans and hopes would introduce me. To say nothing of spiritual blessings, new fields of science were thus to be opened to me, where wonders yet more attractive awaited me. My eyes failed in the spring of 1814, and for two years darkness that might be felt rested upon my prospects. Still I could not give up study, and tried all manner of ways to make some progress. In 1816, the Trustees of Deerfield Academy ventured to commit that Institution to my care; where for three years I labored intensely to maintain myself, in spite of a defective education, weak eyes, and poor health. It was at this time that I commenced study for the Christian ministry, having been led by my trials to feel the infinite importance of eternal things, and the duty of consecrating myself to the promotion of God's glory and man's highest good. There, too, at first, chiefly as a means of promoting health, my attention was turned to Natural History. About that time Professor Amos Eaton had been lecturing at Amherst, and we became acquainted with him, and I always regarded him as the chief agent of introducing a taste for these subjects in the Connecticut Valley. Dr. Stephen W. Williams, Dr. Dennis Cooley, and myself, all of Deer field, took hold of mineralogy and botany with great zeal. Dr. Cooley and myself collected nearly all the plants, phenogamous and cryptogamous, in the Valley. Dr. Cooley became an excellent botanist; and even to a recent date, when he died in Michigan, had pursued the subject with zest. Dr. Williams afterwards became Professor of Medical Jurisprudence in the Berkshire Medical School.

"I ought also to state a few facts which formed a part of my education, and which served to diminish the evils of a self-taught course. I have already referred to the benefits which I derived from being for many years a leading member of a debating society. I there had an opportunity to practice extempore speaking and composition, and to acquire facility in philosophical reasoning, probably to a ten times greater extent than does a student in college. It was also an admirable discipline I was compelled to go through when called to instruct in the academy in Deerfield. As there were always in the school a number who were fitting for college, I found a thorough review of a large part of my classical studies indispensable—not once merely, but over and over again, so that the details have remained in my mind even to the present time, and the same is true of the many other studies one is called to teach in an academy. It was a much more severe discipline than if I had been through college drilling; and I would advise no young man to venture upon it unless driven to it, as I was, by dire necessity.

"The academy owned a very good philosophical apparatus, and I prepared a number of lectures on natural philosophy, which were delivered with experiments before the school, and in the evening before the citizens of the village. This was my first attempt at lecturing.

"But my best mental discipline was connected with the use of the astronomical instruments of the academy. In another place I have described the observations which I made on the comet of 1811, as well as on other heavenly bodies. The subsequent winter was in a good measure devoted to a reduction of those observations; and as I had access to only a few books, I was obliged to calculate by spherical trigonometry many elements which at this day are found in the tables of practical astronomy. The mere effort to form an accurate idea of the numerous spherical triangles I had to construct out of the imaginary circles of the celestial sphere, was an admirable discipline, and their accurate solution not less so."

Much more might be usefully said on this subject; but we turn to his experiences as Professor and President at Amherst College.

"When I joined the College in the winter of 1826, there was no laboratory, no philosophical cabinet, no natural history cabinet, and no chapel. Two dormitory buildings had been erected, and in the fourth story of the most northerly of these (the present North College South Entry) two rooms were thrown together, a platform built on which was placed a small tub-like pulpit, which could be moved off to allow the Professor of Natural Philosophy to lecture one part of the day, and the Professor of Chemistry the other part, taking care to finish before evening prayers.

"On the catalogues for 1825 and 1826 my title appears as Professor of Natural History and Chemistry. The order of these subjects was changed on the subsequent catalogues, and continued thus till 1845. For nearly twenty years I had entire charge of these two wide fields, except that in 1843 Mr. Sheppard was appointed Lecturer of Agricultural Chemistry and Mineralogy. But it should be recollected that these branches, especially natural history, thirty years ago were but little thought of in this country, and were in fact in comparative infancy. And besides, we had then next to no collections, and a leading object before me was to provide them. Indeed, I may state it as a general fact, that in all the subjects in which I have given instruction in Amherst College, I have been obliged to provide the apparatus, models, and specimens, sometimes with, but more often without, funds, except my private resources. Nevertheless, my first courses of lectures and recitations were nearly as extensive as they have been since. They averaged nearly four exercises per week, or about one hundred and fifty in the year. In particular branches, as new instructors have been appointed, more time has been given. For instance, when Professor Adams took the department of zoölogy he was allowed from thirty to forty recitations and lectures, as was also Professor Clark, though, for what reason I know not, they have since been reduced to ten lectures, which is equivalent to five recitations; for it is common now to put lectures in different departments side by side, so that two shall be equal to one recitation—that is a half day. Even in its infant days, I never gave less than twenty or thirty lectures on zoölogy—say ten to fifteen on mammalogy, ornithology, herpetology, and ichthyology, and ten to fifteen on conchology and the other branches of invertebrate zoölogy; also ten to fifteen on botany. At this day, all those important discussions respecting the distribution of species, their metamorphoses, and the unity of the human species, must require several more lectures, or it is impossible to teach graduates how to defend religion against the assaults of sceptics.

"The title of Professor of Chemistry and Natural History, which I had for twenty years, conveys but an imperfect idea of what I attempted to teach, or rather of the grand object I had in view. That object was to illustrate, by the scientific facts which I taught, the principles of natural theology. This I stated at the commencement of my course, and on other proper occasions. At length when I became President, I took natural theology as the leading title of my professorship. And really the instruction given in the natural sciences in college is scarcely more—often less—than is necessary to understand their religious bearing. But this is their most important use, as it is of all knowledge, and this thought I made the basis of my Inaugural Address, when inducted into the Presidency. I had endeavored to act on this principle in all my teaching; but now I put it into the form of a professorship, and a richer or nobler field I do not know in the whole circle of science. I called it a Professorship of Natural Theology and Geology, adding this latter science because I have been in the habit of going more into detail concerning it, and because no science equals this in its religious applications.

"It was a deep conviction of the importance of such a professorship that led me to seek its endowment. The manner in which it was secured has already been referred to. Mr. Williston had just agreed to endow a professorship, which was finally called the Graves Professorship, in honor of Mrs. Williston's maiden name, and he offered to give half enough to endow another, if some gentleman could be found to take the other half, and proffer his name to the whole. I immediately communicated with Samuel A. Hitchcock, of Brimfield, and I merely stated the case and told him that as he was childless, I wanted that he should make the Professorship of Natural Theology and Geology his heir, and that so long as I was connected with the College, I would fill the chair, and thus make it a Hitchcock *affair* all round. The conceit struck him favorably, and by return mail the proposal was accepted. Subsequently, through fear that some of his securities might fall below par, he added two thousand dollars more, making the whole endowment twenty-two thousand dollars, which is the largest among the professorships, and the income is almost sufficient to sustain two professors."

The perplexities in the management of a New England College are amusingly sketched as follows:

"There are three bodies of men officially connected with College, at whose meetings the President is expected to preside, and for which his duty is to prepare business. The first is the Trustees, whose meetings, in ordinary times, are only once a year. The second is the Prudential Committee, who look after pecuniary affairs, and almost anything, in fact, needed to be done in the absence of the Trustees. These hold their meetings regularly as often as once a month, and frequently much oftener. The third is the Faculty, who hold a weekly meeting for attending to the discipline and government of the College, considering petitions, and seeing to it that everything is in place and order. Here everything that makes friction or is out of gear, among officers or students, is developed; and though men who have a knack of throwing off personal responsibility and shirking their duties can go through such meetings lightly, and even jocosely, they often weigh heavily upon the President, who is personally responsible for the proper adjustment and management of the whole machine. Consequently these Faculty meetings, held, as they usually are, in the evening, and sometimes protracted to a late hour, are among the most trying of a President's duties. They often wore very much upon me, especially when followed, as they sometimes were, by the admonition, dismissal, or expulsion of delinquents. In almost every such case, the public sentiment and sympathy in College would be with the offender, however gross his crimes. The same would generally be the case with friends at home, and with the community at large. A college Faculty are looked upon by many as an aristocratic, arbitrary, and tyrannical set, whom every humane man is bound to oppose; and multitudes who never saw even the outside of a college, feel fully competent to sit in judgment upon their acts and to denounce them. It is this outside sympathy with those who are under discipline that does more than anything else to sustain them in their misdeeds, and to encourage the rebellions that are the frequent consequence of college discipline; and it is the necessity of thus going against the popular will, and of encountering reactions as the consequence that may rend the college in pieces, that is more trying to a President than all his literary labors. Even in a Christian college, where is often a sprinkling of some of the most difficult elements to control, he is not unfrequently made to feel that he sits upon a volcano, which, though now quiet, may at any moment become active.

"My epistolary correspondence in the Presidency was peculiarly onerous. I had previously been so much of a *jack at all trades* that I had laid myself open to enquiries and assaults from all classes. The same mail (and I hardly exaggerate the literal fact) might bring inquiries about some point in the theory of temperance —how to employ garnet in making sand-paper—how to reconcile the imputation of Adam's sin with our sense of justice—where to find the best beds of sulphate of baryta—whether I would like to exchange or buy shells, minerals, and fossils—how cheaply an indigent young man can go through the college, and with what helps —whether I knew of any one who would make a good teacher of a common school or of an academy, or a professor in a college, or any one to supply a pulpit—what I thought of a new theory of drift, or of latent heat—or new views of the relations of geology to Moses—or a new poem—or a new work—all of which were sent, and an answer requested, if possible, by return mail. During my Presidency I calculated that I was obliged to answer as many as four hundred or five hundred letters annually, and to these should be added at least one hundred recommendations to students going out to teach school, and for other purposes, and to graduates."

Along with this we may place the practical difficulties of the Professor of Chemistry:

"I have already given some idea of the state of preparation in the College for chemical experiments when I joined it. Not only was I obliged to lecture in the fourth story and in a sort of chapel, but there were no instruments or ingredients worth naming provided by those who preceded me. For four gentlemen had lectured on that subject before me, viz., Col. Rufus Graves, Professor Olds, Professor Amos Eaton, and a Mr. Cotting, who was afterwards appointed State Geologist in Georgia.

"I must have given at least two fourth-story courses of lectures. But when the chapel building was erected in 1826, an opportunity was presented for fitting up a laboratory. The basement story at the east end was mostly above ground, with cellar rooms adjoining. I had ample space for a large lecture-room, apparatus-room, and office, and means enough were furnished for supplying economically furnaces, cisterns, gasometers, and apparatus. The only difficulty was that the room was beneath all the others, and partially under ground. But at that time the idea generally was that such was the proper place for a laboratory. Because the chemist eliminates many mephitic gases, therefore place him where he cannot get them out of his room; or if they do escape through the ceiling, they will let all in the rooms above him get a whiff of the atmosphere which he is obliged to breathe in concentrated purity. Nevertheless, I spent at least a third of my time for eighteen years in that laboratory, and found it in most respects very convenient. I do not doubt that its dampness and the unwholesome gases which I got rid of only by opening the doors and windows, have contributed to bring on and aggravate those pulmonary and bronchial difficulties that now press so heavily upon me, and will soon terminate my days. But probably a person in good health need not fear *active* employment in such rooms. I have found analytical chemistry to be more trying in such a place than the mere preparation for lectures, because the former requires such long-continued attention."

We reserve our remaining space for extracts from the remarkable history of Dr. Hitchcock's museum; the whole of which is well worthy of being read:

"When I came here, in 1826, a Natural History Society existed among the students, which had begun to bring together specimens chiefly in mineralogy, geology, and mammalogy; but they were too few to be employed in lecturing. I therefore took up the business of collecting. I had, however, in previous years, obtained a few hundred specimens, mostly in mineralogy and geology, and the Trustees in 1826 "voted that Professor Hitchcock be requested to deposit his private geological cabinet in the Cabinet of the College." Previous to this time, I believe, the Natural History Society had presented the whole or part of their collections; so that, so far as numbers were concerned, our cases looked quite respectable. But to one acquainted with natural history, probably the larger part would come under the ironical title of *Jactalites;* that is, specimens to be thrown away. However they did a very good service so long as no better collections were near. And it is a fact that some of the ablest naturalists who graduated here (ex. qr. Shepard and Adams), started in these days of meagre scientific illustration. Their fewness led such men to study what we had with more attention, and that awakened the desire to see and possess more; and in these two facts, conjoined with good native talent and scholarship, you have the elements of able naturalists.

"In 1830 I was appointed to make a geological survey of Massachussetts, and this opened a door for the introduction of numerous specimens. The Government, indeed, directed that a collection of the rocks and minerals of the State of moderate size should be collected for each of the colleges. They amounted, I believe, in the first survey, to about eight hundred. I also collected four times as many for the State Cabinet, and nearly as many for myself. Having deposited the latter in the Cabinet, the Trustees, feeling under obligation to Williston Seminary, or rather to its founder, presented to it the collection of eight hundred specimens.

"Another way which has been a prolific one of increasing the Cabinet in all its branches, organic and inorganic, is by securing the help of the graduates of the College, especially the foreign missionaries. The Zoölogical Museum has in this way often been enriched. In the Woods Cabinet is a collection of rocks and minerals chiefly from Asia, of more than twelve hundred specimens, sent in a great measure by missionaries, or by men on missionary ground. Many of these specimens possess a special interest from the sacred localities from which they came. But they are numerous enough from some extensive regions to give a tolerable idea of the geology; as for instance Syria and Palestine, especially Mount Lebanon, Armenia, and the north-west part of Persia, and the Ghaut Mountains of India.

"My collection of fossil footmarks was begun in 1835. For as soon as I had turned my attention to Ichnology, I commenced the accumulation of specimens, and from that day to the present I have never ceased to gather in all which I could honestly obtain. For no other part of the cabinet have I labored so hard or encountered so many difficulties. True, for some years at first I had the field essentially, to myself; and had I then been fully aware of its richness and extent, I might have secured a large amount of specimens at a reasonable rate. But the subject opened upon me gradually, and the disclosures made by my writings attracted others into the field who became uncompromising competitors in the way of collecting, and with some it became a matter of trade. The consequence was that the value of specimens rose to almost fabulous prices. The man who had made the largest collection was Dexter Marsh, of Greenfield, who was himself a quarryman, and had the ambition, as he told me, to get together the largest collection in the world. He succeeded, if we take into account the quality of the specimens. But, poor man! he died before his work was done; having, in my opinion, hastened his decease by excessive labor in the hot sun in getting out beryls and other minerals. His executors sold his collections at auction. I knew they would sell high, for I was one of the appraisers, and we marked them high. But I could not see those fine specimens all scattered through the land without making an effort to raise some money to secure some of them, and I adopted this plan. My collection of footmarks had become so large, that, in the opinion of so good a judge as Professor C. U. Shepard, its value was not less than $3,500; and that it could be disposed of for at least $2,000 in cash. In a circular to several benevolent gentlemen, I offered to present this to the College, if others would furnish me with six or seven hundred dollars with which to secure some of the slabs at Marsh's auction. It so happened, or rather, as I view it, Providence so ordered it, that I first addressed John Tappan, Esq. He responded by a subscription of $500. To this extraordinary liberality I attribute my success in filling up the present large cabinet. For so high a standard had imitators. Hon. David Sears soon added another $500; Gerard Hallock followed with $250, Hon. E. P. Prentice with $150, and several other gentlemen with $100 each. So that I went to the auction with nearly $2,000 in my pocket. Moreover the stream of benevolence which had thus been diverted into this channel did not cease to flow with the Marsh sale; but almost to the present day new and liberal increments have continued to be made to the funds in my hands chiefly devoted to footmarks; so that they have risen to $3,800. Among the donors was the widow of Hon. Abbott Lawrence, who sent me $300, although I suggested as a maximum only $100. Had Mr. Tappan headed the subscription with $50, —and I could not reasonably have expected more,—probably I should have been compelled to see it close at $500, and the Ichnological Cabinet would have been a meagre affair compared with what it is now.

"When I reached Greenfield to attend the auction in September, 1853, I found several naturalists there from Boston with pockets well lined, who came with the intention—as they had a right to do—to take the whole of Mr. Marsh's collection for the Boston Society of Natural History. I told them that there were many duplicates in the collection, enough if divided to supply both the College and their Society. But if they insisted upon monopolizing the whole, I had made up my mind, having $2,000 on hand, to be very *benevolent* towards the widow by compelling them to pay very liberal prices. They seemed to feel the reasonableness of my suggestions, and they found as I stated that there were enough specimens for us both. My bill went as high as $700, and theirs higher.

"Since this auction I have continued to lay out large sums in the purchase of footmarks. To Roswell Field, who lives on the most remarkable known locality, and has disinterred more tracks than any other man, I have paid not far from $4,000. His prices have indeed been generally high, but when the specimen was unique, I must give him what he asked, or leave it for some one else; and Mr. Field has, in at least two cases, presented specimens to the Cabinet which I have estimated at $300.

"To persons not familiar with the value of natural history specimens, the idea of giving $150 for a broken slab of stone a few feet square—I have several specimens that cost me that sum—seems extravagance and folly. I may mention an anecdote in point. After the auction at Greenfield, I employed a waggoner to transport my specimens to the railroad. I happened to be a little out of sight, and heard him describing to a citizen standing by the sums I had paid for them. 'The man,' said the citizen, 'who will waste money like that, should have a guardian placed over him.' I could not restrain a loud laugh, which brought us into conversation, when I said, 'You will at least acknowledge that my insane prodigality is a good thing for Mrs. Marsh.'

"I must acknowledge, however, that in no enterprise in my life have I been obliged to work so hard, and exercise so much strategic skill to avoid paying exorbitant prices, and even being defeated, as in the collection of this Ichnological Cabinet. The high prices paid at the auction (one slab sold for $375) produced an impression of the great value of these relics throughout the Valley, and exorbitant prices were attached to them wherever found. But very few, however, knew enough about the different kinds to distinguish the rare and valuable ones. But since I had studied them all, I found that wherever I expressed any particular interest in a specimen the presumption was that it was rare, and the price went up accordingly. I was obliged, therefore to exercise a good deal of prudence, and show much *sang froid*, or I could not, with my small means, make much headway. I worked as quietly as possible, with my plans locked up in my own bosom, yet with inflexible resolution and perseverance, looking constantly to God for help. I felt that such a collection would illustrate a curious chapter of His providence towards our globe, and that the larger the collection, the more full the illustration. I expected myself to make only a beginning; but I wanted to provide the means for my successors to carry forward the work which they never could do if the specimens are scattered all over the world, or rather if all the varieties are not found in some one cabinet. Large as the collection now is, I have been often pained to see very fine specimens taken out of my hands by those who could pay more for them than I could, and carried, I know not whither.

"In such circumstances, I have tried to be as economical as possible in the use of the money in my hands for this purpose. Whenever I could, I have myself gone to the quarries and dug out the specimens. When not too large, also, I have transported them on my own business-waggon. Again and again have I entered Amherst upon such a load; generally, however, preferring not to arrive till evening; because, especially of late, such manual labor is regarded by many as not comporting with the dignity of a professor. I have not however, in general, paid much attention to such a feeling, except to be pained by seeing it increase, because its prevalence would change the character of the College, by driving away those who are obliged to do their own work.

"During these twenty-six years' experience in gathering these footmarks, I have met some very unique examples of human nature. While some of my countrymen in the lower classes of society have shown a shrewdness and generosity and made me feel proud of New England, others have exhibited a selfishness and meanness that made me exclaim, *Parvum parva decent!* For instance, suppose on your arrival at a locality of footmarks, one had preceded you with whom you were on friendly terms, but who was so anxious to prevent your obtaining any specimens, that he had mutilated the good ones that were accessible, which he had not time to remove! Alas, if I had not known this vandalism practiced several times by professedly respectable naturalists, I should not mention it.

"Some of my experiences have been quite amusing. Having found some impressions which I called tracks (*Harpagopus Hudsonius*) in the sidewalks of Greenwich Street, in New York city, I requested a moulder to take a plaster cast of them, which he did. But on going to the spot again some hours later, I was told that some one else had meantime taken casts of them! although he could not have known that they were of any value; but it shows how prone men are to follow an example. A large crowd had gathered when I took the first cast; and I was told afterwards that all which saved me from being voted a fit subject for a lunatic asylum, was the testimony of a young lady, in one of the adjoining houses, who had attended my lectures on geology at Amherst, and who testified that I was no more deranged than such men usually are."

These are but specimens of the enthusiastic work of a lifetime, which occupies in the narrative no small portion of the book. The results are very marvellous, even when we take into account the credit due to Profs. Adams and Sheppard, and others; all of which is acknowledged by Dr. Hitchcock. The museum, as it now stands, is one of the finest in America, and, in some respects, as in phonolites and meteorites, second to none in the world. It is valued at more than $100,000, and has been collected at an expense to the College almost nominal.

A useful purpose will be served in this country, where such things are as yet too little appreciated, by quoting Dr. Hitchcock's estimate of the utility of natural history collections.

"1. They are indispensable to give students a knowledge of the natural productions of different parts of the earth; and without which, their views would be narrow, and they would be liable to constant blunders in their literary productions.

"2. When studied, they help very much to sharpen the discrimination, and teach students how to distinguish between the apparent and the real. Indeed, as a means of mental discipline, no branch of knowledge goes before natural history; though, from the very limited attention usually given to such subjects, this effect is but slightly realized.

"3. They are indispensable, also, to give facilities to any students who have a natural taste and fitness for such pursuits, to qualify themselves for future distinction in them; and this they can do, if the collections are good, without interfering with recitations in other branches, by devoting those leisure hours to the cabinets, which most give to useless recreation or to something worse.

"4. They deeply interest and instruct the community surrounding a college, and all who visit it, and thus give reputation to it. Visitors cannot be shown much in mathematics, or in the classics, as they pass through college-halls, unless particularly well acquainted with the subjects, and even large libraries are all seen at a glance. But almost every one will see enough in nature's products to awaken interest, inquiry, and admiration. This explains the fact that as many as fifteen thousand visitors annually have registered their names in the Amherst Cabinets, small and retired as the place is. The College could not afford to lose the influence in favor of the institution thus spread through the country. It turns the attention of many young men to this place; and when they learn that in all other respects the institution stands high, this feature often brings them here, in spite of the claims of rival colleges. This is not indeed the most important thing in the College; but we need to combine all the influences that we can to enable the College to maintain the high position it has taken, and to continue its upward course.

"5. These cabinets form an anchor to steady the College in stormy times. Such periods of trial not unfrequently come, when the temptation is to give up the ship, or transfer it to to some other place. But though it be easy to transfer able teachers and funds, and even libraries, large cabinet buildings, with costly fixtures, cannot so easily be changed; and the friends of the College would be quite apt to rally around the fruit of seventy-five years of labor which they contain, since mere money cannot make their place good.

"6. These cabinets are indispensable to teach young men how to defend and illustrate religion. This is their most important use. For I hesitate not to say, that, however otherwise well educated a scholar is, he cannot defend Christianity, or even natural religion, from the subtle attacks which of late years have been drawn from natural history, from geology and zoölogy. For instance, if he has not seen, and to some extent studied the specimens on which these objections are founded, he must see and examine rocks and fossils before he can understand the discussions raised by geology on the age of the world, on the eternity of matter, on the pre-adamic existence of suffering and death, on special Divine interventions in nature, and on the extent of the deluge. He must study animals and plants, or he cannot refute the advocates of the development-hypothesis or of the plurality of origin of the human species. Where else but in college can those who mean to be ministers of the Gospel acquire such knowledge? Surely not in our theological seminaries, nor in the families of private clergymen. The abstract, metaphysical way of treating those subjects which they may learn elsewhere, will only excite the ridicule or contempt of the able, sceptical naturalist.

"On the other hand, it is only by the study of cabinets that theological students can learn how to use with ability those numerous illustrations and confirmations of religious truth which of late years have been derived from natural history. The larger part and the most striking of the proofs and illustrations regarding the Deity and his attributes, have been derived from this department of knowledge. It is a rich field, and furnishes, besides the case just indicated, numerous striking confirmations and illustrations of some of the most precious truths of revealed religion, as the works of McCosh, Hugh Miller, Dana, Harris, Chalmers, and many others show.

"7. Finally, large cabinets are necessary to enable instructors to make new discoveries in science, and to trace out new religious illustrations. With small collections, the prospect of finding undescribed objects would be small. And in this fact, not in want of ability, do we see a reason why so few professors of natural history add many new facts to their departments, or suggest new illustrations of religion. True, the want in our libraries of the great standard books on these subjects published in Europe, is another almost equally powerful obstacle to new discoveries, as the want of specimens. But what a pity that in both these ways our professors should be deprived of a credit they ought to have the power to attain, and be compelled to put into the hands of European naturalists every object apparently new which they meet, because they are afraid to describe it, lest it should have been already described by transatlantic naturalists!

"It is for such reasons that I felt justified in devoting so much time and effort during thirty-eight years, to build up and fill the Cabinets at Amherst. I have no expectation or wish to give the subjects of natural history here an undue prominence, but only to make them subserve the objects I have specified, and to do something towards sustaining the credit and popularity of the institution."

NOTES ON THE HABITATS AND VARIETIES OF SOME CANADIAN FERNS.

By David R. McCord, B.A., Montreal.

Polypodium vulgare.—Common in Lower Canada; eight to twelve inches long, occasionally smaller. As it grows upon rocks, it may sometimes be seen curled up by drought. I have not yet observed any abnormal forms; but since in Great Britain there are, according to Lowe, thirty-seven varieties more or less constant in cultivation, attention to this fern is particularly to be desired from Canadian pteridologists. Montreal, not common; Chatham; Waterloo; Sorel, Lady Dalhousie; Temiscouata, common, J. G. Thomas, M.D.; Quebec, Hon. William Sheppard. White Mountains, New Hampshire.

Polypodium hexagonopterum.—Usually thinner, less coriaceous than *P. Phegopteris*. Waterloo; Chatham; Sorel, Lady Dalhousie; Quebec, Hon. William Sheppard.

Polypodium Phegopteris.— Rhizoma many rooted, stipes ascending at short intervals; occasionally sixteen inches in height, (including stipe). Temiscouata, common, J. G. Thomas, M.D.; Waterloo; Lennoxville; Chatham; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Rev. Prof. Brunet.

POLYPODIUM DRYOPTERIS.—Rhizoma black, few rooted. Montreal, not fine; Waterloo; Lennoxville, very fine; Chatham; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Hon. William Sheppard; Temiscouata, common, J. G. Thomas, M.D. White Mountains, New Hampshire.

β. erectum.—I have a specimen which appears to correspond with this variety, fifteen inches high and nine inches broad, but its size is the chief difference I can detect between it and the normal smaller specimens. The pinnæ are however more deeply pinnatifid, and, in the case of the lowest ones, almost pinnate. Waterloo, June 6, 1862.

POLYPODIUM ROBERTIANUM.—Sorel, Lady Dalhousie.

ADIANTUM PEDATUM.—When it first appears in spring, in the early part of May, the stipe is covered with thick chaffy scales, and the frond circinate; the scales soon disappear, and in a week or two the stipe is at full height. Common almost everywhere in Lower Canada. Montreal; Lennoxville; Waterloo; Chatham; Sorel, Lady Dalhousie; Quebec, Hon. William Sheppard; Durham, Wickham and Melbourne, John A. Bothwell, B.A. White Mountains, New Hampshire.

Var. triangulare. — From Chatham, where a large clump grew. Very deep green, fewer pinnæ (branches) than normal, and fewer pinnules; these more deeply pinnatifid, sometimes divided half way to the midrib at back. Instead of the common oblong-shaped pinnules, this variety displays a triangular form, and the whole aspect is in a measure different.

PTERIS AQUILINA.—Common everywhere in Lower Canada. Montreal; Waterloo; Chatham; Lennoxville; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J. G. Thomas, M.D.; Sorel, Lady Dalhousie. White Mountains, New Hampshire; Portland, Maine.

The varieties of this fern are very numerous. *Vars. a. vera* and *β. integerrima.* I have collected specimens of both these varieties, though they do not adhere exactly to Dr. Lawson's descriptions of them. I have also one or two beautiful specimens of another variety, with a brown stripe of six and a half inches in length, surmounted by the frond, which is three inches high, and three and a half broad. The branches are pinnate, the pinnæ pinnatifid and very clearly divided. The specimens were minutely chaffy-hairy and in fruit. Now the *vars a. vera* and *β. integerrima* are of large size, and not so thick or coriaceous, though they agree with this variety in the number of branches and in point of pinnatification. Whether specimens of this variety in a sterile state would be less coriaceous, I am not in a position to say. These last mentioned specimens were collected at Chatham on the Ottawa, a locality rich in ferns; and I may also add, in phœnogamous plants. I have also another variety of *P. aquilina* displaying extremely lanceolate pointed pinnules; but whether this acuminate property be constant, I cannot now affirm.

Allosorus gracilis.—Rare. Rocks, county of Prescott, C. W.; on the shore of River Ottawa, opposite the residence of Lemuel Cushing, Esq.; Chatham; Cacouna, very fine specimens, Dr. J. W. Dawson; Rivière du Loup (en bas), J. G. Thomas, M.D.; near Britannia Mills, rare, Hon. William Sheppard; Murray Bay, R. Anstruther Ramsay, B.A.

Struthiopteris Germanica.—Very common. Among other localities:—Montreal; Waterloo; Lennoxville; Chatham; Sorel, Lady Dalhousie; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; along the Green River, J. G. Thomas, M.D. White Mountains, New Hampshire.

Onoclea sensibilis.—A very variable and interesting fern. Of many barren specimens some are deeply pinnatifid, which appears the normal state, or with the last pair of divisions almost pinnate; but in every case that I have yet observed there is a wing, however minute, upon the rachis, so that we cannot properly apply the term pinnate to this fern. I have several sterile varieties, one covered with glands, another in which the properties of the sterile and fertile are seen in the same frond, as may be observed in pinnules of *Osmunda regalis*, var. *spectabilis*. Some are contracted and deeply pinnatifid; one obtusely terminated at apex and at ends of divisions. Whether these would be constant under cultivation I cannot say, as I have not had time to investigate this fern sufficiently, and have only mentioned these varieties as a stimulus to observation. On the whole it would appear that from the earliest development of *Onoclea* there are two general forms. One from the multiplication of wavy-toothed divisions, the other by the development of lanceolate-triangular divisions; under these may be included all the abnormal forms which I have seen. Common. Montreal; Sorel, Lady Dalhousie; Waterloo; Chatham; Lennoxville; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J.G. Thomas, M.D.; White Mountains, New Hampshire; Portland, Maine.

ASPLENIUM VIRIDE.—Gaspé, John Bell, B.A. A very interesting little fern. From the specimens that I have seen, though not from the above-mentioned locality, it may be distinguished from *A. Trichomanes* (among other differences,) by having a green rachis, and a dark colored stipe, while *A. Trichomanes* bears a stipe and rachis of dark shining blackish-brown. In *A. viride* the fructification occupies more of the surfaces of the pinnæ, and they are less numerous.

ASPLENIUM TRICHOMANES.—Chatham, on rocks, in large clumps; observed in no other locality in Lower Canada.

ASPLENIUM ANGUSTIFOLIUM.—Very beautiful, not common. Montreal, larger and smaller mountains; open woods, in company with *Lastræa Goldiana;* Sept., 1863. Observed specimens with a bifurcation at apex, as in some British varieties of *Polypodium* and also of *A. Felix-fœmina.*

ASPLENIUM THELYPTEROIDES.—Montreal; Waterloo; Lennoxville; Chatham, and northward to Wentworth, Harrington, Howard, and Arundel; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A. Portland, Maine; White Mountains, New Hampshire.

β. serratum.—Very fine, Chatham.

ATHYRIUM FELIX-FŒMINA.—Common, Montreal; Chatham, and northward; Lennoxville; Waterloo; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, very common, J. G. Thomas, M.D. White Mountains, New Hampshire; Portland, Maine. I have a variety or two, agreeing in some respects with *β. erectum*, and also with *γ. rhæticum*, but would not presume to identify them, as I have not studied the varieties of this fern.

CAMPTOSORUS RHIZOPHYLLUS.—Rare; dry rocks at l'Abord-à-Plouffe, on the river Jesus, rear of the island of Montreal; but not easily found even there. St. Helen's Island, rare, Hon. William Sheppard; Sorel, Lady Dalhousie, as *Asplenium rhizophyllum.*

LASTRÆA DILATATA.—(*Aspidium spinulosum*, of Gray's Manual.)—I have many specimens of this most variable species from those short both in stipe and frond, and triangular, the pinnules being deeply toothed or lobed, hardly pinnatifid, to those that are broadly lanceolate, spreading or not, and finely cut. I cannot, however, identify *β. tanacetifolia* with any of them. I have the var. *Boottii* (of Gray's Manual), with glandular indusium. I also found at Waterloo, June 5th, 1862, a contracted, depauperated, though tall, specimen of *L. dilatata*, which bore indusia thickly covered with glands, stalked, and many furnished with a funnel-shaped head. In this case the pinnules were curved towards the back of frond, and these glands were also thickly scattered over the front and the back of the pinnæ. The abnormal appearance of this specimen induced me to examine the front of the frond for glands, and in other specimens they might perhaps be discovered similarly situated, if search were made. This fern requires careful study. Montreal; Chatham; Lennoxville; Sorel, (?) Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, common, J. G. Thomas, M.D.; Quebec, Rev. Prof. Brunet. White Mountains, New Hampshire; Portland, Maine.

LASTRÆA MARGINALIS.—Common. Montreal; Chatham; Lennoxville; Quebec, Hon. William Sheppard; Sorel, Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J. G. Thomas, M.D. White Mountains, New Hampshire; Portland, Maine. I do not know the var. *β. Traillæ*, which must be very handsome. I have two specimens of a small variety (eleven inches long), with few pinnæ, where the apex is composed of a pinna instead of the ordinary mode of growth; similar in style to the top of *Polypodium vulgare*, var. *crenatum* (Moore), or var. *semilacerum*. I do not think this variety is constant. Another variety displays only three pinnæ in a slightly circular form. Montreal, 1863.

LASTRÆA CRISTATA.—Not uncommon. Montreal; Chatham; Lennoxville; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A. I am inclined to think, that, from a number of specimens I possess, there is a variety of this fern, larger, broader, the pinnules less triangular, more lanceolate and more scythe-shaped than the normal, and, from their size and their position, not to be referred to *L. Goldiana*. It is a handsomer fern than the common *L. cristata*; and intermediate forms may be traced between this variety and the triangular-pinnated specimens. Chatham, C. E.

LASTRÆA GOLDIANA.—I think my specimens may be referred to var. *a. serrata*, but cannot speak certainly, as I have only observed the fern in one spot, near Montreal; and the sori are larger than in any other fern we have, which bears an indusium; whereas Dr. Lawson says the sori are small. My barren fronds are smaller than the fertile. Montreal, smaller mountain, with

Asplenium angustifolium. Durham, Wickham, and Melbourne, John A. Bothwell, B.A.

Lastræa Thelypteris.—Common. Montreal, very fine specimens; Chatham; Waterloo; Sorel, Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Rev. Prof. Brunet. White Mountains, New Hampshire; Portland, Maine.

Lastræa Nov-Eboracensis.—Montreal; Waterloo; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.

Polystichum angulare.—*β. Braunii.* Quebec, Hon. William Sheppard, as *P. aculeatum.* Temiscouata, not common, J. G. Thomas, M.D.

Polystichum acrostichoides.—Montreal; Waterloo; Chatham; Lennoxville; Sorel, Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Hon. William Sheppard.

β. incisum.—Montreal, July 24th, 1861.

Cystopteris fragilis.—Montreal; Shefford Mountains, near Waterloo, in one spot only; Chatham, very fine; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Quebec, Rev. Prof. Brunet. My specimens from Montreal measure about ten inches in length, three of which are stipe; narrowly lanceolate, not more than one and a half inch in breadth; while those from Chatham are much finer, being eight inches long, exclusive of stipe, three inches broad, bi-pinnate, pinnules incised, and, like the ordinary specimens, the pinnæ are not approximate. This constitutes, I think, a variety. Those from Waterloo are more triangular, thinner, pinnæ more approximate, but are twice pinnate, hence they cannot be referred to Mr. Bell's specimens, whose pinnæ are not pinnate. This fern requires careful study.

Cystopteris bulbifera.—Montreal; Chatham; Waterloo, rare, only one clump seen; Quebec, at the Falls of Lorette, north declivity of the river, Hon. William Sheppard; Upper Falls of the Rivière du Loup en bas, variable in outline, J. G. Thomas, M.D.; Sorel, Lady Dalhousie.

Dennstædtia punctilobula.—Said to be at Long Point, near Montreal, but I cannot vouch for it. Sorel, Lady Dalhousie; Dalesville, near Chatham; Lennoxville; Waterloo; Quebec, Hon. William Sheppard; Durham, Wickham, and Melbourne, John A. Bothwell, B.A. Portland, Maine; White Mountains, New Hampshire.

WOODSIA ILVENSIS.—Montreal; Chatham; Wolfe's Cove, Quebec, Hon. William Sheppard; Lachute; Rivière du Loup en bas, on rocky banks, J. G. Thomas, M.D.; Sorel, Lady Dalhousie.

β. gracilis.—If I have this variety, as I am disposed to think, the pinnæ and pinnules are both more lanceolate, and more covered with chaffy scales, as mentioned by Dr. Lawson; the stipes are also not so dark in color.

WOODSIA GLABELLA.—Montreal? very rare; Chatham; rare, at the Upper Falls of the Rivière du Loup en bas, J. G. Thomas, M.D.

OSMUNDA REGALIS, var. *β. spectabilis.*—Montreal; Waterloo; Chatham; Lennoxville, rare; Quebec, Hon. William Sheppard; Sorel, Lady Dalhousie, as *Osmunda regalis;* Durham, Wickham, and Melbourne, John A. Bothwell, B.A. I also noticed this fern in the White Mountains, New Hampshire; Portland, Maine. It is common in this fern to observe a pinnule partly in fruit and partly barren.

OSMUNDA CINNAMOMEA.—Montreal; Chatham; Waterloo; Lennoxville; Quebec, Hon. William Sheppard; Sorel, Lady Dalhousie; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J. G. Thomas, M.D. Portland, Maine; White Mountains, New Hampshire.

OSMUNDA CLAYTONIANA. — Variable in size. Montreal; Lennoxville; Waterloo; Chatham; Sorel, Lady Dalhousie; Quebec, Hon. William Sheppard; Temiscouata, J. G. Thomas, M.D. White Mountains, New Hampshire; Portland, Maine.

BOTRYCHIUM VIRGINICUM.—Common. Montreal; Chatham; Waterloo; Quebec, Hon. William Sheppard; Lennoxville; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.; Temiscouata, J. G. Thomas, M.D.

γ. simplex.—Montreal, July 28th, 1861; Quebec, Rev. Prof. Brunet; Temiscouata, rare, near the sea-shore, J. G. Thomas, M.D.

BOTRYCHIUM LUNARIOIDES.—Rather rare. Montreal; Sorel, Lady Dalhousie, as *B. fumarioides;* Quebec, Hon. William Sheppard, rare; Durham, Wickham, and Melbourne, John A. Bothwell, B.A.

My specimens hardly agree with Dr. Lawson's division of this fern. One, with barren branch bi-pinnate and fertile branch bi-almost tri-pinnate, would appear to agree with *B. lunarioides;* another with a large, tri-pinnate fertile frond, agrees in this respect with *B. obliquum*, but not in the barren frond, which, although bipinnate, has not narrower divisions. They are simply more coarsely crenate and more coriaceous. This may of course be not at all *B. obliquum* of Dr. Lawson, and I had regarded it as a variety of the *B. lunarioides*. I can add nothing further, as I have not seen many specimens of this fern. I have a variety of it collected at Lake Memphramagog, C E., in 1862, by Mrs. J. H. Thompson, which would be in the same relation to *B. lunarioides* that the variety *γ. simplex* is to *B. Virginicum*. The sterile branch is almost twice pinnate, with few wedge-shaped minutely-toothed lobes; the fertile branch is also almost or entirely twice pinnate: but the whole specimen has this peculiarity, that instead of there being three barren branchlets, and one fertile, there are three fertile and one barren.

BOTRYCHIUM LUNARIA.—North side of Island of Orleans, J. F. Whiteaves, F.G.S.; and Rivière du Loup en bas.

OPHIOGLOSSUM VULGATUM.—Melbourne, C. E., where exceedingly fine specimens are to be found, Miss Isabella McIntosh, Burnside House, Montreal. This fern, with the *Botrychium Lunaria* mentioned above, are now for the first time recorded as being natives of Canada proper.

The above brief statement of the Lower Canadian ferns, intended as a supplement to Dr. Lawson's valuable paper, includes thirty-seven species, to which, if we add the six additional ones which are as yet peculiar to Upper Canada, we have a total of forty-three species of Canadian ferns. I enumerate the six above alluded to.

PELLÆA ATROPURPUREA, Link.

CRYPTOGRAMMA ACROSTICHOIDES, R. Brown.

ASPLENIUM EBENEUM, Aiton.

WOODWARDIA VIRGINICA, Willdenow.

SCOLOPENDRIUM VULGARE, Smith.

POLYSTICHUM LONCHITIS, Roth.

There are, then, in Canada almost as many species of ferns as in Great Britain, and much is yet left for observation, particularly in Lower Canada,—where other species may, perhaps, be discovered; and we have also the investigation of varieties to interest us.

There are forty-nine species mentioned by Gray as being in the northern United States; and of these a good number, as *Lygodium palmatum*, Swartz, *Schizaea pusilla*, Pursh, and others, are not to be looked for in Canada, from its northern position. On the other hand, Dr. Lawson's lists include *Asplenium viride*, Hudson, *Botrychium lunaria*, Swartz, and others which are beyond Gray's stated limits, (see page 263). Should we, then, not find some Canadian ferns recorded by Gray or other American authorities, we must look to other countries of the same latitude, elevation, &c., as ours. Taking a general view, more than half of the Lower Canadian ferns are inhabitants of tracts of country not dry; they are found in open meadows, or swamps; the remainder grow upon rocks, with little moisture, as *Woodsia Ilvensis*, *Cystopteris fragilis*, (occasionally,) *Allosorus gracilis*, &c.; or upon rocky positions but requiring moisture, in which case they suffer during dry seasons, as *Asplenium Trichomanes*, &c. Not a few grow in either dry or damp positions, in shade or sunshine, when different varieties may be looked for; while a change of habit, such as is produced by clearing land, proves fatal to some species. A northern aspect is also sometimes noticed. What the progress of civilization may do in affecting the ferns, time will evince, as I have noticed ferns slowly disappearing; though the loss of species will of course require long lapses of time. For instance, have we any record what were the ferns of Europe, or of Great Britain, some centuries ago?

With regard to Quebec, one of the localities indicated in the above notes, the Honorable William Sheppard, who kindly furnished me with a list of the ferns to be found there, is disposed to think that some more species than he has named might be discovered. He was guided by notes, and by memory, as his own collection was unfortunately destroyed by fire some years ago.

ON THE FOSSILS OF THE GENUS RUSOPHYCUS.

By J. W. Dawson, LL.D., F.R.S., &c.

The genus *Rusophycus* was established by Prof. Hall for certain transversely wrinkled impressions found in the Clinton group of Oneida County, New York, and supposed to be fossil sea-weeds. Objects of similar appearance have been detected by Mr. Billings in the Chazy sandstone of Grenville, and described by him under the name of *R. Grenvillensis.* They much resemble one of Prof. Hall's species, *R. bilobatus*, which is the type of short bilobate forms included in the genus. Similar markings, but of much smaller size, occur in the Lower Carboniferous of Nova Scotia, and have been described and figured by the writer as probably casts of the lower extremities of worm-burrows, in the *Journal of the Geological Society of London*, vol. xiv, p. 74. In the 12th volume of the same journal, Mr. Salter had described small bilobate impressions, not striated transversely, from the Longmynd rocks of England, under the name *Arenicolites didyma.* He supposed them to be burrows of worms.

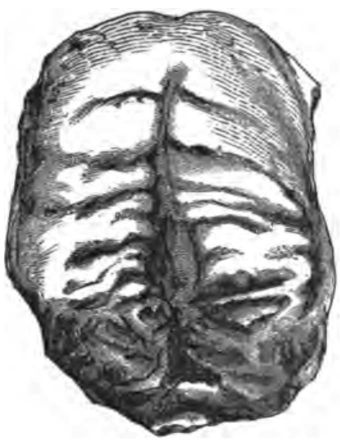


Fig. 1. *Rusophycus Grenvillensis*, var. *a*, half nat. size.

I had an opportunity last summer, in company with Mr. J. A. Bothwell, B.A., to examine the locality of the Grenville specimens, and found them to be quite abundant in certain layers of sandstone alternating with shale on the bank of the Grenville canal. The facts obtained from their study in place enable me to throw some light on their probable nature, and possibly to rescue them from the convenient group of fucoids, into which palæontologists have thrown so many obscure and doubtful fossils.

Mr. Billings describes the species as follows:

"This species is found in the form of irregular, oblong-ovate or depressed hemispherical masses, one end usually divided into two

Fig. 2. *Rusophycus Grenvillensis*, var. *b*, half nat. size.

parts by a furrow of more or less depth. The whole mass is generally crossed by numerous undulating wrinkles, which have a transverse direction to that of the furrow. The more common dimensions are from three to four inches in length, and from

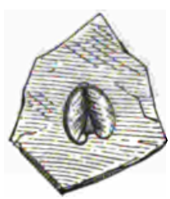


Fig. 3. *Rusophycus carbonarius.*

two and a half to three and a half in breadth, but occasionally specimens occur much larger and also smaller; one of them is nine and a half inches by five and a half, and, in addition to the principal groove, exhibits two or three obscure furrows on each side."

To this description it is only necessary to add, that, in comparing a large number of specimens, many diversities are apparent in the relief of the forms, in the extent of the longitudinal furrow, and in the number of the transverse wrinkles. The two lobes are also most frequently slightly unequal in their relief; and some of the specimens slope gradually at one end, and are thus somewhat elongated. In all cases, however, the general form is the same, the longitudinal and transverse furrows are constant, and the former is always more strongly marked at one extremity of the fossil. The specimens have no indication of a stem or stalk; though a cast of a worm-burrow or shrinkage-crack sometimes simulates such an organ.

In viewing these fossils and the surfaces of the beds containing them, it appeared evident that they are in reality casts of hollows or holes excavated in clay, and filled with sand which has taken and retained in its consolidated state the impression of their forms. The supposed fossils project from the lower surface of the sandstone, where this rests on friable, dark grey shale. They have the same appearance with the surfaces of the beds of sandstone, and show no traces of organic matter. There are on the same surfaces casts of worm-tracks, also in relief, and which sometimes extend over the specimens of *Rusophycus*. There are also on these surfaces rows of wrinkles, or casts of furrows similar to those of *Rusophycus*; and some of these form trails to or from the ends of the latter. (Fig. 2, a.) Casts of shrinkage-cracks in relief, also occur on the same surfaces. Large specimens of *Rusophycus* sometimes overlap small ones in such a manner as to show that they must have been scooped out of the clay. On the other hand, if the supposed fucoids were really of that character, they must have been solid masses or vesicles, and in the former case must have left some trace of organic matter, while in the latter they could scarcely have impressed themselves so deeply on the clay.

These appearances can, I think, be explained on the supposition that some animal crawling on the soft mud at the bottom of shallow water, by means of feet which made a double series of transverse marks, was in the habit of excavating deep burrows for shelter or repose, and that these burrows were filled with drifted sand constituting the lower part of what is now a thin bed of dark-colored sandstone. The burrowing of the modern *Limulus*, as described by the writer in vol. vii of this journal, would produce a similar effect. I have not seen the burrows of *Limulus* in clay;

and in sand a quantity of this material is thrown out behind, which in a cast would have left two hollows, not present in the fossils; but should a *Limulus* burrow in fine mud, which would become diffused or washed away as thrown out, then the appearance would be not unlike that of these fossils. The front of the carapace would give the rounded, anterior end; the two rows of walking and swimming feet would form the depressions with transverse striæ; and the only addition would be the mark of the caudal spine of *Limulus*, of which there is no trace in the fossils. The animal required would therefore be a crustacean, having feet and habits of life generally resembling those of *Limulus*, but without a caudal spine. The only known animals of the period that could have fulfilled these conditions are the Trilobites; and since the interesting discovery, by Mr. Billings, of the feet, or bases of the feet, of *Asaphus*, the objection to this view which might have been taken from our ignorance of the feet of these animals, no longer exists. The feet of *Asaphus*, in short, appear to constitute just such a double series of laminæ as would necessarily produce markings like those referred to.

From the great depth of these burrows, and the indications of shallow water in the vicinity of a shore presented by the shrinkage-cracks, I would further consider it probable that these holes were places of incubation; and that the Trilobites carried their spawn attached to their swimming-feet, and were in the habit of resorting to shallow water for the purpose of incubation.

The above remarks apply more especially to *R. Grenvillensis*. I can speak with less confidence of Professor Hall's species; but the only specimen which I possess of the *R. bilobatus* of New York, differs from the Grenville specimens only in the proportions of length and breadth; as might be expected, if, as is probably the case, it is the track of a different species. My bilobate impressions from Nova Scotia have been produced by a small animal; perhaps the little species of *Phillipsia* which occurs in the same formation. Mr. Sälter's *Arenicola* from the Longmynd wants the transverse markings, and the impressions are somewhat separate, so that they may be of a different character from the others. I think it quite likely, however, that the more elongated species of *Rusophycus*, in the Clinton of New York, may be casts of tracks of Trilobites, and I have long believed that a similar explanation will apply to some at least of the supposed fucoids known as *Arthrophycus*.

Taking this view of the origin of these singular objects, I would suggest to change the generic name of the Grenville fossil to *Rusichnites*. In such impressions it is scarcely to be expected that good specific characters can exist. I think it probable, however, that the Grenville specimens may indicate the presence of three species of Trilobites. Some of the smaller specimens are more elongated than the others, and have more numerous furrows. Other and larger ones are shorter and with fewer and more obtuse transverse furrows. A third variety is that referred to by Mr. Billings in his description, as having traces of lateral longitudinal furrows. These may in the meantime be included under *R. Grenvillensis*, Billings, as varieties (*a*), (*b*), and (*c*). (Figs. 1 and 2).

My Nova Scotia specimens, though small, show little difference of character, but I would regard them as constituting a distinct species, under the name *R. carbonarius*. (Fig. 3).

A third species of *Rusichnites* has recently come into my possession, in a collection of fossils from the coal formation of Sydney, Cape Breton, sent to me by my friend Richard Brown, Esq. These impressions are, like the others, casts in relief, on a slab of sandstone. Each impression consists of the casts of contiguous rounded furrows, each about one-eighth of an inch in breadth, and crossed by curved undulations and striæ, in such a manner as to give the appearance of a pinnate leaf carved in high relief. At each side of these impressions, and about a tenth of an inch distant from them, are interrupted lines, in relief in the casts, and running parallel with the casts of the furrows. The whole has exactly the appearance of the track of the swimming feet and edges of the carapace of a small *Limulus*, about half an inch wide. The tracks have also the same tortuous character with those of the modern Limulus. *Limuli* have not yet occurred in the coal formation of Nova Scotia, though they occur in rocks of this age elsewhere; but from these tracks I infer that animals of this kind lived in the Sydney coal field, where their remains will probably hereafter be found. I propose for these impressions the name *R. Acadicus*, and will endeavor to figure them in the next number of the *Naturalist*.

ON THE GEOLOGY OF EASTERN NEW YORK.

By Professor James Hall and Sir William E. Logan.

Professor James Hall and Sir William Logan spent a few days together last summer in examining some points of the geology of Eastern New York, and propose to continue their examinations next season, when we may expect from them a detailed account of their results. Their principal object was to compare the rocks of that region with some of those of Eastern Canada; and I have now permission, in the absence of these gentlemen, to lay before this Society some of the results of this exploration.

The shales of the Hudson River group, which are seen for a considerable distance north and south of Albany, disappear a few miles east of the Hudson, and are succeeded by harder and coarser shales, sometimes red or green in color, and passing into green argillaceous sandstones. These various strata, which are associated with concretionary and shaly limestones, are now recognized as belonging to the Quebec group. The line of contact between this and the much more recent Hudson River group has nowhere been clearly seen in this region, but the two series are readily distinguished by their differences in color, texture, and hardness,—differences which were formerly supposed to depend upon the partial metamorphism of the eastern portion, when this was looked upon as a part of the Hudson River group. The green sandstones and conglomerates of Grafton Mountain, formerly looked upon as a portion of the Shawangunk conglomerate, are recognized as belonging to an outlying portion of the Sillery formation. This mountain Professor Hall had found in a previous exploration (1844–45) to have, at a point farther south, a synclinal structure, and it probably lies in three low synclinal axes. The Sillery formation scarcely extends south of Rensselaer County.

Canaan Mountain is also apparently synclinal, and, while limestones appear in the valleys on each side of it, consists chiefly of slates, the highest beds being a hard green sandstone, sometimes shaly, without any of the conglomerates of the Sillery; although boulders and angular fragments of these are found in the adjacent valleys. To the east of this, Richmond Mountain, in Massachusetts, presents in its upper portion a compact green slate, passing upwards into a harder rock similar to that of the summit of Canaan Mountain. To the southward, as far as Hillsdale, the sparry limestones of the Quebec group appear in the valleys, while the hills are of slate. Proceeding thence westward towards the river, only the lower portions of the Quebec group are met with, until we come upon the rocks of the Hudson River group.

Washington Mountain is also of slate, flanked by limestone, all of the Quebec group, and is probably synclinal in structure. The valley to the south of the mountain exhibits limestones, apparently alternating with slates. Columbia and Dutchess counties appear to be mainly occupied by the shales of the Quebec group, with broad exposures of its limestones, until we approach the river to the westward, when the shales of the Hudson River group are met with, extending a considerable distance below the city of Hudson.

From Fishkill the explorers proceeded to Coldspring, crossing what Mather called the Mattewan granite, but which they found to be an altered sandstone. Soon after this they came upon the great gneiss formation of the Highlands of the Hudson, which continues beyond Peekskill. They failed to find the sandstone described by Mather as coming out at this place; nor was anything representing the Potsdam sandstone detected in approaching the Highlands from Fishkill, nor elsewhere along their northern limits. Near to Peekskill, in the valley of the creek, was found a low ridge of black slate, supposed to belong to the Quebec group, and a similar slate was observed along the north side of the Highland range, not far from the gneiss. The gneiss of the Highlands presents all the aspects and characteristics of that of the Laurentian system, as seen in northern New York and in Canada.

Further examinations are necessary to determine the extension to the north-east of the Laurentian rocks of the Highlands, and also the succession of strata to the south-east of them. The recognition of the Sillery and of the Quebec group in this region are great and important facts for its geology, and not less so the identification with the Laurentian system of the gneissic district of the Highlands, to which the interesting mineral region of Orange county and the adjacent parts of New Jersey doubtless belongs. This conclusion, although opposed to the views of Mather and Rogers, who looked upon the crystalline rocks of the latter region as altered Lower Silurian strata, is in accordance with the older observations of Vanuxem and Keating, and with the more recent ones of Professor Cook, according to all of whom the gneiss and crystalline limestones of Orange County and of New Jersey underlie unconformably the Lower Silurian strata. T. S. H.

NATURAL HISTORY SOCIETY.

The first monthly meeting of the Society for the Session 1864-65 was held at its rooms on Monday evening, September 26th, Dr. Dawson, President, in the chair. A large number of donations were announced:

To the Museum.

Blackburnian warbler (*Dendroica Blackburniæ*) and the black-throated green warbler (*Dendroica virens*), shot near Montreal, and presented by Mr. W. Hunter. A large collection of English beetles, from W. M. S. D'Urban, Esq. A fine series of Canadian insects, of all orders, from Messrs. John B. Goode, C. Foley, R. J. Fowler, and Jas. Ferrier, jun. Fossils and recent shells from Prof. Dana (New-haven), Dr. Hubbard (Staten Island), E. Seymour (New York), and C. Hart. Also a number of single specimens of interest, but which we cannot particularize from want of space. The donations to the Library were also numerous.

New Members.

Prof. R. Bell was elected a corresponding, and G. W. Simpson, Esq., an ordinary member of the Society.

Proceedings.

The first paper (On *Rusophycus Grenvillensis*, Billings) was then read by Principal Dawson. This paper is printed in the present number.

Mr. Billings read a paper, " On a remarkable specimen of *Asaphus Platycephalus*." The principal point of interest in this communication was that the author claims to have discovered what the legs of trilobites were like. The structure of the upper part of these remarkable fossils, so familiar to the student of the older fossiliferous rocks, has long been known to naturalists. Dr. Buckland, in his Bridgewater treatise, has described the microscopic details of the eyes of these curious crustaceans, which organs are not unfrequently preserved in the rocks,—and has fully illustrated their complex, compound character. But until now, the only portion of the under surface known was the part containing the mouth. This organ is situated in a plate on the under surface of the head, a considerable distance from its apex. From this circumstance Burmeister infers that "they swam in an inverted position, the belly upwards and the back downwards," as the mouth is situated so far backwards on the under side. But although even the eyes of these curious creatures are often preserved, no traces of the legs have hitherto been detected. It was supposed that they were thin and foliaceous, for it was plausibly urged that if these animals had the stout, calcareous legs of ordinary crabs, some trace of them would have been met with in the rocks.

Mr. Billings exhibited a specimen from the Trenton limestone of Ottawa, which had been in part carefully extricated from the matrix. He stated that in his opinion trilobites had a pair of thin, foliaceous legs to each segment of the thorax, or rather abdomen. The specimen of *Asaphus Platycephalus* which he passed round for examination was a specimen with eight thoracic segments, and exhibited on the under side eight semicylindrical ridges on each side of the median line, all curving outwards and forwards. These he believed to be the bases of the attachment of eight pairs of swimming feet—one pair for each segment of the thorax. Burmeister had made a sketch of what he supposed the legs of a trilobite would be like, and Mr. Billings stated that this ideal restoration was fully borne out by his specimen, except that in Burmeister's drawing the legs were directed backwards, whilst those of the actual specimen pointed forwards.

Dr. Dawson remarked that the Natural History Society might well feel proud that this important discovery in palæontology had been made by one of its own members.

Mr. Billings said that in his opinion the specimen exhibited tended to verify the views that Dr. Dawson advocated with respect to the Grenville fossil previously treated of.

Mr. D. R. McCord, B.A., next made a communication "On Canadian Ferns, their Varieties and Habitats." This paper is printed in the present number.

The Recording Secretary exhibited a collection of native ferns, collected and prepared by Miss Isabella McIntosh (of Burnside House), among which were three species of peculiar interest. The first was the "green spleenwort" (*Asplenium viride*, Hudson), a small species occurring somewhat rarely in mountainous districts in England, and in various localities in Europe. It had been previously detected in Gaspé, in the summer of 1863, by John

Bell, B.A., and this was the only station in which it was previously known to occur in Canada. The other species are the "Adder's tongue fern," (*Ophioglossum vulgatum*), of which fine specimens were collected at Melbourne, in the Eastern Townships; and the "Moonwort" (*Botrychium Lunaria*), two species well known to inhabit Europe, but now for the first time recorded as occurring in Canada.

C. Robb, Esq., exhibited a series of ferns collected in Canada West, by Mrs. Traill, the well-known authoress.

Dr. Dawson remarked that the study of the non-flowering plants of Canada was as yet but in its infancy, and that Prof. Lawson's and Mr. McCord's papers, excellent as they were, must be considered as only forming the commencement of an investigation full of interest and promise.

The second monthly meeting of the Society for the Session 1864–65 was held in its rooms on Monday evening, October 24th.

The following donations were announced:

To the Museum.

From Principal Dawson, twenty-three species of Canadian drift-fossils, and twenty-two specimens of coal-plants from Nova Scotia.

From C. Robb, Esq., *Columnaria alveolata*, a fossil-coral from the Black River limestone of Burgess, C. W. Specimen of diallage from Brompton, and examples of native and manufactured antimony from South Ham.

From Mr. W. Hunter, stuffed specimen of the night heron (*Nyctiardea Gardeni*), Baird.

From Mrs. McIntosh, a quantity of living fishes for the Aquaria.

To the Library.

From the Author, Geological Survey of Michigan, 1860, by Prof. A. Winchell.

New Members.

Hugh Fraser, Esq., was elected a life member, and the Rev. Robt. McDonald and Prof. H. Y. Hind, corresponding members of the Society.

Proceedings.

The first paper, entitled "Notes on the Geology of Eastern New York, by Prof. James Hall and Sir W. E. Logan," was read by Dr. T. Sterry Hunt. This paper is printed in the present number.

Dr. Hunt then made a verbal communication on phosphate of lime; he described its nature and composition generally, its sources in nature, and its various uses, particularly as a manure. After noting the manufacture of superphosphate of lime from bones, coprolites, and guano, he proceeded to describe the supplies of the phosphate of lime known to mineralogists as apatite, which is met with in crystalline rocks and especially in Canada; where the mineral is found abundantly in the vicinity of Perth, and also at several points along the Ottawa. The phosphate occurs both disseminated in small crystals through certain beds of crystalline limestones of the Laurentian system, and in regular veins which intersect the rocks of the same system. In these veins the mineral is sometimes found nearly pure, and at other times associated with pyroxene, large crystals of magnesian mica (which are wrought), and other silicated minerals. Not unfrequently also it is mingled with lamellar carbonate of lime, which sometimes so far predominates as to give rise to what may be called a crystalline limestone, holding grains and crystals of apatite, and can scarcely be distinguished from those stratified Laurentian limestones of the region, which also contains apatite, except by the fact that it occurs in veins, cutting the strata. Many of these are too poor in apatite to be wrought with advantage; but Dr. Hunt expressed the opinion that all the workable phosphate of the region occurs in true veins, some of which are of considerable width, and are filled with phosphate of lime almost without any foreign admixture. Dr. Hunt then proceeded to give a history of these deposits, which were first described in 1848, in the report of the Geological Survey, the officers of which had since, on repeated occasions, called attention to the value of this material, and had shown it at the great exhibitions of London and Paris. He then described the attempts now being made to work the deposits of this mineral by some New York capitalists in North Burgess, where they have forty or fifty workmen. under the direction of a skillful mining engineer.

ENTOMOLOGICAL SOCIETY OF CANADA.

The ordinary monthly meeting of the Society was held in the Council-room of the Canadian Institute on Tuesday, Dec. 8th, at 3 p.m. Nearly all the members from Toronto and the vicinity were present. In the absence of Prof. Croft and Mr. Saunders, Dr. Morris was called to the chair, and Mr. Hubbert appointed secretary *pro tem.* The minutes of the previous meeting were read and confirmed.

Communications were received from Prof. Hincks, expressing regret at his inability to attend from indisposition; from F Grant, Esq., and R. V. Rogers, Esq., on business connected with the Society.

Rev. H. P. Hope, and Rice Lewis, Esq., Toronto, and James Wright, Esq., Vienna, C. W., were proposed as suitable persons to become members.

The following donations were acknowledged, and the thanks of the Society voted to the donors:

From Prof. Croft.

A cabinet of seven drawers.

To the Library, from the Smithsonian Institution.

Monograph of the Diptera of North America, by H. Low. Part I.

From the author, W. Saunders, Esq., London, C. W.

(1.) Monograph of the Arctiades of Canada. 20 copies.
(2.) Description of ten new species of Arctia.
(3.) "On some hitherto undescribed Lepidopterous Larvæ."

From A. S. Packard, Esq., Jun., Cambridge, Mass., through Principal Dawson.

Photographs of the following undescribed bombyces:

Crambida pallida, Callimorpha vesta, Callochlora chlorata, Cyrtosia albipunctata, male and female, Entrutricudes testacea, Cyrtosia geminata, Cilodasys cinereafrons, Laphodonta ferruginea, Gluphisia trilineata, male and female, Platyarma furcilla, Cilodasys biguttata, Edaplenyx bilineata.

From James Hubbert, Esq., B.A.

Popular Entomology, by Maria E. Catlow.
British Butterflies, by W. S. Coleman.

To the Cabinet, from Prof. Croft.

48 specimens, including 27 species of Chinese Lepidoptera.
164 specimens, including 61 species of Coleoptera.

From B. R. Morris, Esq., B.A., M.D.

47 specimens, including 16 species of Coleoptera.

From J. H. Sangster, Esq., M.A.

23	specimens,	including	17	species	of	Coleoptera.
6	"	"	5	"	"	Lepidoptera.
11	"	"	10	"	"	Diptera.
10	"	"	10	"	"	Hymenoptera.
5	"	"	4	"	"	Neuroptera.
4	"	"	4	"	"	Orthoptera.

From B. Billings, Esq., Ottawa.

236	specimens,	including	132	species	of	Coleoptera.
21	"	"	19	"	"	Lepidoptera.
6	"	"	5	"	"	Diptera.
7	"	"	5	"	"	Orthoptera.
3	"	"	2	"	"	Strepsiptera.
3	"	"	3	"	"	Hemiptera.

From James Hubbert, Esq., B.A.

251	specimens,	including	176	species	of	Coleoptera.
63	"	"	25	"	"	Lepidoptera.
44	"	"	40	"	"	Diptera.
38	"	"	27	"	"	Hymenoptera.
12	"	"	10	"	"	Orthoptera.
12	"	"	8	"	"	Neuroptera.
15	"	"	10	"	"	Hemiptera.

From Thomas Reynolds, Esq., Montreal.

13	specimens,	including	8	species	of	Coleoptera.
159	"	"	53	"	"	Lepidoptera.
1	"	"	1	"	"	Diptera.
9	"	"	6	"	"	Hymenoptera.
2	"	"	1	"	"	Hemiptera.

From W. Saunders, Esq., London.

345	specimens,	including	121	species	of	Coleoptera.
111	"	"	37	"	"	Lepidoptera.
8	"	"	5	"	"	Neuroptera.
1	"	"	1	"	"	Diptera.
4	"	"	1	"	"	Strepsiptera.

A communication was read from Mr. Saunders regarding the practicability of publishing a catalogue of the known Canadian species of each order of insects. After considerable discussion as to the best form, etc., it was moved and seconded, That the Society take immediate steps to prepare and publish catalogues of the Coleoptera and Lepidoptera; to be followed by similar catalogues of the other orders as soon as possible; and that Mr. Saunders, Prof. Croft, and Mr. Billings be a committee on Coleoptera; and Prof. Hincks, Mr. Saunders, and Dr. Morris on

Lepidoptera. Carried. The Committees are very anxious to secure the co-operation of all persons having either named collections or lists of species. Any information which would aid in bringing out full and accurate catalogues should be communicated without delay to Mr. Saunders or Prof. Hincks. Moved and seconded that a supply of entomological pins, and sheet cork for lining cabinets, be procured and kept on hand, to be furnished to members at the lowest cost prices. Carried.

It is intended ultimately to keep all the apparatus required in capturing and preserving insects.

Moved and seconded that the Rev. Chas. J. Bethune, B.A., be requested to use his influence to advance the interests of the Society among entomologists in Britain. Carried.

A verbal communication was made by Dr. Morris on insects captured in the vicinity of Orillia during the summer of 1863.

Among the interesting specimens exhibited by Dr. Morris were several examples of *Colias edusaco*, seldom met with in Canada, only two or three individuals having been taken as yet. The Dr. remarked that this insect seems to differ from the *C. edusa* of British naturalists in its habits of flight, etc., which seem to indicate either a new species or very wide variations.

Both sexes of *Lerias lesa*, also very rare in Canada, had been captured. A species of *Arrhenodes*, taken by Mr. F. Grant of Orillia, was also exhibited. The general appearance of the insect closely resembled that of *A. septentrionis*, of which it is probably a variety. The form of the rostrum, however, is so peculiar as to lead the Dr. to think that possibly there may be two species with us.

Papers presented by Mr. Hubbert:

(1). "Notes on Insects captured near Kingston, 1863."

(2). "What the Insects do in January."

The meeting then adjourned.

ON THE LARVÆ OF ATTACUS POLYPHEMUS.

BY WILLIAM COUPER, QUEBEC.

On the 14th of August 1863, I found two caterpillars of *A. polyphemus* feeding on sweet-briar in the vicinity of Montmorenci river, near Quebec. They were carefully carried to my home, and the above food-plant supplied daily, excepting that the thorns were picked off the branches before the larvæ were attached thereon. The lepidopterist will no doubt understand my astonishment to find the large, soft, thin-skinned, and hairless larva of *A. polyphemus* feeding on the sweet-briar, a plant said to be introduced into Canada. Harris gives three food-plants, *i. e.*, the oak, elm, and lime trees. Formerly I found it feeding on a species of maple at Toronto, and now in the Lower Provinces we find it on the thorny briar. How they manage to turn and creep from one branch to another without coming in contact with the numerous thorns, I am unable to explain. They continued to feed on the supplied food up to the 28th of August, on which day they ceased to feed, and prepared to spin. The caterpillar that produced the male first ceased feeding; it was also the first to issue from its cocoon, although both were subject to an equal temperature. A short time previous to spinning, both caterpillars ejected the contents of the viscera, consisting of about a teaspoonful of a dark green fluid, and immediately afterwards they began to form their cocoons. I notice this singular caterpillar *ejectamentum*, as I think it has been hitherto overlooked, and it would be advancing our knowledge in entomological science to have this fluid analyzed. The caterpillar that produced the male had the dorsal tubercles much shorter than the one that issued from the other cocoon; they were tipped with bright yellow, with a slight golden reflection. The caterpillar of the second cocoon, or the one producing the supposed female, had the lateral and dorsal tubercles bright orange red, mingled with golden, the tubercles were more robust and longer than the one which produced the male. Unfortunately, during my absence from home, the moth from the second cocoon escaped through the window, and I am therefore unable to prove the imago sex with the larvæ. But from external characters alone, I rest satisfied that the future investigator will find that the richest colored caterpillar forms the cradle of the female. I trust my short investigation may lead others to study the metamorphosis of this genus of moths. No doubt if a thorough search is also made for the larvæ of *A. luna* in the Lower Provinces, it will be found feeding on a plant different from its western food, and probably hitherto unknown to be used as such by this beautiful moth.

MISCELLANEOUS.

CALLUNA VULGARIS.—Professor Lawson, of Dalhousie College, Halifax, has sent to one of the editors a specimen of this plant, the common heather of Scotland, from St. Ann's Bay, Cape Breton. This confirms an old report, referred to in vol. vii of this journal, p. 343, of its occurrence in that island; and affords another certainly ascertained American locality, in addition to those previously known in Massachusetts and Newfoundland. It should be satisfactory to the Scotsman in British America to know that there is at least one spot in his adopted country where he can plant his foot on his native heather. The apparent rarity of the plant in America is however no less curious than its extension to this country; and it remains as a question for future botanists to settle whether it is now being introduced to the new world or gradually dying out from it.

THE GEOLOGICAL MAGAZINE.—The *Geologist*, of London, has been merged in a new periodical, to be edited by Prof. T. R. Jones and Henry Woodward. Its prospectus says:

The rapid progress of geology in all its branches, and especially the wide-spread interest imparted to this science by the recent careful investigation of some of the more modern strata, have largely increased the number of those who study geology, either professionally or as amateurs. The frequent discoveries, also, which result from the exertions of practical geologists, both at home and abroad, appear to indicate the necessity of a monthly periodical, not only for the publication of original papers on geology and kindred subjects, as well as of translations of important foreign memoirs, but also as the means of communication between geologists and palæontologists in England and other countries.

The valuable Journal of the Geological Society fulfils some of these requirements; but being published only quarterly, and necessarily restricted almost entirely to the proceedings of that Society, it cannot serve all the purposes proposed by the conductors of *The Geological Magazine.*

In Germany the *Neues Jahrbuch* has fulfilled the requirements of the geological public for the last thirty years with unvarying success; and the editor and publishers of the Monthly *Geologist* have during six years endeavored to meet them in England. The latter work is now merged in *The Geological Magazine.*

The publishers and editors of *The Geological Magazine* have not hastily undertaken the task which lies before them; but, having consulted the most eminent geologists and palæontologists of the day (amongst whom may be mentioned Sir Philip Egerton, Sir Roderick Murchison, Sir Charles Lyell, G. Poulett Scrope, Esq., Professors Sedgwick, Phillips, Owen, Ramsay, Morris, and Huxley, and Dr. Falconer), they are not unaware of what will be expected of them; and they have received such assurances of support and encouragement, as well as promises of original contributions, that they confidently trust their efforts will meet with success.

Another well-known scientific magazine, the *Edinburgh New Philosophical Journal*, has been merged in the new *Quarterly Journal of Science*, published in London.

MEETING OF BRITISH ASSOCIATION.

LECTURE BY DR. LIVINGSTONE.

On the evening of September 20, the theatre was crowded by members of the Association, anxious to hear the lecture announced by Dr. Livingstone on his travels and labors in Africa.

Sir R. Murchison stated that the assistant-general-secretary, Mr. Griffiths, had made such excellent arrangements that, while Dr. Livingstone is lecturing there, his lecture would be read in another place to many hundreds of the Association who could not find room in the theatre; and that when that assembly was adjourned, his friend would move to the other room, and there thank that assembly which was met to do him honor also.

Dr. Livingstone then delivered the following lecture:—In order that the remarks I have to offer may be clearly understood, it is necessary to call to mind some things which took place previous to the Zambesi Expedition being sent out; and most of you are, no doubt, aware, that previous to the discovery of Lake Ngami and the well-watered country in which the Makololo dwell, the idea prevailed that a large part of the interior of Africa was composed of vast sandy deserts into which rivers ran and were lost. In a journey from sea to sea across the continent, somewhat north of the lake first discovered, it was found that there, too, the country was well watered. Large tracts of fertile soil were covered with forest, and occupied by a considerable population. We had, then, the form of the continent revealed to be an elevated plateau, somewhat depressed in the centre, with fissures at the sides, by which the rivers escaped to the sea: and this great fact in physical geography can never be referred to without mentioning the remarkable hypothesis by which the distinguished President of the Royal Geographical Society (Sir R. Murchison) clearly delineated it before it was verified by actual observation of the altitudes of the country and courses of the rivers. It was published in one of his famous anniversary addresses; and he has been equally happy in his last address in pointing out the ancient geological condition of the interior of this continent as probably the oldest in the world—a fact we, who were on the spot, could but dimly guess. But he seems to have the faculty of collecting facts from every source, and concentrating them into a focus in a way no one else can accomplish. (Cheers.) We understand it only after he has made it all plain in his study at home. Then followed the famous travels of Dr. Barth and Francis Galton; the most interesting discoveries of Lake Zangnyika and Victoria Nyawya, of Captain Burton, and Captain Speke, whose sad loss we all now so deeply deplore, and, again, of Lakes Shirwe and Nyassa; the discoveries of Van der Decken and several others; but, last of all, the grand discovery of the main source of the Nile, which every Englishman must feel proud to know was accomplished by our countrymen Speke and Grant. In all this exploration the main object in view has not been merely to discover objects of nine days' wonder—to gaze, and be gazed at by barbarians—I would not give a fig to discover even a tribe with tails!—but, in proceeding to the west coast, to find a path to the sea, whereby lawful commerce might be introduced to aid missionary efforts. I was very much struck by observing that the decided influence of that which is known as Lord Palmerston's policy existed several hundreds of miles from the ocean. I found piracy had been abolished, and that the slave-trade had been so far suppressed as to be spoken of as a thing of the past; that lawful commerce had increased from 20,000*l.* in ivory and gold-dust to between 2,000,000*l.* and 3,000,000*l.*, 1,000,000*l.* of which was in palm-oil to our own country; that over twenty missions had been established, with schools in which 12,000 pupils were taught; that life and property were secure on the coast, and comparative peace established in large portions of the interior; and all this was at a time when, from reading the speeches of well-informed gentlemen at home, I had come to the conclusion that our cruisers had done nothing but aggravate the evils of the slave-trade. Well, not finding what I wished by going to the west coast, I came down the Zambesi to the east coast, and there I found the country sealed up. The same efforts had been made by our cruisers here as on the west coast, but, in consequence of foreigners being debarred from entering the country, neither traders nor missionaries had established themselves. The trade was only in a little ivory, and gold-dust and slaves; just as it was on the west coast before Lord Palmerston's policy came into operation. It seemed to me, therefore, that as the Portuguese Government professed itself willing to aid in opening the country, and we had a large river, Zambesi, which, being full when I first descended, it seemed a famous inlet to the higher lands and interior generally; I knew the natives to be almost all fond of trading, and, when away from the influence of the slave-trade, friendly and mild, the soil fertile, and cotton and other products widely cultivated. It therefore appeared to me that if I could open this region to lawful commerce I should supplement the efforts of our cruisers, in the same way as has been done by traders and missionaries on the west coast, and perform a good service to Africa and to England. To accomplish this was the main object of the Zambesi Expedition, and in speaking of what was done, it is to be understood that Dr. Kirk, Mr. Livingstone, and others composed it; and when I speak in the plural number I mean them, and wish to bear testimony to the zeal and untiring energy with which my companions worked. They were never daunted by difficulties, nor dangers, nor hard fare, and were their services required in any other capacity might be relied on to perform their duty. The first discovery we made was a navigable entrance to the Zambesi, about a degree west of the Quillimane River, which had always been represented as the mouth of the Zambesi, in order, as some maintained, that the men-of-war might be induced to watch the false mouth while slaves were quietly shipped from the real mouth. This mistake has lately been propagated in a map by the Colonial Minister of Portugal. On ascending the Zambesi we found that the Portuguese authorities, to whom their Government had kindly commended us, had nearly all fled down to the sea-coast, and the country was in the hands of the natives, many of whom, by their brands, we saw had been slaves. As they were all quite friendly with us, we proceeded to our work, and ascended the river in a little steamer which, having been made of steel plates, a material never before tried, and with an engine and boiler, the sweepings of some shop, very soon failed us. Indeed, the common canoes of the country passed us with ease, and the people in them looked back, wondering what this puffing, asthmatic thing could mean. The crocodiles thought it was a land-animal swimming, and rushed at it in hopes of having a feast. The river for the first 300 miles is from half a mile to three miles wide. During half the year the water is abundant and deep: during the other half, or the dry season, it is very shallow; but with properly constructed vessels much might be made of it during the whole of ordinary years. We proceeded as soon as we could to the rapids above Zette, our intention having originally been to go up as far as the Great Victoria Falls, and do what we could with the Makololo, but our steamer could not stem a four-knot current. We then turned off to an affluent of the Zambesi, which flows into it about 100 miles from the sea; it is called the Shire, and, as far as we know, was never explored by any European before. It flows in a valley about 200 miles long and twenty broad. Ranges of hills shut in the landscape on both sides, while the river itself winds excessively among marshes; in one of these we counted 800 elephants, all in sight at one time. The population was very large; crowds of natives, armed with bows and poisoned arrows, lined the banks, and seemed disposed to resent any injury that might be inflicted. But by care and civility we gave them no occasion for commencing hostilities, though they were once just on the point of discharging their arrows. On a second visit they were more friendly, and the women and children appeared. We had so far gained their confidence that we left the steamer at Murchison's Cataracts; and Dr. Kirk and I, proceeding on foot to the N.N.E., discovered Lake Shirwe. This lake is not large; it is said to have no outlet, and this is probably the case, for its water is brackish; it abounds in fish, hippopotami, and leeches. The scenery around is very beautiful, the mountains on the east rising to a height of 8,000 or 9,000 feet. We were now among Manganja, a people who had not been visited by Europeans, and as I am often asked what sort of folk these savages are, I may answer they were as low as any we ever met, except Bushmen, yet they all cultivate the soil for their sustenance. They raise large quantities of maize, or Indian corn, and another grain, which grows in a stalk ten or twelve feet high, with grain very much like the hemp-seed given to canaries, and called by the Arabs *dura* (*Hœlcus georghum*); another kind of grain (tennisetum); several kinds of beans, pumpkins, and melons; cucumbers, from the seeds of which a fine oil is extracted; cassava, from which our tapioca is made; ground-nuts, which yield an oil for cooking; castor-oil, with which they anoint their bodies; and tobacco and Indian hemp for smoking. The labor in the fields seemed to be performed by the whole family,—men, women, and children being generally seen in the fields together. Each family had a patch of cotton, just as our forefathers had each a patch of lint; and this cotton was spun and woven by the men, while the women malted and ground the corn, and made the beer. Near many of the villages furnaces were erected for smelting iron from the ore, and excellent hoes were made very cheap. All were very eager traders, and very few were hunters; so they can scarcely be called savages, though, without a doubt, they were degraded enough. Their life has always appeared to me to be one of fear. They may be attacked by other tribes, and sold into slavery; and the idea this brings is, that they will be taken away, fattened, and eaten by the whites. The slave-trader calls them beasts and savages, and they believe the slave-traders to be cannibals. They also live in fear of witchcraft; and suspected persons are frequently compelled to drink the ordeal water, which is just about as sensible a means of detecting witches as our former mode of ducking in a pond. If the suspected person vomits, she is innocent; if not, guilty: and yet we laugh heartily at our forefathers believing that the woman who sank in the pond was innocent, and guilty if she swam,—just as monomaniacs do with their illusions. Cultivating large tracts of land for grain, a favorite way of using the produce is to convert it into beer. It is not very intoxicating, but when they consume large quantities they do become a little elevated. When a family brews a large quantity, the friends and neighbors are invited to drink, and bring their hoes with them. They let off the excitement in merrily hoeing their friend's field. At other times they consume large quantities for the same object as our regular topers at home. We entered one village, and found the people all tipsy together. On seeing us the men tried to induce the women to run away; but the ladies, too, were, as we mildly put it, "a little overcome," and laughed at the idea of their running. The village doctor arranged matters by bringing a large pot of the liquid, with the intention, apparently, of reducing us to the general level. Well, the people generally, if we except the coast tribes, are very much like these, without the drunkenness. Wherever tzetze exists the people possess no cattle, as this insect proves fatal to all domestic animals, except the goat, man, and donkey. Its bite does no harm to man nor to the donkey, though one donkey we took through a tsetse district did die, probably from over-fatigue. We made no discovery as to the nature of the curious poison injected by the insect, nor could we find out where it laid its eggs. Where the slave-trade is unknown the cattle are the only cause of war. The Makololo will travel a month for the sake of lifting cattle; this is not considered stealing; and when the question is put, "Why should you lift what does not belong to you?" they return the Scotch answer, "Why should these Makalaka (or black fellows) possess cattle if they can't defend them?" Having secured the good-will of all the people below and adjacent to Murchison's Cataracts, we next proceeded further north, and discovered the Shire flowing in a broad, gentle stream out to Lake Nyassa, about sixty miles above the cataracts. The country on each side of the river and lake rises up in what, from below, seem ranges of mountains, but when they have been ascended they turn out to be elevated plateaux, cool and well watered with streams. To show the difference of temperature, we were drinking the waters of the Shire at eighty-four degrees, and by one day's march up the ascent, of between 3,000 and 4,000 feet, we had it at sixty-five degrees, or nineteen degrees lower. It felt as if iced. We had no trouble with the people. No dues were levied, nor fines demanded, though the Manganja were quite independent in their bearing towards us, and strikingly different from what they afterwards became. Our operations were confined chiefly to gaining the friendship of the different tribes, and imparting what information we could with a view to induce them to cultivate cotton for exportation. It has already been mentioned that each family had its own cotton-patch; some of these were of considerable extent; one field, close to Zedzan Cataract, I lately found to be 630 paces on one side, and the cotton was of excellent quality, not requiring replanting oftener than once in three years, and no fear of injury by frost. After careful examination, I have no hesitation in re-asserting that we have there one of the finest cotton-fields in the world. On remonstrating with the chiefs against selling their people into slavery, they justified themselves on the plea that none were sold except criminals. The crimes may not always be very great, but I conjecture, from the the extreme ugliness of many slaves, that they are the degraded criminal classes; and it is not fair to take the typical negro from among them any more than it would be to place "Bill Sykes" or some of *Punch's* garrotters as the typical John Bull. For years I had been looking out for the typical negro, and never felt satisfied that I had got him, for many of them are the pictures of the old Assyrians; others, barring color, which we soon forget, closely resemble acquaintances at home. But Mr. Winwood Read, in his work, "Savage Africa," seems to have lighted right on the head of the idea, in saying that no typical negro is seen in the portraits and monuments of the ancient Egyptians. When we had succeeded in gaining the goodwill of the people which crowded the Shire valley, the mission under the late Bishop Mackenzie came into the country. Dr. Kirk had performed a journey from the Murchison Cataracts across to Zette, a Portuguese village upon the Zambesi. Slave-hunters then were sent along Dr. Kirk's route by the sanction of the present Government, calling themselves "my children." The scamps! They joined themselves to another tribe called Ajawa, then in the act of migrating from the south-east, and who had been accustomed to take slaves annually down to Quillimane, and other settlements on the coast. Furnishing the Ajawa with arms and ammunition, they found it easy to drive those who were armed only with bows and arrows before them. When Dr. Kirk and Mr. Charles Livingstone, and I went up to show Bishop Mackenzie on to the highlands, we met a party of these Portuguese slaves coming with eighty-four captives bound and led towards Zette. The head of the party we knew perfectly, having had him in our employment in Zette. No force was employed, for even the slaves of the Governor knew that they were doing wrong, and fled, leaving the whole of the captives on our hands. Bishop Mackenzie received them gladly, and in a fertile country, with land free, in the course of a year or two, might, by training some sixty boys to habits of industry, have rendered his mission independent as far as native support was concerned. Having been engaged in the formation of two missions in another part of the country, and having been familiar with the history of several, I never knew a mission undertaken under more favorable auspices. This would be the opinion of all who have commenced similar enterprises in other parts, and it was that of the good bishop himself. He was so thoroughly unselfish, and of such a genial disposition, that he soon gained the confidence of people; and this is the first great step to success. The best way of treating these degraded people must always be very much that which is pursued in ragged schools. Their bodily wants must be attended to as the basis of all efforts at their elevation. The slave-trade is the gigantic evil which meets us at every step in the country. We cannot move through any part without meeting captured men and women, bound, and sometimes gagged; so no good can be done if this crying evil is not grappled with. The good bishop had some 200 people entirely at his disposal, and would soon have presented to the country an example of a free community, supported by its own industry, where fair dealing could be met, which undoubtedly would have created immense influence; for wherever the English name is known it is associated with freedom and fair play. Some seem to take a pleasure in running down their fellow-countrymen; but the longer I live, I like them the better. They carry with them some sense of law and justice, and a spirit of kindliness; and were I in a difficulty, I should prefer going to an Englishman rather than to any other for aid. And as for Englishwomen, they do, undoubtedly, make the best wives, mothers, sisters, and daughters in the world. It is this conviction that makes me, in my desire to see slavery abolished, and human happiness promoted, ardently wish to have some of our countrywomen transplanted to a region where they would both give and receive benefit, where every decent Christian Englishman, whether churchman or dissenter, learned or unlearned, liberal or bigoted, would certainly become a blessing by introducing a better system than that which has prevailed for ages. We conducted Bishop Mackenize and party up to the highlands, and after spending three or four days with them, returned, and never had any more connection with the conduct of that mission. We carried a boat past Murchison's Cataracts. By these the river descends at different leaps of great beauty, 1,200 feet in a distance of about 40 miles. Above that we have sixty miles of fine deep rivers, flowing placidly out of Lake Nyassa. As we sailed into this fine freshwater lake, we were naturally anxious to know its depth—ten, twelve, twenty, thirty fathoms—then no bottom with all our line; and John Neill, our sailor, at last pronounced it fit for the Great Eastern to sail in. We touched the bottom in a bay with a line of 100 fathoms, and a mile out could find no bottom at 116 fathoms. It contains plenty of fish, and great numbers of natives daily engage in catching them with nets, hooks, spears, torches, and poison. The water remains at 72°, and the crocodiles having plenty of fish to eat rarely attack men. It is from fifty to sixty miles broad, and we saw at least 225 miles of its length. As seen from the lake, it seems surrounded by mountains, and from these furious storms come suddenly down and raise high seas, which are dangerous for a boat, but the native canoes are formed so as to go easily along the surface. The apparent mountains on the west were ascended last year, and found to be only the edges of a great plateau, 3,000 feet above the sea. This is cool, well watered, and well peopled with the Manganja and the Maori, some of whom possess cattle; and I have no doubt but that, the first hardships over, and properly housed and fed, Europeans would enjoy life and comfort. This part of Africa has exactly the same form as Western India at Bombay, only this is a little higher and cooler. Well, having now a fair way into the highlands by means of the Zambesi and Shire, and a navigable course of river and lake, of two miles across, which all the slaves from the Red Sea and the Persian Gulf, as well as some for Cuba took, and nearly all the inhabitants of this densely-peopled country actually knowing how to cultivate cotton, it seemed likely that their strong propensity to trade might be easily turned to the advantage of our own country as well as theirs. And here I beg to remark that on my first journey, my attention not having then been turned to the subject, I noticed only a few cases of its cultivation, but on this I saw much more than I had previously any idea of. The cotton is short in the staple, strong, and like wool in the hand—as good as upland American. A second variety has been introduced, as is seen in the name, being foreign cotton, and a third of very superior quality, very long in the fibre, though usually believed to belong to South America, was found right in the middle of the continent in the country of the Makololo. A tree of it was eight inches in diameter, or like an ordinary apple-tree. And all these require planting not oftener than once in three years. There is no danger of frosts, either, to injure the crops. No sooner, however, had we begun our labors among the Manganja than the African Portuguese, by instigating the Ajawa, with arms and ammunition, to be paid for in slaves, produced the utmost confusion. Village after village was attacked and burnt; for the Manganja, armed only with bows and arrows, could not stand before firearms. The bowman's way of fighting is to be in ambush, and to shoot his arrows unawares, while those with guns, making a great noise, cause the bowmen to run away. The women and children become captives. This process of slave-hunting went on for some months, and then a panic seized the Manganja nation. All fled down to the river, only anxious to get that between them and their enemies; but they had left all their food behind them, and starvation of thousands ensued. The Shire valley, where thousands lived, at our first visit was converted literally into a valley of dry bones. One cannot now walk a mile without seeing a human skeleton; open a hut in the now deserted villages, and there lie the unburied skeletons. In some I opened, there were two skeletons; and a little one, rolled up in a mat, between them. I have always hated putting the blame of being baffled upon any one else, from a conviction that a man ought to succeed in all feasible projects, in spite of everybody; and, moreover, I wish not to be understood as casting a slur upon the Portuguese in Europe, for the Viscount Lavaidio, the Viscount de la Bandeira, and others, are as anxious to see the abolition of the slave-trade as could be desired; but the evil is done by the assertion in Europe of dominion in Africa, when it is quite well known that the Portuguese in Africa were only a few half-castes, the children of converts and black women, who have actually to pay tribute to the pure natives. Were they of the smallest benefit to Portugal? If any one ever made a fortune and went home to spend it in Lisbon; or if any pleasure whatever could be derived by the Portuguese government from spending £5000 annually on needy governors, who all connive at the slave-trade, the thing could be understood. But Portugal gains nothing but a shocking bad name, as the first that began the slave-trade, and the last to end it. To us it is a serious matter to see Lord Palmerston's policy, which has been so eminently successful on the west, so largely neutralised on the east coast. A great nation like ours cannot get rid of the obligations to other members of the great community of nations. The police of the sea must be maintained; and should we send no more cruisers to suppress the slave-trade, we would soon be obliged to send them to suppress piracy, for no traffic engenders lawlessness as does this odious trade. The plan I propose required a steamer on Lake Nyassa to take up the ivory-trade, as it is by the aid of that trade that the traffic in slaves is carried on. The Government sent out a steamer, which, though an excellent one, was too deep for the Shire. Another steamer was then built at my own expense; this was all that could be desired, made to unscrew into twenty-four pieces, and the Lady Nyassa, or Lady of the Lake, was actually unscrewed and ready for conveyance to the scene of the missionary work, but that must be done by younger men, specially educated for it—men willing to rough it, and yet hold quietly and patiently on. When I became Consul, it was with the confident hope that I should carry out this work, and I do not mean to give it up. If being baffled had ever made me lose heart, I should never have been here in the position which by your kindness I now occupy. I intend to make another attempt, but this time to the north of the Portuguese territory; and I feel greatly encouraged by the interest you show, as it cannot be for the person, but from your sympathy for the cause of human liberty; for it startles us to see a great nation of our own blood despising the African's claims to humanity, and drifting helplessly into a war about him, and then drifting quite as helplessly into abolition and slavery principles; then, leading the Africans to fight. No mighty event like this terrible war ever took place without teaching terrible lessons. One of these may be that, though "on the side of the oppressor there is power, there be higher than they." With respect to the African, neither drink, nor disease, nor slavery can root him out of the world. I never had any idea of the prodigious destruction of human life that takes place subsequently to the slave-hunting, till I saw it; and as this has gone on for centuries, it gives a wonderful idea of the vitality of the nation.

EXTRACTS FROM THE ADDRESS OF THE PRESIDENT,

SIR CHARLES LYELL, D.C.L., F.R.S.

Gentlemen of the British Association,—The place where we have been invited this year to hold our thirty-fourth meeting is one of no ordinary interest to the cultivators of physical science. It might have been selected by my fellow-laborers in geology as a central point of observation, from which, by short excursions to the east and west, they might examine those rocks which constitute, on the one side, the more modern, and on other the more ancient records of the past, while around them and at their feet lie monuments of the middle period of the earth's history. But there are other sites in England which might successfully compete with Bath as good surveying stations for the geologist. What renders Bath a peculiar point of attraction to the student of natural phenomena is its thermal and mineral waters, to the sanatory powers of which the city has owed its origin and celebrity. The great volume and high temperature of these waters render them not only unique in our island, but perhaps without a paralled in the rest of Europe, when we duly take into account their distance from the nearest region of violent earthquakes or of active or extinct volcanoes. The spot where they issue, as we learn from the researches of the historian and antiquary, was lonely and desert when the Romans first landed in this island, but in a few years it was converted into one of the chief cities of the newly conquered province. On the site of the hot-springs was a large morass from which clouds of white vapor rose into the air; and there first was the spacious bath-room built, in a highly ornamental style of architecture, and decorated with columns, pilasters, and tessellated pavements. By its side was erected a splendid temple dedicated to Minerva, of which some statues and altars with their inscriptions, and ornate pillars, are still to be seen in the Museum of this place. To these edifices the quarters of the garrison, and in the course of time the dwellings of new settlers, were added; and they were all encircled by a massive wall, the solid foundations of which still remain.

A dense mass of soil and rubbish, from 10 to 20 feet thick, now separates the level on which the present city stands from the level of the ancient Aquæ Solis of the Romans. Digging through this mass of heterogeneous materials, coins and coffins of the Saxon period have been found; and lower down, beginning at the depth of from 12 to 15 feet from the surface, coins have been disinterred of Imperial Rome, bearing dates from the reign of Claudius to that of Maximus in the fifth century. Beneath the whole are occasionally seen tessellated pavements still retaining their bright colors; one of which, on the site of the Mineral-water Hospital, is still carefully preserved, affording us an opportunity of gauging the difference of level of ancient and modern Bath.

On the slopes and summits of the picturesque hills in the neighborhood rose many a Roman villa, to trace the boundaries of which and to bring to light the treasures of art concealed in them, are tasks which have of late years amply rewarded the researches of Mr. Scarth and other learned antiquaries. No wonder that on this favored spot we should meet with so many memorials of former greatness, when we reflect on the length of time during which the imperial troops and rich colonsits of a highly civilized people sojourned here; having held undisturbed possession of the country for as many years as have elapsed from the first discovery of America to our own times.

One of our former Presidents, Dr. Daubeny, has remarked that nearly all the most celebrated hot-springs of Europe, such as those of Aix-la-Chapelle, Baden-Baden, Naples, Auvergne, and the Pyrenees, have not declined in temperature since the days of the Romans; for many of them still retain as great a heat as is tolerable to the human body, and yet when employed by the ancients they do not seem to have required to be first cooled down by artificial means. This uniformity of temperature, maintained in some places for more than 2000 years, together with the constancy in the volume of the water, which never varies with the seasons, as in ordinary springs, the identity also of the mineral ingredients which, century after century, are held by each spring in solution, are striking facts, and they tempt us irresistibly to speculate on the deep subterranean sources both of the heat and mineral matter. How long has this uniformity prevailed? Are the springs really ancient in reference to the earth's history, or, like the course of the present rivers and the actual shape of our hills and valleys, are they only of high antiquity when contrasted with the brief space of human annals? May they not be like Vesuvius and Etna, which, although they have been adding to their flanks, in the course of the last 2000 years, many a stream of lava and shower of ashes, were still mountains very much the same as they now are in height and dimensions from the earliest times to which we can trace back their existence? Yet although their foundations are tens of thousands of years old, they were laid at an era when the Mediterranean was already inhabited by the same species of marine shells as those with which it is now peopled; so that these volcanoes must be regarded as things of yesterday in the geological calendar.

Notwithstanding the general persistency in character of mineral waters and hot-springs ever since they were first known to us, we find on inquiry that some few of them, even in historical times, have been subject to great changes. These have happened during earthquakes which have been violent enough to disturb the subterranean drainage and alter the shape of the fissures up which the waters ascend. Thus during the great earthquake at Lisbon in 1755, the temperature of the spring called La Source de la Reine at Bagnères de Luchon, in the Pyrenees, was suddenly raised as much as 75° F., or changed from a cold spring to one of 122° F., a heat which it has since retained. It is also recorded that the hot-springs at Bagnères de Bigorre, in the same mountain-chain, became suddenly cold during a great earthquake which, in 1660, threw down several houses in that town.

It has been ascertained that the hot-springs of the Pyrenees, the Alps, and many other regions are situated in lines along which the rocks have been rent, and usually where they have been displaced or "faulted." Similar dislocations in the solid crust of the earth are generally supposed to have determined the spots where active and extinct volcanoes have burst forth ; for several of these often affect a linear arrangement, their position seeming to have been determined by great lines of fissure. Another connecting link between the volcano and the hot-spring is recognizable in the great abundance of hot-springs in regions where volcanic eruptions still occur from time to time. It is also in the same districts that the waters occasionally attain the boiling-temperature, while some of the associated stufas emit steam considerably above the boiling-point. But in proportion as we recede from the great centres of igneous activity, we find the thermal waters decreasing in frequency and in their average heat, while at the same time they are most conspicuous in those territories where, as in Central France or the Eifel in Germany, there are cones and craters still so perfect in their form, and streams of lava bearing such a relation to the depth and shape of the existing valleys, as to indicate that the internal fires have become dormant in comparatively recent t mes. If there be exceptions to this rule, it is where hot-springs are met with in parts of the Alps and Pyrenees which have been violently convulsed by modern earthquakes.

To pursue still further our comparison between the hot-spring and the volcano, we may regard the water of the spring as representing those vast clouds of aqueous vapor which are copiously evolved for days, sometimes for weeks, in succession from craters during an eruption. But we shall perhaps be asked whether, when we contrast the work done by the two agents in question, there is not a marked failure of analogy in one respect—namely a want, in the case of the hot-spring, of power to raise from great depths in the earth voluminous masses of solid matter corresponding to the heaps of scoriæ and streams of lava which the volcano pours out on the surface. To one who urges such an objection it may be said that the quantity of solid as well as gaseous matter transferred by springs from the interior of the earth to its surface is far more considerable than is commonly imagined. The thermal waters of Bath are far from being conspicuous among European hot-springs for the quantity of mineral matter contained in them in proportion to the water which acts as a solvent; yet Professor Ramsay has calculated that if the sulphates of lime and of soda, and the chlorides of sodium and magnesium, and the other mineral ingredients which they contain, were solidified, they would form in one year a square column nine feet in diameter, and no less than 140 feet in height. All this matter is now quietly conveyed by a stream of limpid water, in an invisible form, to the Avon, and by the Avon to the sea; but if, instead of being thus removed, it were deposited around the orifice of eruption, like the siliceous layers which encrust the circular basin of an Icelandic geyser, we should soon see a considerable cone built up, with a crater in the middle; and if the action of the spring were intermittent, so that ten or twenty years should elapse between the periods when solid matter was emitted, or (say) an interval of three centuries, as in the case of Vesuvius between 1306 and 1631, the discharge would be on so grand a scale as to afford no mean object of comparison with the intermittent outpourings of a volcano.

Dr. Daubeny, after devoting a month to the analysis of the Bath waters in1833, ascertained that the daily evolution of nitrogen gas amounted to no less than 250 cubic feet in volume. This gas, he remarks, is not only characteristic of hot-springs, but is largely disengaged from volcanic craters during eruptions. In both cases he suggests that the nitrogen may be derived from atmospheric air, which is always dissolved in rain-water, and which, when this water penetrates the earth's crust, must be carried down to great depths, so as to reach the heated interior. When there, it may be subjected to deoxidating processes, so that the nitrogen, being left in a free state, may be driven upwards by the expansive force of heat and steam, or by hydrostatic pressure. This theory has been very generally adopted, as best accounting for the constant disengagement of large bodies of nitrogen, even where the rocks through which the spring rises are crystalline and unfossiliferous. It will, however, of course be admitted, as Professor Bischoff has pointed out, that in some places organic matter has supplied a large part of the nitrogen evolved.

Carbonic-acid gas is another of the volatilized substances discharged by the Bath waters. Dr. Gustav Bischoff, in the new edition of his valuable work on chemical and physical geology, when speaking of the exhalations of this gas, remarks that they are of universal occurrence, and that they orginate at great depths, becoming more abundant the deeper we penetrate. He also observes that, when the silicates which enter so largely into the composition of the oldest rocks are percolated by this gas, they must be continually decomposed, and the carbonates formed by the new combinations thence arising must often augment the volume of the altered rocks. This increase of bulk, he says, must sometimes give rise to mechanical force of expansion capable of uplifting the incumbent crust of the earth; and the same force may act laterally so as to compress, dislocate, and tilt the strata on each side of a mass in which the new chemical changes are developed. The calculations made by this eminent German chemist of the exact amount of distention which the origin of new mineral products may cause, by adding to the volume of the rocks, deserve the attention of geologists, as affording them aid in explaining those reiterated oscillations of level—those risings and sinkings of land—which have occurred on so grand a scale at successive periods of the past. There are probably many distinct causes of such upward, downward, and lateral movements, and any new suggestion on this head is most welcome; but I believe the expansion and contraction of solid rocks, when they are alternately heated and cooled, and the fusion and subsequent consolidation of mineral masses, will continue to rank, as heretofore, as the most influential causes of such movements.

The temperature of the Bath waters varies in the different springs from 117° to 120° F. This, as before stated, is exceptionally high, when we duly allow for the great distance of Bath from the nearest region of active or recently extinct volcanoes and of violent earthquakes. The hot-springs of Aix-la-Chapelle have a much higher temperature, viz. 135° F., but they are situated within forty miles of those cones and lava-streams of the Eifel which, though they may have spent their force ages before the earliest records of history, belong, nevertheless, to the most modern geological period. Bath is about 400 miles distant from the same part of Germany, and 440 from Auvergne—another volcanic region, the latest eruptions of which were geologically coëval with those of the Eifel. When these two regions in France and Germany were the theatres of frequent convulsions, we may well suppose that England was often more rudely shaken than now; and such shocks as that of October last, the sound and rocking motion of which caused so great a sensation as it traversed the southern part of the island, and seems to have been particularly violent in Herefordshire, may be only a languid reminder to us of a force of which the energy has been gradually dying out.

But there are other characters in the structure of the earth's crust more mysterious in their nature than the phenomena of metalliferous veins, on which the study of hot-springs has thrown light—I allude to the metamorphism of sedimentary rocks. Strata of various ages, many of them once full of organic remains, have been rendered partially or wholly crystalline. It is admitted on all hands that heat has been instrumental in bringing about this re-arrangement of particles, which, when the metamorphism has been carried out to its fullest extent, obliterates all trace of the imbedded fossils. But as mountain-masses many miles in length and breadth, and several thousands of feet in height, have undergone such alteration, it has always been difficult to explain in what manner an amount of heat capable of so entirely changing the molecular condition of sedimentary masses could have come into play without utterly annihilating every sign of stratification, as well as of organic structure.

Various experiments have led to the conclusion that the minerals which enter most largely into the composition of the metamorphic rocks have not been formed by crystallizing from a state of fusion, or in the dry way, but that they have been derived from liquid solutions, or in the wet way—a process requiring a far less intense degree of heat. Thermal springs, charged with carbonic acid and with hydro-fluoric acid (which last is often present in small quantities), are powerful causes of decomposition and chemical reaction in rocks through which they percolate. If, therefore, large bodies of hot water permeate mountain-masses at great depths, they may in the course of ages superinduce in them a crystalline structure; and in some cases strata in a lower position and of older date may be comparatively unaltered, retaining their fossil remains undefaced, while newer rocks are rendered metamorphic. This may happen where the waters, after passing upwards for thousands of feet, meet with some obstruction, as in the case of the Wheal-Clifford spring, causing the same to be laterally diverted so as to percolate the surrounding rocks. The efficacy of such hydro-thermal action has been admirably illustrated of late years by the experiments and observations of Sénarmont, Daubrée, Delesse, Scheerer, Sorby, Sterry Hunt, and others.

The changes which Daubrée has shown to have been produced by the alkaline waters of Plombières, in the Vosges, are more especially instructive. These thermal waters have a temperature of 160° F., and were conveyed by the Romans to baths through long conduits or aqueducts. The foundations of some of their works consisted of a bed of concrete made of lime, fragments of brick, and sandstone. Through this and other masonry the hot waters have been percolating for centuries, and have given rise to various zeolites—apophyllite and chabazite among others; also to calcareous spar, arragonite, and fluor spar, together with siliceous minerals, such as opal,—all found in the interspaces of the bricks and mortar, or constituting part of their rearranged materials. The quantity of heat brought into action in this instance in the course of 2000 years has, no doubt, been enormous, although the intensity of it developed at any one moment has been always inconsiderable.

The study, of late years, of the constituent parts of granite has in like manner led to the conclusion that their consolidation has taken place at temperatures far below those formerly supposed to be indispensable. Gustav Rose has pointed out that the quartz of granite has the specific gravity of 2·6, which characterizes silica when it is precipitated from a liquid solvent, and not that inferior density, namely 2·3, which belongs to it when it cools and solidifies in the dry way from a state of fusion.

But some geologists, when made aware of the intervention on a large scale, of water, in the formation of the component minerals of the granitic and volcanic rocks, appear of late years to have been too much disposed to dispense with intense heat when accounting for the formation of the crystalline and unstratified rocks. As water in a state of solid combination enters largely into the aluminous and some other minerals, and therefore plays no small part in the composition of the earth's crust, it follows that, when rocks are melted, water must be present, independently of the supplies of rain-water and sea-water which find their way into the regions of subterranean heat. But the existence of water under great pressure affords no argument against our attributing an excessively high temperature to the mass with which it is mixed up. Still less does the point to which the melted matter must be cooled down before it consolidates or crystallizes into lava or granite afford any test of the degree of heat which the same matter must have acquired when it was melted and made to form lakes and seas in the interior of the earth's crust.

The evidence of a period of great cold in England and North America, in the times referred to, is now so universally admitted by geologists, that I shall take it for granted in this Address, and briefly consider what may have been the probable causes of the refrigeration of central Europe at the era in question. One of these causes, first suggested eleven years ago by a celebrated Swiss geologist, has not, I think, received the attention which it well deserved. When I proposed, in 1833, the theory that alterations in physical geography might have given rise to those revolutions in climate which the earth's surface has experienced at successive epochs, it was objected by many that the signs of upheaval and depression were too local to account for such general changes of temperature. This objection was thought to be of peculiar weight when applied to the glacial period, because of the shortness of the time, geologically speaking, which has since transpired. But the more we examine the monuments of the ages which preceded the historical, the more decided become the proofs of a general alteration in the position, height, and depth of seas, continents, and mountain-chains since the commencement of the glacial period. The meteorologist also has been learning of late years that the quantity of ice and snow in certain latitudes depends not merely on the height of mountain-chains, but also in the distribution of the surrounding sea and land even to considerable distances.

M. Escher von der Linth gave it as his opinion in 1852, that if it were true, as Ritter had suggested, that the great African desert, or Sahara, was submerged within the modern or post-tertiary period, the same submergence might explain why the Alpine glaciers had attained so recently those colossal dimensions which, reasoning on geological data, Venetz and Charpentier had assigned to them. Since Escher first threw out this hint, the fact that the Sahara was really covered by the sea at no distant period has been confirmed by many new proofs. The distinguished Swiss geologist himself has just returned from an exploring expedition through the eastern part of the Algerian desert, in which he was accompanied by M. Desor, of Neuchatel, and Professor Martins, of Montpellier. These three experienced observers satisfied themselves, during the last winter, that the Sahara was under water during the period of the living species of Testacea. We had already learnt in 1856, from a memoir by M. Charles Laurent, that sands identical with those on the nearest shores of the Mediterranean, and containing, among other recent shells, the common cockle (*Cardium edule*), extend over a vast space from west to east in the desert, being not only found on the surface, but also brought up from depths of more than 20 feet by the Artesian auger. These shells have been met with at heights of more than 900 feet above the sea-level, and on ground sunk 300 feet below it; for there are in Africa, as in Western Asia, depressions of land below the level o the sea. The same cockle has been observed still living in several salt-lakes in the Sahara: and superficial incrustations in many places seem to point to the drying up by evaporation of several inland seas in certain districts.

Mr. Tristram, in his travels in 1859, traced for many miles along the southern borders of the French possessions in Africa lines of inland sea-cliffs, with caves at their bases, and old sea-beaches forming successive terraces, in which recent shells and the casts of them were agglutinated together with sand and pebbles, the whole having the form of a conglomerate The ancient sea appears once to have stretched from the Gulf of Cabes, in Tunis, to the west coast of Africa north of Senegambia, having a width of several hundred (perhaps where greatest, according to Mr. Tristram, 800) miles. The high lands of Barbary, including Morocco, Algeria, and Tunis, must have been separated at this period from the rest of Africa by a sea. All that we have learnt from zoologists and botanists in regard to the present fauna and flora of Barbary favors this hypothesis, and seems at the same time to point to a former connexion of that country with Spain, Sicily, and South Italy.

When speculating on these changes, we may call to mind that certain deposits, full of marine shells of living species, have long been known as fringing the borders of the Red Sea, and rising several hundred feet above its shores. Evidence has also been obtained that Egypt, placed between the Red Sea and the Sahara, participated in these great continental movements. This may be inferred from the old river-terraces, lately described by Messrs. Aaams and Murie, which skirt the modern alluvial plains of the Nile, and rise above them to various heights, from 30 to 100 feet and upwards. In whatever direction, therefore, we look, we see grounds for assuming that a map of Africa in that glacial period would no more resemble our present maps of that continent than Europe now resembles North America. If, then, argues Escher, the Sahara was a sea in post-tertiary times, we may understand why the Alpine glaciers formerly attained such gigantic dimensions, and why they have left moraines of such magnitude on the plains of northern Italy and the lower country of Switzerland. The Swiss peasants have a saying, when they talk of the melting of the snow, that the sun could do nothing without the Föhn, a name which they give to the well-known sirocco. This wind, after sweeping over a wide expanse of parched and burning sand in Africa, blows occasionally for days in succession across the Mediterranean, carrying with it the scorching heat of the Sahara to melt the snows of the Appennines and Alps.

M. Denzler, in a memoir on this subject, observes that the Föhn blew tempestuously at Algiers on the 17th July 1841, and then, crossing the Mediterranean, reached Marseilles in six hours. In five more hours it was at Geneva and the Valais, throwing down a large extent of forest in the latter district, while in the cantons of Zurich and the Grisons it suddenly turned the leaves of many trees from green to yellow. In a few hours new mown grass was dried and ready for the haystack; for although, passing over the Alpine snows, the sirocco absorbs much moisture, it is still far below the point of saturation when it reaches the sub-Alpine country to the north of the great chain. MM. Escher and Denzler have both of them observed on different occasions that a thickness of one foot of snow has disappeared in four hours during the prevalence of this wind. No wonder, therefore, that the Föhn is so much dreaded for the sudden inundations which it sometimes causes. The snow-line of the Alps was seen by Mr. Irscher, the astronomer, from his observatory at Neuchatel, by aid of the telescope, to rise sensibly every day while this wind was blowing. Its influence is by no means confined to the summer season, for in the winter of 1852 it visited Zurich at Christmas, and in a few days all the surrounding country was stripped of its snow, even in the shadiest places and on the crests of high ridges. I feel the better able to appreciate the power of this wind from having myself witnessed in Sicily, in 1828, its effect in dissolving, in the month of November, the snows which then covered the summit and higher parts of Mount Etna. I had been told that I should be unable to ascend to the top of the highest cone till the following spring; but in thirty-six hours the hot breath of the sirocco stripped off from the mountain its white mantle of snow and I ascended without difficulty.

It is well known that the number of days during which particular winds prevail, from year to year, varies considerably. Between the years 1812 and 1820 the Föhn was less felt in Switzerland than usual; and what was the consequence? All the glaciers, during those eight or nine years, increased in height, and crept down below their former limits in their respective valleys. Many similar examples might be cited of the sensitiveness of the ice to slight variations of temperature. Captain Godwin-Austen has lately given us a description of the gigantic glaciers of the western Himalaya in those valleys where the sources of the Indus rise, between the latitudes 35° and 36° N. The highest peaks of the Karakorum range attain in that region an elevation of 28,000 feet above the sea. The glaciers, says Captain Austen, have been advancing, within the memory of the living inhabitants, so as greatly to encroach on the cultivated lands, and have so altered the climate of adjoining valleys immediately below, that only one crop a year can now be reaped from fields which formerly yielded two crops. If such changes can be experienced in less than a century, without any perceptible modification in the physical geography of that part of Asia, what mighty effects may we not imagine the submergence of the Sahara to have produced in adding to the size of the Alpine glaciers? If, between the years 1812 and 1820, a mere diminution of the number of days during which the sirocco blew could so much promote the growth and onward movement of the ice, how much greater a change would result from the total cessation of the same wind! But this would give no idea of what must have happened in the glacial period; for we cannot suppose the action of the south wind to have been suspended; it was not in abeyance, but its character was entirely different, and of an opposite nature, under the altered geographical conditions above contemplated. First, instead of passing over a parched and scorching desert, between the twentieth and thirty-fifth parallels of latitude, it would plentifully absorb moisture from a sea many hundreds of miles wide. Next, in its course over the Mediterranean, it would take up still more aqueous vapor; and when, after complete saturation, it struck the Alps, it would be driven up into the higher and more rarified regions of the atmosphere. There the aërial current, as fast as it was cooled, would discharge its aqueous burden in the form of snow, so that the same wind which is now called "the devourer of ice" would become its principal feeder.

If we thus embrace Escher's theory, as accounting in no small degree for the vast size of the extinct glaciers of Switzerland and Northern Italy, we are by no means debarred from accepting at the same time Charpentier's suggestion, that the Alps in the glacial period were 2000 or 3000 feet higher than they are now. Such a difference in altitude may have been an auxiliary cause of the extreme cold, and seems the more probable now that we have obtained unequivocal proofs of such great oscillations of level in Wales within the period under consideration. We may also avail ourselves of another source of refrigeration which may have coincided in time with the submergence of the Sahara, namely, the diversion of the Gulf-stream from its present course. The shape of Europe and North America, or the boundaries of sea and land, departed so widely in the glacial period from those now established, that we cannot suppose the Gulf-stream to have taken at that period its present north-western course across the Atlantic. If it took some other direction, the climate of the north of Scotland would, according to the calculations of Mr. Hopkins, suffer a diminution in its average annual temperature of 12° F., while that of the Alps would lose 2° F. A combination of all the conditions above enumerated would certainly be attended with so great a revolution in climate as might go far to account for the excessive cold which was developed at so modern a period in the earth's history. But even when we assume all three of them to have been simultaneous in action, we have by no means exhausted all the resources which a difference in the geographical condition of the globe might supply. Thus, for example, to name only one of them, we might suppose that the height and quantity of land near the north pole was greater at the era in question than it is now.

The vast mechanical force that ice exerted in the glacial period has been thought by some to demonstrate a want of uniformity in the amount of energy which the same natural cause may put forth at two successive epochs. But we must be careful, when thus reasoning, to bear in mind that the power of ice is here substituted for that of running water. The one becomes a mighty agent in transporting huge erratics, and in scoring, abrading, and polishing rocks; but meanwhile the other is in abeyance. When, for example, the ancient Rhone glacier conveyed its moraines from the upper to the lower end of the Lake of Geneva, there was no great river, as there now is, forming a delta many miles in extent, and several hundred feet in depth, at the upper end of the lake.

The more we study and comprehend the geographical changes of the glacial period, and the migrations of animals and plants to which it gave rise, the higher our conceptions are raised of the duration of that subdivision of time, which, though vast when measured by the succession of events comprised in it, was brief, if estimated by the ordinary rules of geological classification. The glacial period was, in fact, a mere episode in one of the great epochs of the earth's history; for the inhabitants of the lands and seas, before and after the grand development of snow and ice, were nearly the same. As yet we have no satisfactory proof that man existed in Europe or elsewhere during the period of extreme cold; but our investigations on this head are still in their infancy.

In an early portion of the postglacial period it has been ascertained that man flourished in Europe; and in tracing the signs of his existence, from the historical ages to those immediately antecedent, and so backward into more ancient times, we gradually approach a dissimilar geographical state of things, when the climate was colder, and when the configuration of the surface departed considerably from that which now prevails.

I will now briefly allude, in conclusion, to two points on which a gradual change of opinion has been taking place among geologists of late years. First, as to whether there has been a continuous succession of events in the organic and inorganic worlds, uninterrupted by violent and general catastrophes; and secondly, whether clear evidence can be obtained of a period antecedent to the creation of organic beings on the earth. I am old enough to remember when geologists dogmatized on both these questions in a manner very different from that in which they would now venture to indulge. I believe that by far the greater number now incline to opposite views from those which were once most commonly entertained. On the first point it is worthy of remark, that, although a belief in sudden and general convulsions has been losing ground, as also the doctrine of abrupt transitions from one set of species of animals and plants to another of a very different type, yet the whole series of the records which have been handed down to us are now more than ever regarded as fragmentary. They ought to be looked upon as more perfect, because numerous gaps have been filled up; and in the formations newly intercalated in the series we have found many missing links and various intermediate gradations between the nearest allied forms previously known in the animal and vegetable worlds. Yet the whole body of monuments which we are endeavoring to decipher appears more defective than before. For my own part, I agree with Mr. Darwin in considering them as a mere fraction of those which have once existed, while no approach to a perfect series was ever formed originally, it having never been part of the plan of Nature to leave a complete record of all her works and operations for the enlightenment of rational beings who might study them in after-ages.

In reference to the other great question, or the earliest date of vital phenomena on this planet, the late discoveries in Canada have at least demonstrated that certain theories founded in Europe on mere negative evidence were altogether delusive. In the course of a geological survey, carried on under the able direction of Sir William E. Logan, it has been shown that northward of the river St. Lawrence there is a vast series of stratified and crystalline rocks of gneiss, mica-schist, quartzite, and limestone, about 40,000 feet in thickness, which have been called Laurentian.

They are more ancient than the oldest fossiliferous strata of Europe, or those to which the term primordial had been rashly assigned. In the first place, the newest part of this great crystalline series is unconformable to the ancient fossiliferous or so-called primordial rocks which overlie it; so that it must have undergone disturbing movements before the latter or primordial set were formed. Then again, the older half of the Laurentian series is unconformable to the newer portion of the same. It is in this lowest and most ancient system of crystalline strata that a limestone, about a thousand feet thick, has been observed, containing organic remains. These fossils have been examined by Dr. Dawson, of Montreal, and he has detected in them, by aid of the microscope, the distinct structure of a large species of Rhizopod. Fine specimens of this fossil, called *Eozoon Canadense*, have been brought to Bath by Sir William E. Logan, to be exhibited to the members of the Association. We have every reason to suppose that the rocks in which these animal remains are included are of as old a date as any of the formations named azoic in Europe, if not older, so that they preceded in date rocks once supposed to have been formed before any organic beings had been created.

But I will not venture on speculations respecting "the signs of a beginning," or "the prospects of an end," of our terrestrial system—that wide ocean of scientific conjecture on which so many theorists before my time have suffered shipwreck. Without trespassing longer on your time, I will conclude by expressing to you my thanks for the honor you have done me in asking me to preside over this meeting. I have every reason to hope, from the many members and distinguished strangers whom I already see assembled here, that it will not be inferior in interest to any of the gatherings which have preceded it.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ *N. Longitude, 4h. 54m. 11s. W. of Greenwich. Height above level of the Sea* 182 *feet. For the month of September*, 1864.

BY CHARLES SMALLWOOD, M.D., LL.D., D.C.L.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F. Highest	Lowest.	Mean.	Reading of Thermometer. Max.	Min.	Mean	Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Inches.	Inches.	Inches												
1	29.919	29.897	29.906	88.1	53.0	72.3	.628	.775	w bys	114.80	3.3	....	....	1.0	
2	.878	.819	.841	76.0	53 1	66.1	.522	.792	N E	99.30	9.6	....	....	1 3	
3	.759	.724	.741	64.2	51.0	59.1	.481	.889	N E	60.09	10.0	0.089	....	2.6	Rain.
4	.742	.721	.727	59.1	54.2	51.1	.422	.891	N E	139.29	10.0	0.942	....	2.6	Rain.
5	.906	.867	.889	66.2	48.2	58.0	.455	.907	N E	100.29	5.3	....	....	2.3	Au. Bor.
6	30.069	.990	30.019	88.0	48.0	67.9	.575	.793	N N E	77.59	0·0	....	....	1.3	
7	.195	30.191	.193	75.7	47.0	58.6	.467	.861	W N W	14.79	0.0	....	....	1.3	
8	29.964	29.959	29.961	72 1	48.2	61.1	.475	.842	N E	54 34	6.6	...	....	1.0	
9	.764	.624	.689	69.1	48.3	62.2	.417	.863	S W	90440	8.0	0.031	....	2 0	Rain.
10	.634	.553	.596	61.2	48.1	58 4	.428	.874	N W	138.74	5.3	....	....	2.0	
11	.673	.641	.654	65.9	54.2	60.1	.457	.878	N E	90.30	9.6	....	....	2.0	
12	.757	.616	.705	55.2	49.4	50.8	.352	.935	N E	90.07	10 0	0.084	....	3.0	Rain.
13	.679	.617	.657	54 7	48.0	52.8	.375	.9:3	N E	152.20	10.0	0.171	....	3.0	Rain.
14	.611	.576	.597	60 9	46.8	55.9	.407	.913	N E	227.14	10.0	0 171	....	2.3	Rain.
15	.500	.421	.454	58.1	54.2	55.1	.445	.954	W S W	33.50	10.0	0.100	....	2.3	Rain.
16	.574	.472	.519	54.2	47.9	52.1	.360	.893	W S W	188.75	8.0	0.362	....	1.6	Rain.
17	.860	.779	.814	72.2	43 3	58.8	.480	.909	W N W	103.25	1 3	0.084	....	2.0	Rain—A.Bor.
18	.869	.509	.727	74.6	57.1	64.4	.568	.917	W	203.00	8.0	....	....	2.3	Lightning.
19	.700	.473	.629	60.1	44.7	58.1	.448	.898	S W	120.70	10.0	0.162	....	2.6	Rain.
20	.807	.716	.772	70.9	43 2	58.4	.383	.872	W S W	135.80	8.0	Inapp	....	2.0	Rain.
21	.807	.749	.785	64.7	48.7	58 2	423	851	W S W	79.40	8.0	Inapp	....	1.6	Rain.
22	30.011	.873	.922	60.2	33 7	50.1	.323	.850	N E	82.68	5 8	Inapp	....	1 3	Rain.
23	29.730	.566	.646	81 0	64.1	65.6	.575	.886	N by W	100.26	7 6	....	....	1.0	
24	.521	.507	.515	69 4	63 4	64.2	.544	.883	S W	142 49	7.6	Inapp	....	2.0	Rain.
25	.774	.510	.625	55.9	46.1	51.3	.327	.846	N E	76.15	6.6	0.261	....	2.0	Rain.
26	.824	.800	.811	69.4	32.9	50.7	.354	.863	N W	124.40	1.3	....	....	1.8	
27	.604	.583	.595	76.4	37.4	64.6	.754	.884	W	271.95	6.0	0.140	....	8.0	Rain.
28	30.061	.009	.833	76.9	48.4	65.5	.541	.873	W	191.49	4.6	0.064	....	1.3	
29	.066	.590	.842	62.3	40.9	55.5	.392	.846	W	103.56	9.6	Inapp	....	2.0	Rain.
30	.100	.804	.968	61.1	43.0	51.6	.343	.868	W	224.60	8.8	0.872	....	3.8	Rain.

Remarks for the Month.

Barometer .. { Highest, the 7th day, 30.195 inches. Lowest, the 15th day, 29.421 " Monthly Mean, 29.753 " Monthly Range, 0.774 " }

Thermometer { Highest, the 6th day 88°0. Lowest, the 26th day, 32°9. Monthly Mean, 58.91. Monthly Range, 55°1. }

Greatest intensity of the Sun's rays, 111° 9.
Lowest point of Terrestrial radiation, 31° 7.
Mean of Humidity, .870.
Rain fell on 19 days, amounting to 3.482 inches, it was accompanied by Thunder on 1 day.
Most prevalent wind, N. E.
Least prevalent wind, N. N. E.
Most windy day the 27th day, mean miles per hour, 10.54.
Least windy day, the 15th day, mean miles per hour, 1.39.
Amount of Evaporation 1.17 inches.
Aurora Borealis visible on 2 nights.

THE

CANADIAN NATURALIST.

SECOND SERIES.

OBSERVATIONS ON CANADIAN GEOGRAPHICAL BOTANY.

By A. T. Drummond, B.A., LL.B.

The more observable features in the distribution of our native plants can now, I think, be indicated with some degree of accuracy by the aid of the catalogues, published and unpublished, of various collectors in different parts of the province. The range of many species is of course not yet satisfactorily ascertained, and doubtless in coming years there may be some plants at present thought to be restricted to particular localities, which will be found to have a somewhat wider distribution. I feel certain, too, that a careful search along our boundary-lines will be rewarded by the discovery of many species as yet unknown to Canadian collectors, which will thus increase the floras peculiar to different districts. Many details, therefore, require to be yet worked out, before results entirely satisfactory can be arrived at.

Geographically, Canada extends over an area of about twenty-eight degrees of longitude and ten and three quarters degrees of latitude; stretching from East Cape, Anticosti, to the River Kaminastiquia, which flows into Lake Superior; and from Point Pelée, which juts into Lake Erie, to latitude 52° 45′, the northern limit. This area, whilst extensive, has some peculiar physical features, which have a most important bearing upon the distribution of the plants composing its flora. The southern and western limits are bounded, for the greater part of the distance, by the river St. Lawrence and a chain of extensive sheets of water, which stretch through several degrees of latitude, locating our province in the same parallels with Maine, Vermont, New Hampshire, and nearly the whole of New York and Massachusetts on the east, and with Michigan on the west. Our north-eastern border, moreover, adjoins Labrador, and extends far into the Hudson's Bay Territory. We therefore meet in the western part of the province many plants having decidedly a southern character, and some of a peculiarly western type; while on Anticosti and the neighboring shores are found alpine species till recently unobserved south of the Labrador coast.

While the remarkable natural extension of our boundaries has the effect of including within our limits many interesting plants, other causes have also exerted their influence. Apart from the characters of soils, as their looseness and temperature, there is one cause—the chain of great lakes—which must exert a very considerable influence upon the vegetation of Canada. These bodies of water, on account of their great extent and depth, have an equalizing effect upon the temperature of the air near their shores, the water not being subject to those sudden extremes of heat and cold which we observe in the atmosphere. The great amount of evaporation, constantly taking place over the broad surface of each lake, also tends to make the neighboring air more moist than in inland localities. A similar effect being produced upon the sea-coast, instances of alpine and sub-alpine plants occurring far down on the coast-line are not rare.

In taking a general view of the distribution of the various species of plants which occur in Canada,—excluding mosses, lichens, and lower forms,—I think that the following types will be readily recognized:

I. Canadian Type.—Species generally distributed through the whole or greater part of the province.

II. Erie Type.—Species chiefly restricted to the district bordering Lake Erie.

Note.—In addition to published catalogues of plants, I have to acknowledge having received much valuable information from lists made at the following places:—Newfoundland, J. Richardson of Geol. Survey, coll. in herb. Bot. Soc. Can.; Gaspé, J. Bell, B.A.; Quebec, J. Richardson, coll. in herb. Bot. Soc. Can.; L'Orignal, J. Bell, B.A.; Carleton Place, J. Bell, B. A.; Ramsay, Rev. J. K. McMorine, M.A.; Brockville, R. Jardine, B.A.; Belleville, J. Macoun. My own collections have been chiefly made at Montreal, among the Thousand Islands, at Kingston, Stone Mills, Cobourg, Collingwood, Niagara Falls, London, and Port Stanley.—A.T.D.

III. Superior Type.—Species only found about Lakes Huron and Superior, and most of which have evidently migrated from the country watered by the Saskatchewan.

IV. Maritime Type.—Species confined to the sea-shore.

V. Alpine Type.—Species chiefly known, at present, to occur about our north-eastern borders.

I. Canadian Type.

The flora of Canada (as do the floras of all other countries) includes a very large number of species which are widely spread over the whole province. They are found thriving upon the shores of Lakes Superior, Huron, and Erie, and range thence to the mouth of the St. Lawrence, and many even beyond into Newfoundland. A considerable number appear to have their centre of range within the province or near its north-western border. They are distributed over the more northern portions of the United States, and, overspreading Canada, find their limit in the Hudson's Bay Territory; but the maxima of the individuals of each species appear rather to be in Canada than in the wide districts on either side. Other Canadian species, again, extend not only throughout the northern United States, but even as far south as the Gulf of Mexico. Very many, too, are common to Europe and America, whilst a number are widely diffused over the temperate regions of both hemispheres. And did I include the lower cryptogamic plants, numerous instances might be noted of species which are almost, if not quite, cosmopolites.

As yet the north-eastern and north-western limits of some of our most common plants have not been ascertained as definitely as could be desired. Some species met with in almost every other part of the province do not appear—judging by lists to which I have had access—to range down the St. Lawrence banks beyond Quebec; and quite a number, as *Tilia Americana*, *Hepatica acutilobia*, and *Hepatica triloba*, abundant in Central and Western Canada, are entirely wanting in the Lake Superior lists and in the lists from the maritime counties. More northern limits than hitherto observed may yet be ascertained for many of them. Distributed, however, as they are, over the greater portion of the province, they may be classed under the general Canadian flora.

It is not difficult to trace somewhat approximately the northern limit of distribution of some of the more conspicuous plants. Surveyors and others readily recognize our forest trees, and with the identity of some of these trees there can be no possibility of error. I shall only here instance the basswood (*Tilia Americana*), and the red oak (*Quercus rubra*),—trees not easily mistaken. Entering Canada from Maine, the basswood is observed in the counties of Arthabaska, Wolfe, and Nicolet, thence it ranges along the St. Lawrence to the river Ottawa, and far up that stream, through Argenteuil and Ottawa, to the Island of Alumette. Crossing the country, it is met with in the townships of Richards, Brunel, and Stephenson, and finally appears to take its leave of Canada at Sturgeon Bay on Lake Huron. It re-appears on the south shore of Lake Superior, and at Rainy Lake on the British side, whence it extends to the Red River, and northward to latitude 52°. A most remarkable locality is Lake St. John near its outlet into the Saugenay, recorded by Professor Bell in the Geological Súrvey Report for 1857. The red oak, again, ranges from the neighborhood of Quebec, where the variety *Q. rubra* var. *borealis* is said by Cooper (Smithsonian Reports) to attain its north-eastern limit, up to Montreal, and thence skirting the Ottawa, apparently sparingly, it extends westward to Lake Huron; on the north shore of which, and on the Manitoulin Islands, where it is said to attain considerable size, it is frequently observed. On the eastern shores of Lake Superior, too, red oaks are met with; but, according to Agassiz, Michipicoten Island forms in Canada the north-western limit of distribution.

The following species may be instanced as some which have a wide range over the province:

Anemone Pennsylvanica.
Thalictrum cornuti.
Ranunculus repens.
Caltha palustris.
Nuphar advena.
Nasturtium palustre.
Drosera rotundifolia.
Stellaria longifolia.
Impatiens fulva.
Rhus Toxicodendron.
Acer saccharinum.
A. spicatum.
Lathyrus palustris.
Prunus Virginiana.
P. Pennsylvanica.
Geum strictum.
Rubus strigosus.
Solidago bicolor.
S. Canadensis.
Antennaria margaritacea.
Vaccinium Pennsylvanicum.
Chiogenes hispidula.
Veronica Americana.
Lycopus Virginicus.
Menyanthes trifoliata.
Ulmus Americana.
Corylus rostrata.
Betula papyracea.
Populus tremuloides.
Platanthera psycodes.
P. dilatata.
Smilacina racemosa.
Streptopus roseus.
Scirpus Eriophorum.

Rubus triflorus.
Epilobium angustifolium.
Ribes lacustre.
Mitella nuda.
Sanicula Marylandica.
Linnæa borealis.
Lonicera ciliata.
Aster punfceus.
Eupatorium purpureum.
Carex aurea.
Avena striata.
Equisetum sylvaticum.
E. arvense.
Polypodium vulgare.
Struthiopteris Germanica.
Asplenium filix-fœmina.
Lycopodium complanatum.
L. dendroideum.

Among the larger orders, Rosaceæ and Ericaceæ afford, in proportion to the species represented in Canada, the greatest number of species of very extensive distribution. Coniferæ and Betulaceæ, among the smaller orders, have a large proportion of a wide range. Among the Coniferæ, in fact, only *Abies Fraseri*, *Pinus rigida*, *P. Banksiana*, and *P. mitis* appear to be sparingly diffused.

II. Erie Type.

The forests of that part of the deep peninsula of Upper Canada which borders Lake Erie, are characterised by an abundance of beech (*Fagus ferruginea*), sugar-maple (*Acer saccharinum*), oak (*Quercus rubra*, *Q. macrocarpa*, and *Q. alba*), and walnut (*Juglans nigra*). Clumps of white pine (*Pinus strobus*) are sometimes seen; but I have not yet observed the red pine (*Pinus resinosa*), so common in some parts of Canada. The flats on either side of the Thames, in the neighborhood of London, are remarkable for a splendid growth of the buttonwood (*Platanus occidentalis*), which in this locality is rarely seen elsewhere. Nearer the mouth of the river, where the country is very level, this tree attains an enormous size. The chestnut (*Castanea vesca*), though not abundant, is yet characteristic of these western forests. Neither the chestnut nor buttonwood appear to extend farther north than the counties of Middlesex and Halton. The tulip-tree (*Liriodendron tulipifera*) rarely occurs in the central part of the district around London and St. Thomas, but is a familiar tree at Chatham, and is occasionally met with in the Niagara district as far west as Hamilton.

The flora of the Lake Erie district resembles very much that of the western part of the State of New York; and this resemblance will become closer the more the district is explored. *Magnolia acuminata* and *Asimina triloba*, both of which have been observed at Lewiston on the Niagara river, *Gillenia stipulacea*, *Silphium trifoliatum*, and others of similar range in the Northern States, and not yet familiar to us as Canadian plants, are to be looked for here; and possibly some species of a more Southern type may, like *Viola villosa*, *Polygala Nuttallii*, and *Agrimonia parviflora*, also be discovered in this district.

The flora, peculiar as regards other parts of Canada to the neighborhood of Lake Erie, embraces no plant not likewise met with in one or other of the adjacent United States. Many of the species composing it form only the outliers, as it were, of a flora which has its centre in the central States of the Union. Others, again, are rather western in their range. To those of a somewhat southern type already mentioned, may be added *Polygala fastigiata*, *Phaseolus helvolus*, *Cornus florida*, *Lobelia puberula*, *L. Nuttallii*, *Scutellaria integrifolia*, and *Urtica purpurascens*. Among western and south-western species, or species not frequently observed in the Eastern States, are *Jeffersonia diphylla*, *Baptisia leucantha*, *Artemisia biennis*, *Lithospermum canescens*, *Platanus occidentalis*, *Juglans nigra*, and *Quercus castanea*. *Platanus occidentalis* is said to be also a native of Lower Canada, and I have seen one or two trees of *Quercus castanea* in the township of Pittsburg, near Kingston. The Erie district, however, here forms the northern limit of these species, though many of them extend north-westwardly to Wisconsin, and even penetrate the section of country watered by the Saskatchewan. This peculiar north-westward distribution of many American plants is a remarkable feature in the vegetation of both the northern United States and Canada. Humboldt, I believe, ascribes the circumstance to the different directions of the valleys in the Atlantic and Western States.

Among the species characterising the district along Lake Erie, are:

Liriodendron tulipifera.	Gerardia integrifolia.
Jeffersonia diphylla.	Scutellaria integrifolia.
Iodanthus hesperidioides.	Onosmodium Carolinianum.
Viola villosa.	Lithospermum canescens.
Hypericum kalmianum.	Hydrophyllum appendiculatum.
Euonymus atropurpureus.	Frasera Carolinensis.
E. Americanus.	Asclepias variegata.
Polygala Nuttallii.	Montelia tamariscina.
P. fastigiata.	Sassafras officinale.
Lupinus perennis.	Benzoin odoriferum.
Campanula Americana.	Euphorbia corollata.

Phaseolus helvolus.
Baptisia leucantha.
Gillenia trifoliata.
Agrimonia parviflora.
Lythrum alatum.
Œnothera chrysantha.
Thaspium barbinode.
Erigenia bulbosa.
Rudbeckia fulgida.
R. horta.
Artemisia biennis.
Lobelia puberula.
L. spicata.
L. Nuttallii.
Platanus occidentalis.
Castanea vesca.
Urtica purpurascens.
Boehmeria lateriflora.
Juglans nigra.
Quercus castanea.
Hypoxis erecta.
Lilium superbum.
L. Catesbæi.
Prosartes lanuginosa.
Andropogon argenteus.
Allosorus atropurpureus.

Two or three of the species above enumerated are stated by Prof. Gray to be common in the northern United States, but I am not aware that they have been observed in Canada in localities beyond the Erie district.

III. SUPERIOR TYPE.

It is upon the shores of Lakes Huron and Superior, especially of the latter, that the vegetation begins to partake somewhat of the character of that west of the Red River. Such plants as *Linum perenne*, *Lonicera involucrata*, *Crepis runcinata*, and *Coriospermum hyssopifolium* do not fail to remind us of the country watered by the Saskatchewan, and of the adjacent American territories. Not many of these far-western species have as yet been met with; nevertheless, the resemblance is sufficiently marked to be noticeable. Future collectors will, there is little doubt, not only increase the number of these species already detected, but also add to the list of sub-alpine plants whose occurrence has been noted on the north shore of Lake Superior.

Were these western plants absent, the flora of the east and north shores of Lake Superior would much resemble that of the section of country along the south shore of the St. Lawrence from about Quebec downwards to the Gulf. The Cupuliferæ find their limits upon the eastern coasts of the lake, whilst *Tilia Americana* is entirely absent. *Fraxinus sambucifolia* is still met with, but *F. Americana* does not penetrate much beyond the upper shores of Lake Huron.

Among the western species at present known to diffuse themselves as far as our borders, are included the following plants:

Anemone narcissiflora.
Ranunculus abortivus, var. micranthus.
Crepis runcinata.
Mulgedium pulchellum.
Tanacetum Huronense.

Caltha natans.	Senecio canus.
Aquilegia vulgaris.	Artemisia Ludoviciana.
Arabis petræa.	Nardosmia sagittata.
Turritis patula.	Melampyrum pratense.
T. brachycarpa.	Mertensia pilosa.
T. retrofracta.	M. paniculata.
Drosera linearis.	Polemonium cæruleum.
Linum perenne.	Humulus Lupulus.
Rosa stricta.	Coriospermum hyssopifolium.
Rubus Nutkanus.	Elæagnus argentea.
Lonicera involucrata.	Comandra livida.
Symphoricarpus occidentalis.	Echinodorus subulatus.
Matricaria inodora.	Carex Vahlii.
Aster graminifolius	Allosorus acrostichoides.
Cirsium Pitcheri.	Aspidium fragrans?
C. undulatum.	A. Lonchitis.

I have not stations for *Anemone narcissiflora*, *Turritis patula*, *T. retrofracta*, *Linum perenne*, and *Polemonium cæruleum*, beyond the mere fact of their presence in Canada; but judging by their range in British America, the Lake Superior or Lake Huron region must be the place of their occurrence.

The shores of Lake Huron, it may be mentioned, are the only recorded stations in Canada for *Matricaria inodora*, *Mulgedium pulchellum*, *Cirsium undulatum*, *Crepis runcinata*, *Senecio canus*, and *Aspidium Lonchitis*. Owen Sound, on the Georgian Bay, is a station for the very rare *Scolopendrium officinarum*. *Hesperis matronalis*, and *Poterium sanguisorba*, both garden-plants, are said by Hooker to have been found on the shores of the same lake. The very rare *Juncus stygius* has also been gathered at the Bruce Mines.

In addition to the plants enumerated in the above list, there are some which in Canada appear to be confined to this district, but in their range beyond the province cannot be classed as western plants. Such are *Sisymbrium canescens*, *Coreopsis lanceolata*, and *C. verticellata* (?), which extend into the southern United States.

There are also a few species met with around the upper lakes, which in the United States flora appear to be exclusively north-western plants, but which re-appear near the north-eastern Canadian boundary-line, and doubtless are spread over the intervening space. *Parnassia palustris*, a species of Upper Michigan, the Lake Superior region, and north-westward, likewise occurs in Labr.dor and Newfoundland; and *Artemisia borealis*, another north-western plant, appears also in Anticosti and Labrador. *Botrychium Lunaria*, a foreigner to the United States flora, and *Allium Schœnoprasum*, have a similar range to the Atlantic coast, the former occurring on Orleans Island, and the latter extending, according to Prof. Bailey, to the Nepisiquit in New Brunswick.

Some of the plants which I have above enumerated are distributed through Michigan, Wisconsin, and Minnesota, and others even extend to Oregon and California. The following are, however, not included in Gray's Manual of Botany, as being within those States east of the Mississippi River:

Anemone narcissiflora.	Crepis runcinata.
Caltha natans.	Matricaria inodora.
Aquilegia vulgaris.	Mulgedium pulchellum.
Arabis petræa.	Melampyrum pratense.
Turritis patula.	Mertensia pilosa.
T. retrofracta.	Polemonium cæruleum.
Linum perenne.	Coriospermum hyssopifolium.
Rosa stricta.	Elæagnus argentea.
Lonicera involucrata.	Echinodorus subulatus.
Senecio canus.	Carex Vahlii.
Nardosmia sagittata.	Allosorus acrostichoides.

Carex Vahlii and *Allosorus acrostichoides*, it is to be observed, have been found on Isle Royale; which island forms a part of the State of Minnesota, and is therefore within Gray's limits. *Melampyrum pratense* and *Echinodorus subulatus*, though not in the Manual, are, according to Dr. Parry (Owen's Geological Survey of Wisconsin and Minnesota), found at St. Croix in Wisconsin.

It will, in this place, be proper to mention, before adverting to the maritime type, that Upper Canada and Lower Canada appear each to have a peculiar flora. The materials requisite to define with sufficient accuracy the distinctive features of each flora, which are at command, are not, however, so ample as could be desired. From the upper province I have several full and reliable catalogues, though much may yet there be done; but the eastern townships and vicinity of the neighboring United States boundary-line, have not been sufficiently explored to preclude the hope that not a few species, at present thought not to range into Lower Canada, will be detected there. Most of the plants indigenous to the northern districts of Maine and Vermont, should occur there.

I may here, for the sake of illustrating the two floras mentioned, and with a view of more fully indicating in this paper the general features in the distribution of our Canadian plants, point out a few of the species which seem to be restricted, or nearly so, to each province.

There appears to be a very large number of Upper Canadian species which have not been met with in Lower Canada. Many of these, however, occur in Maine and Vermont, and will, I doubt not, be observed by collectors in the eastern townships. Still, there are a number in the upper province which, judging by the range ascribed to them by Gray, are not to be looked for far beyond the dividing-line between the provinces. Among these are such plants as *Hydrastis Canadensis*, *Alsine Michauxii*, *Polygala senega*, *Astragalus Canadensis*, *Myriophyllum heterophyllum*, *Lonicera oblongifolia*, *Viburnum pubescens*, *Liatris cylindracea*, and *Aster ptarmicoides*. *Pinus rigida* appears to be of very restricted occurrence,—the only reliable locality of which I know being the Thousand Islands; and recorded stations for, among others, *Helianthemum corymbosum*, *Rhus aromatica*, *Geum triflorum*, *Valeriana sylvatica*, *Pycnanthemum lanceolatum*, and *Asplenium ebeneum* (for which fern I may here mention the neighborhood of Kingston as a third Canadian locality), are as yet rare.

In Lower Canada there are a number of species which may be regarded as confined to that province, others which range for a considerable distance along the St. Lawrence towards Lake Ontario, and not a few which appear on the shores of Lake Superior, though not found elsewhere in Upper Canada. Thus *Draba verna*, *Stellaria crassifolia*, *Astragalus alpinus*, *Oxytropis Lamberti*, *Cornus suecica*, *Rhodora Canadensis*, and *Platanthera fimbriata*, have no recorded Upper Canadian stations; and *Corydalis glauca*, *Viola Selkirkii*, *Claytonia Caroliniana*, *Betula alba* var. *populifolia*, with others, have but a limited range in the triangular section of country between the rivers Ottawa and St. Lawrence. As to those eastern species which are common to Lower Canada and the Lake Superior country, in addition to *Allium Schœnoprasum* and *Botrychium Lunaria* already noted, it will not be necessary here to refer to more examples than *Anemone parviflora*, *Draba arabisans*, *Potentilla tridentata*, *P. fruticosa*, *Gentiana saponaria* var. *linearis*, and *Pinus Banksiana*.

I shall not at present farther illustrate these two floras, but hope to recur to the subject on some future occasion, and to be able to give fuller and more definite details.

IV. MARITIME TYPE.

Dr. Gray, in the American Journal of Sciences, has enumerated sixty species of maritime plants inhabiting the American coast between Maine and Virginia. Our maritime district, in addition to being situated far up on the Atlantic coast-line, is of very limited latitudinal extent, and yet I have evidence of the occurrence there of twenty-eight shore species. This number includes *Subbatia gracilis*, which is a Canadian plant according to Kalm, and *S. stellaris*, the occurrence of which within our limits rests upon the authority of Wood. The sea-lavender (*Statice Limonium*), judging by the range assigned it by Dr. Gray, is to be looked for upon the gulf-coast. It is a native of Newfoundland. *Aster Radula*, a coast form, which, in the United States, ranges from Delaware to Maine, is found in Anticosti and Newfoundland. Though resembling the sea-shore species in its preference for the coast, it does not appear to be a strictly maritime form. It is not included in Dr. Gray's list.

The small catalogue here given embraces every species known to me to occur on the gulf-coast between the Bay of Chaleurs and Labrador.

Ranunculus Cymbalaria.
Cakile Americana.
Hudsonia tomentosa.
Honkenya peploides.
Spergularia rubra,
var. marina.
Hibiscus moscheutos.
Lathyrus maritimus.
Ligusticum Scoticum.
Archangelica peregrina.
Solidago sempervirens.
Plantago maritima,
var. juncoides.
Armeria vulgaris.
Glaux maritima.
Mertensia maritima.
Sabbatia gracilis.
S. stellaris.
Atriplex hastata.
Salicornia herbacea.
Chenopodina maritima.
Salsola Kali.
Acnida cannabina.
Euphorbia polygonifolia.
Triglochin palustre.
T. maritimum.
Juncus bulbosus.
Calamagrostis arenaria.
Spartina polystachya.
Brizopyrum spicatum.

In connection with this subject, it may not be inappropriate here to notice the peculiar occurrence of maritime species in the interior of Canada, and of New York and other States. They are found as well upon the coasts of Lakes Superior and Huron, as near the margins of Lakes Erie, Ontario, and Champlain. Mr. J. E. Cabot, the author of the narrative of the expedition in Agassiz's Lake Superior, thus adverts to the eastern side of the lake: "The resemblance to the sea-shore often recurred to my mind. According to Dr. Leconte, several insects found here are identical with species belonging to the sea-shore, and others corresponding or similar. The beach-pea (*Lathyrus maritimus*), and *Polygonum maritimum*, both of them sea-shore plants, are abundant in this neighborhood; the former, indeed, throughout the north shore of the lake." In addition to these two species, six truly sea-shore species have been observed in the immediate vicinity of the same lake.

The neighborhood of the large lakes is not, in every instance, the place of growth of these maritime plants; for at the salt-springs of Salina in New York State, according to Torrey, Gray, and other authorities, there have been found *Ranunculus Cymbalaria*, *Hibiscus moscheutos*, *Salicornia herbacea*, *Triglochin maritimum*, *T. palustre*, and *Scirpus maritimus*.

From various sources, I have ascertained that the following species occur along the Great Lakes, or near salt-springs in New York.

Ranunculus Cymbalaria.	Euphorbia polygonifolia.
Hudsonia ericoides.	Polygonum maritimum.
H. tomentosa.	Rumex maritimus.
Cakile Americana.	Triglochin maritimum.
Hibiscus moscheutos.	T. palustre.
Lathyrus maritimus.	Scirpus maritimus.
Atriplex hastata.	Calamagrostis arenaria.
Salicornia herbacea.	Hordeum jubatum.

The occurrence of these maritime species in localities now so far distant from their natural homes appears to point to a time when a very considerable portion of the province was covered by the ocean; when the ocean limits were much farther inland than they are now, and sea-shore vegetation, as a consequence, occupied a different location from that which it at present retains. The most recent period during which such a change in the aspect of our province took place, was at the time when the marine clays of the Ottawa valley were deposited. There is evidence derived from vegetable remains in these clays that some of our most common plants had an existence then, and we have thus reason to suppose that present species, including maritime plants, had been created at that time. During this period, the maritime plants, compelled by the gradual depression of the land and the consequent inroads of the ocean over what is now eastern Canada, must have migrated to localities previously far inland, and towards the lakes. The lakes were then, doubtless, much larger than at present, and it may be that at that time they were united into one vast inland fresh-water sea, extending from near the then ocean-coast westward. Means of diffusion was thus afforded, to these sea-shore plants. The presence of extensive bodies of fresh-water would have a moderating effect upon the atmosphere, which would, with the exception of the absence of the saline element, be much the same as that of the sea-coast. That the vicinity of these lakes would form a not altogether unfavorable habitat for a maritime vegetation is shown by the fact, that, as a general rule, the maritime species scattered through Canada at the present time, are only found in such localities. We may then readily imagine that having become settled there, when, after the gradual lapse of time, the waters of the lake retreated to their present limits, these plants would follow, still continuing to retain their positions near the shores, which would thus account for their wide diffusion throughout the country at the present time. We may then regard these peculiarly distributed plants as the relics of a more extended maritime vegetation of the post-tertiary period.

This theory of the causes of the distribution of sea-shore plants over Canada, which I have briefly endeavored to explain, resting as it does almost entirely upon a consideration of the past geological conditions of the country, and upon some assumptions not yet fully sustained by facts, may be open to objections. It may be a question whether the facilities for migration to the ancient lakes and for distribution along their shores, were, at that time, so ample as I have supposed. Still it is conceived that the peculiar diffusion of these species must have originated in some such way as that conjectured. I cannot think that it is due to mere accident.

V. Alpine Type.

The species enumerated in the list given below to illustrate our alpine and sub-alpine floras have been chiefly obtained from the Mingan Islands, Anticosti, and Gaspé. The Mingan Islands and Anticosti have recently afforded to collectors many very interesting alpine forms,—some hitherto unknown south of Labrador, unless found upon the high alpine tops of the White Mountains. *Draba incana*, *Cochlearia tridactylites*, *Dryas integrifolia*, *Rubus arcticus*, and some other boreal forms detected there, form valuable additions to the Canadian flora. On the Gaspé cliffs, however, the vegetation partakes more of a sub-alpine character. *Solidago thyrsoidea*, *Dryas Drummondii*, *Vaccinium Vitis-Idœa*, and *Saxifraga aizoon* are there, with *Asplenium viride*, a fern until lately unknown on the Atlantic coast south of Greenland. The northern shore of Lake Superior appears also to be sub-alpine.

The north-western parts of Newfoundland near the Straits of Belisle have been recently visited by Mr. Richardson of the Geological Survey of Canada, and in a small collection of plants made by him occur *Lychnis alpina*, *Dryas integrifolia*, *Rubus arcticus*, *Solidago virga-aurea* var. *alpina*, *Diapensia Lapponica*, *Salix reticulata*, and *S. phylicifolia*, all alpine species. *Rubus Chamœmorus*, *Vacccinium uliginosum*, *V. Vitis-Idœa*, *Empetrum nigrum* and two or three other sub-alpine forms, were also obtained by him in the same localities. On the neighboring coast of Labrador the alpine plants collected by the Abbé Ferland were *Silene acaulis*, *Rubus arcticus*, *Sedum Rhodiola*, *Arctostaphylos alpina*, *Diapensia Lapponica*, *Pleurogyne rotata*, and *Salix alpestris*. Anticosti and the north-western part of the island of Newfoundland appear to form the southern limit of alpine vegetation upon the Atlantic coast. Their complete exposure to the effects of the polar current, as well as the rather high latitude occupied by them, must aid in giving their shores an alpine aspect.

In addition to the list of alpine plants, I enumerate a number of species which, judging by their range in Canada, or their limits upon high mountains in the United States, must be regarded as sub-alpine. *Vaccinum cæspitosum*, *Loiseleuria procumbens*, *Castilleia septentrionalis*, and *Phleum alpinum* do not, according to Gray, descend beyond the alpine districts on the mountains of New England, but with us range into the sub-alpine districts around Lake Superior, and the latter two have been likewise observed in Gaspé. *Woodsia alpina* and *Asplenium viride* I also provisionally class as sub-alpine. *Cassiope hypnoides* can hardly be even regarded as sub-alpine, if Professor Bell's locality on the south side of La Cloche Island in Lake Huron be correct.

1. Alpine species.

Thalictrum alpinum.
Ranunculus affinis.
Draba incana.
Erysimum lanceolatum.
Vesicaria arctica.
Sedum Rhodiola.
Saxifraga stellaris.
S. nivalis.
Nabalus nanus.
Antennaria Carpathica.

Cochlearia tridactylites.
Thlaspi montanum.
Viola palustris.
Parnassia parviflora.
Dryas integrifolia.
D. octopetala.
Sibbaldia procumbens.
Rubus arcticus.
Epilobium alpinum,
var. majus.
S. Grœnlandica.
Senecio pseudo-arnica.
Erigeron acre.
Arctostaphylos alpina.
Andromeda tetragona.
Pleurogyne rotata.
Rumex domesticus.
Betula nana.
Salix reticnlata,
var. vestita.
S. repens.

2. Sub-Alpine species.

Alsine Grœnlandica.
Hedysarum boreale.
Astragalus secundus.
Dryas Drummondii.
Rubus Chamæmorus.
Solidago thyrsoidea.
S. virga-aurea.
Arnica mollis.
Vaccinum uliginosum.
V. Vitis-Idæa.
V. cæspitosum.
Castilleia septentrionalis.
Euphrasia officinalis.
Polygonum viviparum.
Empetrum nigrum.
Tofieldia palustris.
Scirpus cæspitosus.
Poa alpina.
Phleum alpinum.
Woodsia alpina.
Asplenium viride.
Lycopodium Selago.

Of the alpine species enumerated, only eight are natives of the United States; but in the sub-alpine list there are only six,—*Astragalus secundus*, *Dryas Drummondii*, *Tofieldia palustris*, *Poa alpina*, *Woodsia alpina*, and *Asplenium viride*, which are not likewise indigenous to the Northern States. *Tofieldia palustris* is omitted from Dr. Gray's Manual, apparently under the mistaken impression that Isle Royale on which it has been observed does not form a part of the Union. The island belongs to Minnesota, and does therefore strictly come within the limits of the work.

London, C. W., Oct., 1864.

THE GEOLOGY OF THE OTTAWA VALLEY.

By Jas. A. Grant, M.D., F.R.C.S.E., F.G.S.

The channel of the river Ottawa, in this immediate neighborhood, is wholly excavated in the Trenton limestone, which, to a considerable extent, can be seen on both sides; it also constitutes the projecting points of rock seen from the Suspension Bridge, as well as the small island immediately beneath,—upon which island it has been proposed to erect a monument to the Prince of Wales.

The range of hills seen running along the north shore of the St. Lawrence from its mouth to Quebec, and onward in a westerly direction, along the north side of the Ottawa River, is looked upon as being at one time the shore of an ancient ocean. A view from the summit of one of these hills in a direction south, exhibits a great tract of level country, low lying, and considered as the wide, flat valley of an ancient ocean, whose waters, long since removed, have left behind, in remembrance of their existence, the great beds of Silurian rocks, abounding in fossilized remains of the various organisms which flourished during that interesting epoch. Of the strata entering into the formations of this section, the lowest rock is the Potsdam Sandstone, excepting the Metamorphic Rocks, which, although stratified, may be distinguished by a more or less granitic, and crystalline aspect, and are of older date. The greater number of the boulders scattered so profusely over the entire face of the country, are gneiss in one of two forms,—as either the micaceous or ordinary gneiss, or hornblendic gneiss. The former consists of quartz, feldspar, and mica; the latter, of quartz, feldspar, and hornblende. Gneiss is generally known from granite by its striped or banded character.

Potsdam Sandstone is a term given by the New York geologists to a formation which is well developed at Potsdam, in northern New York, and is there considered as forming the base of the palæozoic series of rocks. Sir William Logan considers this formation as a member of the Potsdam Group. It crosses from St. Lawrence County, New York, into Canada; the greatest development on this side being at the County of Beauharnois. It is said to fill up the inequalities of the underlying Laurentian series. This formation is met with to the eastward, between Lake Chaudière and a spur of Laurentian rocks, from three to five miles removed from the right bank of the Lac des Chats, to Nepean, a distance of fully thirty miles. In Nepean the rock dips northward, and thus sinks beneath the calciferous formation. By means of a dislocation, the south side of the band, after leaving the gneiss, is brought against the Chazy and Trenton formations. The continuation of the dislocation on the south side of the Laurentian spur, accounts for the absence of Potsdam sandstone in that particular position. In the "Geology of Canada" it is here stated as constituting the south side of a synclinal form, on the north side of which it rises in Hull, from beneath the higher members of the Lower Silurian series. In Hull it is observed about five miles north of the Ottawa, and about two miles east of the Gatineau, where it is also brought into view by a dislocation which branches in Osgoode and Gloucester, from the one previously mentioned, and, passing in a direction somewhat west of north, crosses the Ottawa at the Little Chaudière Falls, and shows a downward throw on the east side. According to Professor Dana, during the first half of the Lower Silurian era, the whole east and west were alike in being covered with the sea, and that in the first or Potsdam period, this continent was just beneath or at the surface. Afterwards, in the Trenton period, the depth became greater, and afforded pure waters for the very abundant marine life.

Calciferous Sand-Rock succeeds Potsdam sandstone, and the characteristic portion of this formation, in Canada, is a granular magnesian limestone or dolomite, of a dark bluish-gray color, crystalline, strongly coherent, weathering yellowish brown, and frequently containing small geodes, filled either with calcareous spar, quartz crystals, sulphate of barytes, sulphate of strontia, or sulphate of lime. Its fossils are very imperfect, and in most cases only moulds of these are to be found. In some places the upper part of this formation is of a bluish-gray calcareous argilite. When exposed to the air, it turns yellow or brown, and frequently develops a bituminous odor. The calcareous beds in many districts yield a poor description of lime, and hence the term bastard limestones is applied to them by settlers and others. Calciferous Sandrock forms part of the great series of strata called the Quebec Group. It is seen along the south shore of the Ottawa in many localities from Carillon to the Chats. At Aylmer it occurs on both sides of the river, and from the Alumette Island extends south to Prescott, at which point it crosses the St. Lawrence into the United States. A little below Prescott, on the spot where the battle of the Windmill was fought, gentle undulations are to be observed in the strata of this formation, but more particularly on descending the river from Maitland to this point. According to Sir W. Logan, the total thickness of this formation is about 300 feet.

Chazy Limestone overlies the Calciferous formation, and derives its name from Chazy, in the State of New York, west of

Lake Champlain, where it was first described by the New York geologists. In Canada it is associated with sandstones and shale, and is here described as Chazy formation. It is exposed in the cutting of the Grenville canal, and there crosses the Ottawa to Hawkesbury. In its geographical distribution, it forms a zone around the geological depression between the Ottawa and the St. Lawrence. It forms two patches on the calciferous outlier of the Lac des Chats, also of the lowest outlier of the Alumette Islands. The arenaceous part of the Chazy is seen at Aylmer, in Hull, and in the eleventh range of Eardley, on the north side of the Ottawa. It is also found in the Townships of Huntly and Ramsay. The great mass of limestone which overlies the Chazy formation is divided into three portions by the New York geologists. The divisions are supposed to have been characterised by peculiar fossils. However, in Canada, a separation of this kind cannot be definitely carried out, owing to the circumstance that the Birdseye and Black River formations become very indistinct; they are, in consequence, grouped together. Not only are the strata blended together, but also the fossils characteristic of the one are found in the other; thus the difficulty of division. According to Sir W. Logan, the Birdseye, Black River, and Trenton formations constitute one of the most persistent and conspicuously marked series of the strata of the Lower Silurian period of North America.

The limestone of the Trenton group is found extensively in Canada East and West, and particularly between the Ottawa and the St. Lawrence, but more especially around the capital of Canada,—Ottawa. The limestones of this locality are affected by two parallel dislocations between five hundred and six hundred yards apart, west of the Rideau. "One of these dislocations comes to the Ottawa a little below the exit of the canal, in a small upthrow to the south; and the other about six hundred yards above it, beyond the Barrack Hill, is a downthrow of seventy feet in the same direction." Farther west this series of limestones come up against the Gloucester and Hull fault, extending from the west side of the junction gore of Gloucester across the Ottawa to the front of the sixth lot of the fifth range of Hull. Owing to these various faults it has been found difficult for the Geological Survey to estimate the thickness of the series in this neighborhood. It is, however, computed that the total volume of the limestones of this locality will not fall short of six hundred feet.

Utica Slate (so termed from Utica in the State of New York).—It comprises a series of dark-brown, bituminous shales, interstratified here and there with a few beds of dark limestone. It is found in considerable quantity near this city, and is seen cropping out directly across the Rideau Bridge, near the General Protestant Hospital. In the Townships of Collingwood and Whitby this shale is sufficiently bituminous to produce mineral oil in considerable quantity.

The Drift or Boulder Formation, of which we have ample evidence in this locality, comes under the Post-pliocene or Post-tertiary period. The clay, sand, and gravel of the valleys of the Ottawa and St. Lawrence, containing sea-shells or the skeletons of marine fish, are also referred to it. Owing to the manner in which drift is supposed to have been formed (that is, transported by ancient glaciers), it is termed Glacial Drift. "The greatest development and extension of these glaciers is said to have been during the interval between the close of the Cainozoic period and the commencement of the existing epoch, properly so called." It forms the surface of country over a great part of the triangular area included by the St. Lawrence and Ottawa rivers. Stratified clays and sand fill up depressions of great extent over this surface, and erratic boulders of great size are to be observed, in localities the most unexpected. A granitic boulder of considerable magnitude is to be seen just above, and to the right of the Suspension Bridge, on the table of rock lying below; and one on the island immediately above the Chaudière Falls, of much greater size. Dana states that nothing but moving ice could have transported the drift, with its immense boulders. In the glacial regions of the Alps, ice is performing this work at present. In that locality there are evidences of stones of great size, which have, in former times, been borne, by a slow moving glacier from the vicinity of Mont Blanc across the low lands of Switzerland to the slopes of the Jura Mountains, and left there, a height of 2,203 feet above the present level of Lake Geneva. The channel of the Ottawa River is contracted at various parts by ridges of glacial drift, of boulders running north and south. The nearest of these is to be seen above the mouth of Green's Creek, between seven and eight miles below this city. In this locality a well-marked line of boulders runs quite across the river, and forms a considerable obstruction to navigation during low water, such as we have had this season particularly. Professor Dawson divides the eastern post-glacial beds into two series, the lower a deep-sea deposit, named the Leda Clay, from one of its characteristic shells; and the upper, for a similar reason, the Saxicava sand, formed in shallow waters. On the south bank of the Ottawa River, from this city to Hawkesbury, the lower clay formation of Dr. Dawson is to be seen in banks from twenty to forty feet high. "The overlying sand generally approaches the river and conceals the clay except along the streams." Wherever these clay formations exist along the river the shells *Saxicava rugosa* and *Tellina Grœnlandica* are to be found, and in a bed of clay at Green's Creek nodular masses exist in considerable abundance. The most common fossil embedded in these, is the *Mallotus villosus* or capeling of the Lower St. Lawrence. This capeling is also found in nodules, in clay, on the Chaudière Lake, 183 feet; on the Madawaska at 206 feet; and at Fort Coulonge Lake, at 365 feet above the sea. This formation contains also various other fossils. On the north side of the Ottawa, from Hull to Isle Jesus, this clay formation covers a considerable breadth between the Laurentian Hills and the river. It can also be traced in considerable abundance along the banks of the Gatineau and river Rouge. In the former locality it is well known to the lumberers, who in wet weather describe it as the sticking clay of the Gatineau. A well-defined hill of clay exists on the front and to the left of the General Protestant Hospital, facing the Rideau River, and to the rear an extensive mound of sand, both of which are drift formations. The boulder formation or glacial drift, both in the British Isles and North America, is referred by Lyell to the age of the newer pliocene, of which it marks its close; while the stratified deposits which overlie it, consisting partly of boulder formation re-arranged by water, are placed among post-tertiary strata. The records of the drift or boulder period extend over North America, north of parallel 40°, as well as over all the northern countries of Europe, and the various boulders have been moved from the north towards the south. Throughout the regions occupied by the drift, the rocks in place are more or less polished, striated, or grooved. These marks are observed on the consolidated formations that appear at the surface, and constitute a very essential part of the records of this period.

Rock Basins or Pot-holes.—These are everywhere common along rapid brooks and rivers. They are most frequently seen on elevated ground, and present all the appearances of those formed at water-falls by the gyration of the pebbles. Professor Emmons gives an example of one, as seen at Antwerp, St. Lawrence County,

N. Y. He states that it is at least one hundred feet above the Oswegatchie, three-fourths of a mile distant, with an intervening hill higher by some fifty feet than this remarkable pot-hole, which is from twenty-four to thirty feet deep, and from twelve to fourteen feet in diameter, bearing the usual marks on the interior of water-worn surfaces. Another example of this kind is described in Grafton, New Hampshire, on the crown of a high valley, between the waters of the Connecticut and Merrimack rivers, at an elevation about 2000 feet above them, and a smaller one eight or ten feet higher. The celebrated basin at Franconia Notch is one of these wells, forty feet in diameter, and twenty-eight feet deep. It is filled to the depth of eight or ten feet with pure water, which revolves with such force that it is considered a dangerous place for even an expert swimmer. These basins have also been noticed in the granites of high and exposed regions of Devonshire, England, varying from one to several feet in depth, and from a few inches to several feet in diameter. At one time superstition ascribed the excavation of these basins or pot-holes, in that locality, to the Druids; but no person now doubts their true origin, as the results of decomposition and attrition on the softer portions of the granite. Pot-holes in process of formation are described in Chambers's Gazetteer, vol. i, p. 188, as seen in the course of the river Devon. Throughout various parts of Canada these pot-holes have been noticed, viz: At French River they occur at considerable distance above the river level, and range from one to three and a half or four feet in depth, and from twelve to eighteen inches in diameter. At the High Falls, on the River du Moine, several pot-holes are to be seen in the gneiss rocks. Very peculiar formations of this description are to be seen at the Roché Capetaine Rapids, on the Ottawa River, at an elevation of fifty to sixty feet above the present river level. Several small ones are met with at and above the High Falls of Dartmouth River, which enters into the north-west arm of Gaspé Bay; also on York River, which enters the south-west arm of Gaspé Bay; also seen in the black shale in the bed of the Black River, lots 16th and 17th, fifth range of Acton, in the Eastern Townships.* Those who take an interest in such formations, need not proceed beyond the limits of Ottawa City in order either to gratify curiosity or satiate a thirst for knowledge in this respect. Numerous small formations are seen in the surface-rock on the roadside towards the Little Chaudière Falls;

* Report of the Geological Survey.

also on the Le Breton Flat, in which locality they possess no small degree of interest, and have called forth considerable remark, owing to several of them appearing as natural wells. Of these, the one most recently discovered is in the foundation just excavated by Mr. Richards, Chaudière, near the residence of the Hon. James Skead. It was exposed after the removal of a bed of alluvium, about two feet in thickness, and was filled above for two feet with drift material, containing numerous recent shells; and below, with sand, pebbles and boulders of various sizes. These being all removed, the dimensions were shown to be in diameter three feet, and in depth thirteen feet. At present this pot-hole is filled with pure water, of excellent quality. Within the last few weeks several hundreds have visited this interesting locality, and a few have taken away a portion of the water, from a belief that it possessed medicinal properties, but in my opinion its properties are equal to those of any other well in that locality, but not superior. A pot-hole in the floom of Mr. Perley's mills, is ten feet in diameter, and fifteen to twenty feet deep.—*Extracted from a lecture on the Geological Structure of the Ottawa, read before the Ottawa Natural History Society.*

ON PEAT AND ITS USES.

By T. S. Hunt, A.M., F.R.S.

The peat deposits of Canada have been made the subject of repeated notice in successive Annual Reports of the Geological Survey, and are at length attracting the attention of practical men. A few years since attempts were made by Mr. C. M. Tate to work the peat of Chambly, which were partially successful; and more recently we learn that Mr. Hodges, having purchased a large area of peat-bog in Bulstrode, on or near the line of the Arthabaska railway, has imported machinery of the most approved construction, for the purpose of compressing the peat for fuel. We think therefore that the following pages extracted from "Geology of Canada" published in 1863, will not be without interest to our readers, as describing both the principal applications of peat, and some of its localities in Canada.

Great deposits of peat are met with in various parts of Eastern Canada, which seems to present conditions of soil and climate peculiarly favorable to its growth and accumulation. The peat-bogs, so far as known, are chiefly confined to the plains along the St. Lawrence and its tributaries, and appear to have been formed in shallow lakes, which have been gradually filled up by a vegetable growth. The peat often rests upon a layer of shell-marl, which at one time formed the bottom of the lake. The vegetation consists, for the most part, of mosses belonging to the genus *Sphagnum*. Besides these, however, the bogs often support a growth of tamarack (*Larix Americana*), and of various ericaceous plants, belonging chiefly to the genera *Cassandra*, *Andromeda*, *Kalmia*, and *Ledum*. The leaves, roots, and stems of these help, with the moss, to make up the peat. The peat near the surface of the bog, consists of the moss but little altered, and is very soft and porous; but in the older and deeper portions of the deposit it is more dense and darker in color; the vegetable tissue having undergone a partial decay, by which its fibrous structure, to a great or less degree, disappears, and the peat becomes earthy in its texture.

These different forms of peat present very great variations in their specific gravity. That from the surface of the Bog of Allen, in Ireland, according to Sir Robert Kane, has a density of 0.335, or only one third that of water; while the blackish-brown earthy peat, from a lower layer in the same bog, is from 0.639 to 0.672, or double that of the surface. A peat which is dug near Tavistock in Devonshire, has a density of 0.850. Similar differences will be found in the peat-bogs of Canada. A specimen of peat from Sherrington, described on page 642, is still more dense than any of these, being so heavy as to sink in water; while at the same time it only contains 3.5 per cent. of ash. One of the great obstacles to the use of peat is the large amount of water which it holds, and the obstinacy with which it retains this water. The average results of a great number of experiments made in the Irish bogs, show that the general mass of the undrained peat, including both the lighter and denser varieties, contains from 92 to 95 per cent of water; while the edges of the bog, and parts more or less drained, in the state in which peat is generally cut, contain from 88 to 91 per cent. The turf, as used in that country, often holds from 20 to 35 per cent of water; while that which has been stacked from six to twelve months, still retains from 18 to 20 per cent, and that which has been kept in a dry house for two years, from 10 to 15 per cent of water. The above details, and many of those which follow, are taken, in part, from Sir Robert Kane's work on "The Industrial Resources of Ireland," and a subsequent report by him on the working of peat; and also in part from a recent paper by Mr. C. Hodgson, read before the Institution of Civil Engineers of Ireland.

From this, it will be seen that in cutting out and removing the peat from the bog, it becomes necessary to transport about nine tons of water for each ton of real fuel. So long as a turf-cutter works along the edge of the bog, or of one of the main drains, he can spread the material as he cuts it; but when large quantities are wanted, additional laborers are required to carry the peat, with its great weight of contained water, to a proper place for spreading and drying. From the slowness of this process of air- and sun-drying, moreover, a given district can only produce a small amount of dried peat annually. The consequence is, that, although peat prepared in the ordinary way is a cheap domestic fuel, and is sold at a moderate price, it is found that as soon as the consumption increases in a district, the price increases, and that it is impossible to augment the supply beyond a certain limit. The Irish Peat Company, who a few years since constructed works near Athy, for distilling peat at the rate of fifty tons daily, had counted upon obtaining this supply at from 2s. 6d. to 3s. the ton; but it was found that before they had secured the quantity necessary for carrying on their works successfully, the price of peat increased to 5s., and ultimately to 6s. 6d., and 7s., sterling the ton. This increase, together, as we are told, with the impossibility of obtaining, at any reasonable price, a much larger supply, were among the causes of the failure of the enterprise.

It is obvious, then, that in order to extend the use of peat, either as a combustible, or as a material for distillation, it becomes necessary to introduce great improvements into its manufacture, which will make it possible to free it as rapidly and as completely as possible from the water which it contains. It is also desirable to reduce its volume, for the convenience of transportation; and to give it a solidity and tenacity approaching to coal, which will allow it to be used in ordinary grates and furnaces, and to bear a strong blast. For this purpose, many plans have been proposed, and numerous patents obtained within the last twenty-five years. One of the most satisfactory processes is said to be that now pursued at Ekman's iron works in Sweden, which is similar to that patented by Linning in 1837. According to his specifications, the peat is first ground to a homogeneous mass in a pug-mill, similar to that used by brick-makers, but with longer and sharper knives, placed obliquely. The pulp thus obtained is moulded into convenient shapes, and consolidated by a hydraulic or other press; after which the blocks are dried by artificial heat. The use of hydraulic pressure was several years since tried on an extensive scale, by Mr. C. M. Williams at Cappogue in Ireland. He, having broken up the peat, placed it in layers between cloths, and subjected it to a powerful hydraulic press. By this means, he succeeded in reducing it to one half its original weight, and to one third its volume. The remaining water was, however, difficult to be expelled from the consolidated peat; and the more fibrous varieties expanded a good deal in drying. This experiment was lately repeated, on a considerable scale, by the Irish Peat Company; and with similar results. They also built large drying-houses, in which attempts were made to dry ordinary peat by artificial heat; but the quantity of fuel required to expel the great amount of water from the peat, was found to be so considerable that the process was not economical.

A different plan was some years since proposed for overcoming certain of the difficulties of the problem; which was, after drying peat in the ordinary manner, to pulverize it by passing it through rollers, then to drive off the remaining water by heat, and consolidate the dry powder by powerful pressure. This process is followed at Rosenheim, in southern Bavaria, where the peat is made into small blocks of eight or ten ounces, and weighing from seventy to eighty pounds to a cubic foot. The latter weight corresponds to a specific gravity of 1.25, which is nearly that of bituminous coal. (Percy's Metallurgy, vol. i, p. 78.) Several patents, based upon this plan of dry compression, have been within the last few years obtained in England; but practical difficulties were met with in the machinery for compression; besides which, as Mr. Hodgson has well remarked, the great problem of obtaining a cheap and abundant supply of dried and powdered peat still remained. This however, according to him, is in great measure resolved by a simple expedient. By passing a very light harrow over the surface of the bog, a thin layer is broken up. After a few hours of exposure to the air, for draining and partial drying, it is removed by scraping; and in this way a powdered peat, far drier than the general mass, may be obtained every day when it does not rain. The material thus collected costs five pence the ton, and contains, on an average, forty-five per cent of solid matter; while recently-cut peat contains only ten per cent. It is heaped in embankments, where it is found not to absorb water, and is dried by being spread out over iron plates warmed by the waste steam from the compressing engine. In this way, according to Mr. Hodgson, the peat standing in the bog in the morning may be harrowed and scraped, brought in, dried, compressed, and converted into an excellent fuel before night. He employs for its compression, an engine patented by himself; which he describes as a horizontal reciprocating ram, working in a cylinder five feet long, with a uniform bore. The powdered peat falls into this as the ram draws back at each stroke, and, soon filling the whole length, considerable friction takes place against the sides of the tube. This becomes so great that as each charge falls in, it is completely consolidated between the advancing ram and the column of peat in the tube, before the frictional resistance of the column is overcome, and the whole mass moves on; so that the blocks formed at the one end are successively discharged at the other, at the rate of sixty a minute; making in an hour about fifteen hundred-weight of compressed peat, equal in density to coal. This apparatus is now in operation at Derrylea, near Monasterevan; and it is said by the inventor to leave no doubt of the practicability of producing dry compressed peat on a large scale, and with profit.

Peat is not only an economical fuel for domestic use, but is in many countries employed for generating steam, and for the manufacture of iron. For the latter purpose, it is used in Sweden, France, and in many parts of Germany, where the supplies of mineral coal are not abundant. It is particularly well fitted for producing steam, and compressed peat has now for several years been used in locomotive engines in Bavaria; but we are told that before this application was successful, many difficulties had to be surmounted. Several years ago, according to Sir Robert Kane, it was in general use upon the steamers on the river Shannon in Ireland.

In a paper communicated to the Society of Arts in London in November, 1862, Dr. B. H. Paul—whose experiments on the distillation of peat are described further on—has given some interesting conclusions as to the relative value of peat and coal as fuel. According to him, while the calorific or heat-giving power of carbon is represented as 1000, that of the various mineral coals is equal to from 903 to 906; while that of perfectly dried peat, as deduced from its average composition, will be 660. But as ordinary air-dried peat contains about one fourth its weight of water, its calorific power is reduced to 495, or about one-half that of the same weight of coal. The average weight of a cubic foot of solid coal is about eighty pounds, while air-dried peat has a density corresponding to only sixty-four pounds. A cubic foot of broken coal, however, contains about sixty pounds, while the same volume of ordinary peat weighs only about thirty pounds; "so that with but half the calorific power, it takes twice the space; and thus to produce a given effect with air-dried peat, it would require twice the weight, and four times the bulk, of the coal necessary to produce the same effect." This calculation as to bulk of course refers to uncompressed peat; if reduced to the density of coal, as claimed by Mr. Hodgson's process, its volume is of course diminished one half. From his own experience in Lewes, Dr. Paul found that on the moors, where peat was to be had for two shillings the ton, it could be economically used for generating steam, and for burning bricks; while at Stornaway, near by, where the cost of the peat, delivered, was six or seven shillings, coal, which was eighteen shillings the ton, was found more advantageous. He concludes that peat cannot be economically transported to any considerable distance; but that wherever a peat having a fuel-value one half that of coal, can be delivered at the place of consumption at a cost of four shillings sterling the ton, it may advantageously replace coal, where this, under the same circumstances, costs more than ten shillings; but if the price of coal is ten shillings or less, there would be a disadvantage in the use of peat. During four years Dr. Paul used it as the only fuel under stationary steam-boilers, and found it to answer admirably; and he states that Mr. James Napier of Glasgow, having tried it upon a steamer, is of opinion that it might be used in place of coal. This, of course, applies to short voyages, and to conditions where space is not a great consideration. It is a question for Lower Canada whether properly dried peat can be furnished at a price per ton less than two fifths that of coal; in which case, it might perhaps be advantageously employed in our inland navigation.

Large quantities of peat-charcoal are manufactured in France, and in Germany. For this purpose, either ordinary stacks, or cylindrical kilns built of brick, are employed. A current of steam heated to 450° or 460° F. has likewise been employed for the purpose; and the compressed peat has also been distilled in iron retorts, like those used for making coal gas; by which means volatile oils and combustible gas are obtained besides the charcoal.

Good air-dried peat, in stacks or in kilns, yields from thirty to forty per cent of its bulk, and from twenty-five to thirty-five per cent of its weight of charcoal; much of course depending on the amount of ash which the peat contains. Large quantities of peat and of peat-charcoal are prepared for the market of Paris; where the latter fuel is largely used for domestic purposes. About fifty miles from Paris, near Liancourt, on the Northern Railway, is a large bog, from which, in 1855, 10,000 or 12,000 tons of peat were obtained. The peat from the whole thickness of the bog, about ten feet, was transferred to flat-boats, trampled, and turned over with shovels, and finally moulded by pressure into small bricks, which when dried are heavier than water. These were charred on the spot, and yielded about forty per cent of charcoal, which gave 27·0 per cent. of ash; the dried peat itself yielding 10·0 or 11·0 per cent. The wholesale price of this compressed peat in Paris was, at that time, $3·75 the ton of 2200 pounds, while the charcoal made from it was $18.00 the ton; its retail price being about $24.00. Its combustion is slower than wood-charcoal, which was sold at about the same price; while both mineral coal and firewood were retailed at from $7.50 to $9.50 the ton weight. These figures will aid in obtaining a notion of the comparative value of the various kinds of fuel.

The object proposed by the Irish Peat Company, as already mentioned, was the distillation of peat; by which it is made to yield a tar, from which are extracted illuminating and lubricating oils, and paraffine; besides ammonia, acetic acid, and pyroxylic spirit, which are dissolved in the watery products of the distillation. A large amount of combustible gas is also disengaged, which may be employed as a source of heat in various operations, such as distilling, burning bricks, and lime. By distilling the dried peat in retorts, a considerable amount of tar is obtained, besides a residue of coke or charcoal, which, however, is not sufficient to heat the retorts, so that there would be a further expenditure for fuel. It was therefore desirable to devise some more simple and economical way of conducting the distillation, and the works of the Company at Athy were built in accordance with the system patented by Mr. Rees Reece in 1849. This consists in burning the air-dried peat by means of a blast, in cylindrical furnaces of brick, shaped somewhat like iron blast-furnaces, but closed at the top, and furnished with pipes for carrying off the volatile products to a proper condensing apparatus. The furnaces being filled with peat, and closed, are lighted from below, and the blast applied. The heat from the combustion of the peat in the lower part of the furnace serves to distil the upper layers; while the gases from the combustion, together with the volatile products of the distillation, are carried forward by the blast towards the condensers.

This process was to a certain extent successful; but it was found that when the force of the blast was augmented, in order to obtain a more rapid combustion of the peat, the amount of tar was greatly diminished. Thus, according to Dr. Paul, it was found, by experiments in Antrim, with a furnace three feet in diameter and fifteen feet in height, that when one and a half tons of peat were burned in twenty-four hours, 3·1 per cent of tar were obtained; with two tons in the same time, 1·8 per cent; with three tons, only 0·98; and when nine tons were burned in twenty-four hours, only two pounds of tar were obtained to the ton. According to the experiments of Sullivan, Irish peat, when distilled in retorts, gave from 1·5 to 3·5 per cent, being an average of 2·5 per cent of tar; which furnished from 38·0 to 72·0 per cent of oil, the mean being 52·0 per cent. Of this oil, 5·0 per cent distilled below 212° F.; 20·0 per cent between 260° and 320°; 35·0 per cent between 320° and 550°; and the residue at a still higher temperature. Hence, as an average, 100 tons of Irish peat would yield 682 gallons of tar, and 333 gallons of refined oils. It was found that under favorable conditions, the amount of tar obtained by Mr. Reece's process was very nearly equal to that produced by distilling the same peat in closed retorts.

Dr. Paul has lately undertaken a series of experiments on the distillation of peat on a large scale, at Stornaway in the island of Lewes; the results of which he communicated to the British Association for the Advancement of Science, at Cambridge, in October, 1862. The mountain peat of that region is compact, heavier than water, and is superior for this manufacture to ordinary bog-peat. By distillation in a retort, it gave: tar 9·08, coke 31·50, water 37·88, gas (loss) 21·54; = 100·00. The tar thus obtained was a soft solid at 60° F.; it had a specific gravity of ·960, an acid reaction, and gave, by rectification, forty-two per cent of a refined oil, boiling above 300°; besides from thirty to forty-six per cent of more volatile liquids. These, as well as the ammonia, acetic acid, and pyroxylic spirit were neglected by Dr. Paul in his experiments. The refined oil contained about one tenth its weight of paraffine (equal to four per cent of the crude tar). About one half of the oil boiled at a temperature between 330° and 500° F.; it burned without charring the wick, had but little odor, was not explosive at ordinary temperatures, and compared favorably with refined petroleum. The remainder, which boiled between 500° and 600° F., had a specific gravity of ·850, and, when mingled with fat oils, was an excellent lubricator.

In his early attempts to work this peat on a large scale, by distillation in brick furnaces or kilns, Dr. Paul substituted for the blast the draught of a chimney; but in this way he was unable to obtain more than three per cent of tar, instead of the nine per cent which the same peat furnished when distilled in retorts. It was found, moreover, that, on an average, only about fifty tons a week were distilled in each kiln; while in order to give a profitable return it was necessary to work about seventy tons weekly, and to obtain five per cent of tar. His apparatus consisted of cylindrical brick chambers, five feet in diameter and twelve feet high; furnished at the bottom with a fire-grate having an area of two feet, and at the top with a hopper and lid for feeding. Ten of these kilns were built side by side, in a block; and from the top of each, a pipe of twelve inches in diameter led to a main of three feet, and thence, through a condensing apparatus, to a chimney. In order to secure a regular current of air through the apparatus, a draught was finally established by means of a thirty-inch fan, of Schiele's patent, making 1600 revolutions a minute, and driven by an eight-inch steam-engine; which worked at the same time some pumps, and a winding-drum by which the peat was drawn up an incline to the kilns. This fan was capable of passing 2000 cubic feet of gas per minute, and of maintaining a steady powerful draught through seven inches of water, without raising the combustion at the fire-grate of the kiln to a greater extent than was desirable. By this means the vapor was rapidly drawn from the kilns, and was passed several times through water, and also through four chambers filled with bundles of heather. This contrivance was found effectual to separate the tarry matter mechanically suspended and carried over by the current of gas. This, when discharged from the fan, was highly inflammable, and was led by an underground tunnel to a proper furnace; where it burned with a flame from six to ten feet high, six feet long and six inches thick, and was available for generating steam, distilling tar, evaporating liquids, or drying peat. It was found that the whole of the charred peat was not required for the distillation; so that by means of an arched opening fitted with a door just above the fire-grate, a portion of the charcoal could be removed from time to time. By this means, the amount of peat which could be worked was much increased, The removal of the charcoal in this way was however attended with difficulty during the prevalence of high winds.

With these improved arrangements, it was found that the amount of peat distilled was always above seventy tons, and in favorable weather upwards of one hundred tons weekly, for each kiln; while the proportion of tar was raised from 3·9 per cent. to 7·5, and was on average as much as 7·0 per cent. In this way there were obtained in the year 1861–62, from one hundred tons of peat—

749 gallons of oil (with paraffine), at 2s,		£74 18 0
From which is to be deducted—		
For 100 tons of peat, at 2s,	£10 0 0	
" cost of manufacture,	28 14 6	
		38 14 6
Leaving a balance of		£36 3 6

These are given by Dr. Paul as his working results within the last year, and contrast most favorably with those obtained in Ireland, as stated by Mr. Sullivan in his report to the directors of the Irish Peat Company in 1855; according to which, one hundred tons of peat gave—

150 gallons of oil at 2s.,	£15 0 0	
300 pounds of paraffine, at 1s.,	15 0 0	
52 gallons of wood-naphtha,	2 10 0	
3 cwt. of sulphate of ammonia,	1 16 0	
		£34 6 0
From which is to be deducted—		
For 100 tons of peat, at 4s.,	£20 0 0	
" cost of manufacture	14 3 4	
		£34 3 4
Leaving a balance of		£0 2 8

It will be seen that the cost of the Irish bog-peat was, for reasons already mentioned, 4s., instead of 2s., the ton; while its yield was so much less than that of Lewes, that even at an expense of manufacturing which was only half the latter, its distillation appears to have been no longer profitable; although the wood-naphtha, pyroxylic spirit, and the sulphate of ammonia, products neglected by Dr. Paul, were preserved. While some of the advantages of the results obtained at Lewes are to be ascribed to the method pursued, the superior quality of the peat is, according to Dr. Paul, a more important element. The light refined oil from the Lewes peat was sold in 1862 in Glasgow, under the name of lignole; and, according to the report of Dr. Anderson, it compared favorably with the burning oils from coal, shale, and petroleum; being pale in color, and with much less unpleasant odor than the coal oils. The statements of Armand that peat may be made to yield as much as fifteen, or even eighteen per cent of tar, do not appear to be confirmed by other investigators. According to Vohl, who in 1858 published an elaborate investigation into the distillation of lignite, peat, and bituminous schists, the various peats, when distilled in retorts, yield from six to nine per cent. of tar; and in the case of a light peat, 5·37 per cent. In rectifying the tar, the distillation may be carried to dryness when it is wished to obtain the greatest amount of liquid products, as in Dr. Paul's operations. By arresting the process at the proper point, a large proportion of the material remains in the retort, as a kind of pitch; which may be used, like asphalt or solid bitumen, for covering roofs and similar purposes. In this way, according to Vohl, one hundred parts of tar yield forty-two parts of pitch. In order to purify the distilled oil for burning in lamps, it is first treated with a solution of soda, and afterwards with concentrated sulphuric acid, as in the refining of petroleum. The alkaline solution dissolves a considerable amount of creosote and of carbolic acid; which may be afterwards separated by means of an acid, and have a commercial value. The paraffine separates in a crystalline form from the heavier and less volatile oils, when these are exposed to cold. With the present demand for oils and paraffine, it is more profitable to distil the tar to dryness, than to manufacture a portion of it into pitch. The value of a ton of crude tar, capable of yielding one hundred gallons of oil and paraffine, may, according to Dr. Paul, be estimated at £5 sterling; and he concludes that peat approaching in richness to that of the Highlands of Scotland may be distilled with great profit. It remains to be seen whether some of the extensive peat-bogs of Canada may not produce a material equally available. The importance of these deposits as a source of fuel to the country should not, however, be lost sight of; and it is to be hoped that before long successful attempts may be made to introduce compressed peat as a combustible, for the generation of steam and for domestic purposes.

The principal deposits of peat which are as yet known in Canada, will now be noticed. It is to be remarked, that, with the exception of a partial trial made of the peat near Chambly, none of these deposits have ever yet been worked; and that it is only in a few localities that the thickness of the peat has been determined by pits, or by borings. Beginning to the westward, a deposit of peat occurs on the twelfth lot of the fourth and fifth ranges of Sheffield; where it overlies a bed of marl already described, and extends over three or four hundred acres. The average thickness of the peat is about four feet, and it is said to be of superior quality. In the level region between the St. Lawrence and Ottawa rivers, described in "Geology of Canada," page 8, several large peat-bogs occur; but from their nature, the vicinity has been avoided by settlers, and they are therefore difficult of access. There is said to be a considerable area of peat in the rear of the seigniories of Vaudreuil and Rigaud; and also in Caledonia, where its thickness does not appear to exceed three or four feet. Peat occurs at the sources of the Pain River in Roxburgh, Osnabruck, and Finch; and also in Clarence, Cumberland, and Gloucester. In the third, fourth, and fifth ranges of the latter township is a tract known as the Mer Bleue, which consists of two long peat-bogs, separated by a narrow ridge of higher land, and occupying each about 2500 acres. These deposits were sounded in many places, with a rod, to a depth of twenty-one feet, without finding bottom; in other parts, the peat was from eight to fifteen feet in thickness. This tract is situated only three miles from the Ottawa, and is about 280 feet above the level of the sea. Three large areas of peat, of from 1000 to 3000 acres each, occur in Nepean and Goulbourn; one of them to the east, and two to the west, of the village of Richmond. It is also found on the third and eighth ranges of Beckwith, to the east of Mississippi Lake; and an area of about 3000 acres of peat occurs in Westmeath, in the rear of front A, and from the first to the fifth range behind it. In the ninth and tenth ranges of Huntley, there are about 2500 acres of peat; which in some parts has a thickness of eight or ten feet, while in other parts no bottom was found at a depth of fifteen feet. It is probable that peat may be met with in many other localities throughout this region.

On the north side of the Ottawa, three small areas of peat have been observed in Grenville. One of these, on the fourth and fifth lots, covers about thirty-six acres, and has a depth of ten feet. It has been used in the neighborhood, and is pronounced of excellent quality. Another deposit of about the same extent occurs on the first lot of the same range, and is in some parts more than fifteen feet in thickness. A third, of about thirty acres, occurs on the fourth lot of the seventh range. On the fourth and fifth lots of the first range of Harrington, is a bog of about forty acres, the peat of which varies in depth from ten to twenty-five feet. Another bog is described as occurring on the first and second lots of the fifth range of the same township. It extends over about sixty acres, and has a thickness, in some parts, of twenty-five feet. All of these areas might be drained without much difficulty. To the eastward of this, a peat-bog is met with in the Rang Double of Mille-Iles. It exhibits a breadth, on the road from St. Janvier to St. Jerome, of about half a mile, and has an area of perhaps five-eighths of a square mile. Its depth along the road was found to be in several places from two to eighteen feet, the greater depth being towards the south-east side, and its average may be taken at eight feet. A smaller deposit of peat occurs half a mile nearer to St. Janvier; it has a breadth of about a quarter of a mile, but its superficies and depth have not been ascertained. Upon the same great plain with these, a little to the north of the church of Ste. Anne des Plaines, and on the north-east side of the road leading to New Glasgow, is a peat-bog having an area of about a square mile. Its depth was not determined, but it is supposed to average about five feet. The farmers are in the habit of burning the surface of parts of this bog, and employing the ashes as a manure for the underlying portions, until by repeated burnings they reach the subjacent clay; which, mingled with the last thin layer of peat and a portion of the ash, constitutes a very fruitful soil.

Near the front of the seigniories of Assumption and St. Sulpice there is a peat-bog three and a half miles in length with an average breadth of half a mile, giving an area of about 1100 acres. Its depth varies from two to fifteen feet; and the result of ten trials made in two lines across the bog gave an average of ten feet. In the seigniories of Lavaltrie and Lanoraye, there are two extensive peat bogs, running parallel with each other. Of these the northern is the larger, and is known as the Grande Savanne. It has a length about eight miles from north-east to south-west, and a breadth of from half a mile to two miles and a half, covering a superficies of from twelve to fifteen square miles. Two sections were made across this bog; one on the line of the railway between Lanoraye and Industry, which traverses it about three miles from its south-west extremity. It here reaches to within four miles of the St. Lawrence, and has a breadth of two and a half miles. The depth along this line was found to be from four to fourteen feet; the average of twelve trials giving about eleven feet. The other section, along the Lavaltrie road, about four miles to the north-east, gave a breadth of half a mile, and a depth of from seven to fourteen feet; averaging, as before, eleven feet. The smaller of these bogs lies between that just described and the St. Lawrence at a distance from the last of about two miles. On the line of the railway it has a breadth of over half a mile, and an average thickness of about five feet. It has a length of more than five miles, extending four and a half miles to the south-west of the railway, and a superficies of about three square miles.

In the fief St. Etienne, about a mile and three quarters south-west of the Grès, on the St. Maurice River, the main road crosses a peat-bog, which is there half a mile in breadth, with an average depth of about six feet. Its extent to the north-east and south-west has not been ascertained. Another was met within the seigniory of Champlain, about three miles from the St. Lawrence, and on the road from the church to the river Champlain. Its breadth on the road is about three quarters of a mile, and its average depth in this part five feet. Its length from north-east to south-west appears to be about two miles; giving to the bog an area of about a mile and three quarters. In the fief D'Auteuil, on the road between Cap Santé and the village of L'Enfant Jésus, there is a peat-bog, with a breadth of about a quarter of a mile, which has not been farther examined. Several other peat-bogs are known to exist between this last locality and the vicinity of Quebec.

On the south side of the St. Lawrence, there is a large area occupied by peat on the west side of the river Richelieu. It covers portions of the seigniories De Léry and Lacolle, and of the townships of Sherrington and Hemmingford, embracing perhaps fifteen or twenty square miles. This area is drained in part by the Lacolle River. It has not been carefully examined as yet; but it contains in some parts, particularly it is said in Sherrington, a very great thickness of peat. Of two specimens from this township, one, which was dark-colored, fine-grained, compact, and so heavy as to sink in water, gave only 3·53 per cent of ash; while the lighter peat from near the surface of the bog yielded 4·66 per cent of ash. Both of these are very pure; and the compact peat, which is remarkable from its great density and its freedom from earthy matters, is particularly worthy of attention.

A large peat-bog occurs in the seigniory of Longueuil, on the road to Chambly; and an attempt was made a few years since to raise the peat and introduce it to the Montreal market. A peat-bog of large size is found in the seigniory of Ste. Marie de Monnoir; and another in the parish of St. Dominique, including part of Ste. Rosalie and St. Pie. Its dimensions may be five or six miles in one direction, by three or four in another. This extent is covered by a layer of peat; which, from two or three feet at the edges, attains a depth of six feet, and in some parts, it is said, is eighteen feet in thickness. The bog has been partially drained, and portions of the land reclaimed for agricultural purposes. The drained land being first cleared of trees, is ploughed, and then, in the dry season, set on fire. In this way, eight or ten inches of peat are burned, leaving an ash which serves as a manure, and enables the surface to yield one or two crops of barley or oats. After two years, the soil becomes exhausted, and it requires to be again burned over to render it productive. When by several repetitions of the process, the peat has been reduced to a few inches, the remaining portion is mingled, by ploughing, with the underlying clay, and a rich mellow soil is obtained. The peat from this bog yields, when heated in close vessels, about thirty-six per cent of coke, and contains from six to seven per cent of ash.

In the seigniory of the Rivière Ouelle, there is a peat-bog which covers about 4000 acres; and another one occurs in the seigniory of Rivière du Loup, having a superficies of 6000 acres. Its breadth on the Temiscouata road is a mile and a quarter, and its depth in some parts has been ascertained to be eighteen feet. Peat is found in abundance on the first and second concessions of the seigniory of Ile Verte; and from a point two miles below the Rimouski, there is a belt of peat-bog extending nearly all the way to the Métis River, a length of over twenty miles. Its distance from the St. Lawrence is from a quarter to half a mile, and its breadth from a quarter of a mile to a mile. The depth of the deposit, where observed, was from one to six feet. To the east of the Rimouski River, there is a peat-bog, which has a length of three or four miles, in the townships of Duquesne and Macpes; with a breadth of about three quarters of a mile, and a thickness which was found to be from five to twelve feet: it is said to be in one place, thirty feet in depth. Another locality of peat is stated to be in the townships of Matanne and Macnider, between the rivers Blanche and Matanne. A peat-bog of about one hundred acres occurs on the left bank of the Madawaska, just above the twelfth-mile post on the road to the Little Falls.

The most extensive peat deposits in Canada are found on Anticosti. Along the low lands on the south coast of the island, from Heath Point to within eight or nine miles of Southwest Point, a continuous plain covered with peat extends for upwards of eighty miles, with an average breadth of two miles; thus giving a superficies of more than one hundred and sixty square miles. The thickness of the peat, as observed on the coast, was from three to ten feet, and it appears to be of an excellent quality. The height of this plain may be, on an average, fifteen feet above high-water mark, and it could be easily drained and worked. Between Southwest Point and the west end of the island, there are many smaller peat-bogs, varying in superficies from 100 to 1000 acres.

NATURAL HISTORY SOCIETY.

The monthly meeting of the Society was held on Monday evening November 28, and, notwithstanding the unfavorable aspect of the weather, the attendance was large.

Among the donations announced, we notice the following:

To the Museum.

Fœtal monkey from Australia, also an antique spoon, two rings, and a fragment of (human) bone dug up in the fields near Cacouna, from Dr. A. Hall; eighty-two beautifully prepared specimens of Canadian butterflies and moths, from Mr. P. Kutzing; specimen of the spruce partridge (*Tetrao Canadensis*, Linn.), from Mr. Jas. Ferrier, jun.; an American woodcock (*Philohela minor*, Gray), from Mr. More; specimen of the painted bunting (*Plectrophanes pictus*), from the plains of the Saskatchewan, from Mr. G. Barnston; and a pair of fine black squirrels from Upper Canada, from Mr. W. Hunter.

New Members.

Captain Rooke, S. F. G., was elected a corresponding member, and Messrs. H. Abbot, T. F. Hanlon, R. E., and W. S. McFarlane, ordinary members of the Society.

Proceedings.

The Report of the Scientific Curator was first read, as follows:

Report of the Scientific Curator.

Since the annual meeting, the Society's yearly report for the session 1863–64 has been prepared and issued to the members. Under the auspices of the council, a catalogue of the Canadian vertebrata contained in the museum has been prepared and published with the Report, in order that friends at a distance may know what species are desiderata in our collection. Care has been taken to make the list of donations to the museum and library for the past year, full and complete. Efforts have been made to make the list of members accurate and trustworthy; but it is feared some errors may yet remain uncorrected. The co-operation of members is desired in order that such mistakes may be avoided in future.

At the date of my last report (May 18) about 1200 specimens of minerals had been carefully labelled. Since then, the remaining part of the Holmes collection, consisting of about 500 specimens has also been carefully labelled. The mass of confusion in the large case in the aquarium-room has been reduced to something like order, and about 430 specimens of rocks and minerals have been named and exhibited. Many packages, that have remained unopened for years, have been unpacked, and some of the best specimens selected, named, and exhibited. Although upwards of 2000 examples of minerals and rocks have been labelled, about as many more remain without their names affixed. As soon as proper cases can be obtained, it is proposed, first to name all those which are unlabelled, as far as possible, and then to thoroughly re-arrange and classify the whole collection. The rock-specimens we ultimately hope to arrange after the classification adopted by Prof. Dana, in the last edition of his Manual of Geology, and simple minerals after the plan followed in the "Mineralogy" of the same author. It is hoped that when the collection of rocks and minerals is thus arranged, it will be of far more use to the student of geology or of mineralogy than in its present scattered state. Our Post Tertiary, Tertiary, Cretaceous, Oolitic, Liassic, and Carboniferous fossils have been mounted on tablets, classified, and named. Mr. Billings has kindly promised to determine the Silurian and Devonian species. The most important part of the summer's work has been the arrangement of the insect-cabinet. Thanks to the liberality of Messrs. W. Saunders, W. S. M. D'Urban, John B. Goode, P. Kutzing, C. Foley, R. J. Fowler, and James Ferrier, jun., the Society's collection of insects, already somewhat large, has been nearly doubled. Our scattered series have been incorporated into one general collection; they have been arranged provisionally, and named as far as possible. Thirteen drawers (22 inches by 16¾ in diameter) are devoted to Canadian insects, and thirteen to British and exotic species. We have more specimens than one cabinet will hold: it would be desirable, at some future time, to get another similar one, to be devoted exclusively to the reception of British and exotic forms. The old specimens have been washed with a solution of corrosive sublimate in alco hol, as a preservative, and many have been replaced by fresh examples. The Annelida from the Gulf of St. Lawrence have been mounted, named, and classified. The Polyzoa (or Bryozoa), from the same district, have been sent to Dr. Dawson for microscopical investigation. They have just been returned, carefully named; and in a short time it is hoped that they will be available for the use of students.

Several of the exotic birds have been named, but as yet a large number of the species are still undetermined. Through the kindness of several personal friends in New Haven and New York, considerable additions have been made to the collections of mollusca, radiata, and fossils. These have had accordingly to be re-arranged and classified. A series of the most critical species of marine shells from the Gulf of St. Lawrence have been sent to Dr. Stimpson, at Washington; and when they are returned I propose to bring before the Society a paper, in which an attempt will be made to clear up the confused nomenclature of the Canadian marine mollusca. Printed labels have been attached to all the specimens of Canadian reptiles, and the snakes in particular have been carefully studied. J. F. W.

To this succeeded a paper on the Night Heron (*Nyctiardea Gardeni*) by Mr. H. G. Vennor, which was read by the Recording Secretary, in the absence of the author.

Mr. Braun's paper on the Atlantic Telegraph was also read by the Recording Secretary. It gave a somewhat elaborate account of the history of the whole scheme, with reasons for its failure; and concluded by a description of some mechanical appliances, the main object of which appeared to be to keep the cable firmly on the sea-bottom. The peculiar mechanism by which this was proposed to be effected was described, and illustrated by diagrams; which latter may be seen, by any persons interested in the subject, at the Society's Museum.

Specimens of the new cable were kindly lent for the occasion by Mr. H. Lyman; and Dr. Smallwood brought a diagram, taken from a series of soundings, in which the differences of level in the sea-bottom between Valentia and Newfoundland were clearly shown.

An animated discussion took place after the reading of this paper, in which Principal Dawson and others took part.

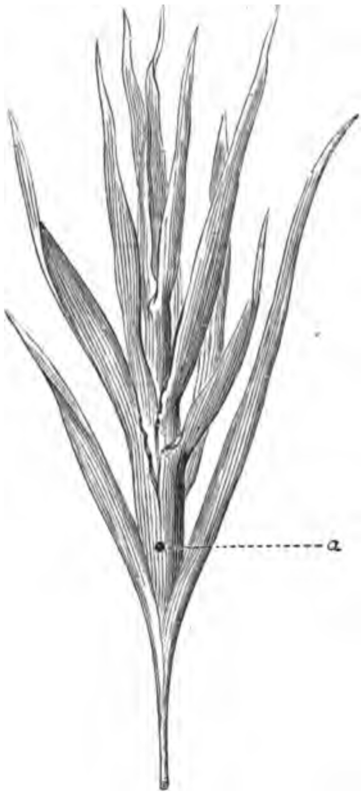
ENTOMOLOGICAL SOCIETY.

ON A GALL-PRODUCING HYMENOPTER, REARED FROM TRITICUM REPENS, LINN.

By Wm. Couper, Quebec.

There is a large extent of cleared land in the neighborhood of Quebec which does not appear to be exhausted for agricultural purposes, and yet it is neglected. The consequence of this neglect is that it becomes occupied by innumerable noxious weeds: one of these is the common creeping wheat-grass, *Triticum repens* of Linnæus. This grass is attacked by a hymenopterous insect which, I suppose, is the yellow-legged or New York barley-fly, *Eurytoma fulvipes* of Fitch. The insect appears in June, when the female deposits an egg in each joint of the grass, producing a gall as represented in the following figure.

This grass is most troublesome to the Canadian farmer owing to its creeping habit. "Its long underground stems penetrate the loose soil in every direction, and, when once they have possession, are very difficult to eradicate, as, broken up by the plough or spade, every fragment vegetates apart, thus renewing and extending the crop. Few plants exhaust the ground so rapidly of nutritive matter, and it can only be got rid of by repeated fallowing or laying down to pasture." If our farmers would appropriate such land to pasture it would help, in a great measure, to remove its present worthless parasite. Although this insect attacks the grass, it by no means lessens its growth; therefore, if we make no effort to check the increase of worthless plants, depend upon it the insects which are attached to them will increase as well, becoming, as in many other cases, a double evil,—for this very *Eurytoma* may some year be produced in such abundance that any of our useful cereals may be destroyed by it. It is different from the barley-straw insect described by Harris in the "New England Farmer," vol. ix, p. 2, as *Eurytoma hordei*. It is larger, and only one insect is found in each gall. As soon as the



Gall of *Triticum repens*.
a, the hole made by the insect by which it escapes.

larva issues from the egg, it places its head downwards in the gall, remaining in that position until it eats its way through. About the end of September it ceases to feed, and prepares to meet a Canadian winter (as far as I have investigated its history, it is able to stand a very low temperature). By this time the gall is hardened, and the larvæ remain in a torpid state, becoming active again in the following spring, changing to the perfect insect in time to attack the young grass of the season. Of thirty-six galls collected early last May, all produced the insect but three, which were empty. I have not detected a parasite on the *Eurytoma* during the advanced stage of the gall; but about the first of August, 1863, when the galls were brought to my notice by Mr. Kirkwood of the Crown Lands Department, I forwarded a few in the green state to Baron Osten Sacken, thinking that they were produced by a cecidomyia. He says, " It is not at all unlikely that *Triticum repens* is infested by a cecidomyia, but in the specimens you sent me I found nothing except a very minute larva of a hymenopterous parasite." Since then I sent more advanced galls, together with the insect, to Mr. Edward Norton, of New York, who is considered good authority on American hymenoptera. He had removed to New Orleans, where my letter found him, and he answers, " that on account of his collection having been left in New York, he was then unable to answer my questions"; however, he forwarded the galls and insects to Baron Osten Sacken for his investigation. The baron writes to me as follows: " The insect is a *Eurytoma*, but whether it is *E. fulvipes* of Fitch, as you suggest, I am unable to tell. This genus is very numerous and apparently very difficult, as the species seem to vary in size, and most of them have nearly the same coloring. I have reared numbers of them from galls, without ever attempting to separate the species."

If it is *E. fulvipes*, then I may safely state that it does not confine itself to a single species of plant, and any of the cereals may be destroyed by it. To bring this insect before Canadian entomologists is the object of this short notice; and I only wish that one of them will find sufficient leisure to investigate its complete history.—*Read before the Quebec Branch, Oct. 6th,* 1864.

MEETING OF BRITISH ASSOCIATION.

OBSERVATIONS ON THE SALMONIDÆ.

Dr. J. DAVY read the following paper, entitled " Some Observations on the Salmonidæ, chiefly relating to their Generative Functions:"—It is now well known as an established fact that the young of the salmon in its parr-stage, has, in the instance of the male, the testes fully developed, so as to be capable of impregnating the ova of the adult fish. Remarkable and anomalous as this must be admitted to be, it is the more so considering that in the female parr of the same age, the ovaries are merely in their rudimentary state, and are indeed so small that they may readily escape observation, and give rise to the opinion that the parrs are exclusively males. Such a notion, I am informed, is even entertained by the fishermen of the river Tyne. That it is founded in error I need hardly remark. When at Newcastle-on-Tyne, in September last, I had an opportunity of examining, through the kindness of Dr. Charlton, six specimens taken the preceding day. Four of them were males, distended with milt, the milt nearly mature, and, notwithstanding, the fish had not fallen off in condition,—a noteworthy circumstance. Two had no vestiges of testes, nor could I discover their ovaries, which may have been owing to solution, to which the parts of the young fish are especially liable where adjoining to the pyloric appendices. From such observations as I have made when on angling excursions, I can state with confidence that the proportion as to number of the two sexes is much the same. A question naturally arises, is this peculiarity of the early development of the male organs confined to the salmon (*Salmo salar*), or is it to be met with in its congeners of the same stage of growth? The common opinion is that the parr of the sea-trout (*S. trutta*) has the same peculiarity; but I am not aware that the conclusion is founded on precise and reliable observation. The determination of this point is a desideratum. This is not an easy matter to accomplish, owing to the near resemblanne of the parr of the two species. To effect this, a river should be selected which is known to be frequented by the sea- or white-trout, of which there are many in Ireland. The probability, I think, is, that a confirmation of the opinion would then be obtained. I am led to think so from the few observations which I have made. These I shall relate. They were made, or part taken, in Leeven, a river that flows out of Windermere, and is frequented by salmon and sea-trout; the latter being most plentiful. Two parrs taken on the 29th of September were each about four inches long; the milt in each was large; their fins were yellow. From their size and yellow fins they were supposed to be the young of the sea-trout, or "morts," the local designation. Six parrs, taken on the 21st of October, were about six inches in length. Of these four were males; their testes voluminous, their fins light-yellowish. These were supposed to be the young of the salmon. A parr taken on the 1st of January was six and a quarter inches in length; it weighed 740 grains; the testes weighed fifty-five grains; the contents were nearly liquid;

its fins were bright yellowish; it, too, was inferred to be a salmon-parr. I need hardly remark that these few observations justify no more than the probability that the male parr of the sea-trout, like the male parr of the salmon, exercises generative functions. The size of the young fish and the color of the fins can scarcely be relied on as characteristics of species. Be this as it may, it is noteworthy in the history of the male parr, that it discharges its milt before it descends to the sea as a smelt, which is the name the young fish receives when the parr-markings are hid by a new growth of silvery scales. In no instance that I have examined smelts, in their advanced stage, when migrating seaward, have I found their testes otherwise than shrunk. No suspicion is entertained that I am aware of, that the brown-trout of our lakes and rivers (*S. fario*) exhibits the peculiarity in question,—the early development of its testes. The absence of it has, I believe, hitherto been taken for granted, rather than proved. To endeavor to satisfy myself about it, I have examined a certain number of young trout when in that stage of growth, similar to the parr; when about eight months old it may be presumed, about four inches long, and having transverse bar-markings on their skin like those of the parr but fainter, and distinguishable only when wet and during the life of the fish. In none of them have I found the testes more than rudimentary, merely fibre-cords, corresponding in size to the rudimentary state of the ovaries of the females of the same species. I shall pass on now to another point which is not without interest, the time, namely, when the salmon and sea-trout begin to breed. It may be stated, I believe, as an established fact, that the salmon breeds on its first return from the sea, when it is designated a grilse, and commonly weighs from five to seven pounds. That it breeds thus early is a conclusion founded on nature, or nearly nature, ova having been found in the female on entering the fresh water, and the disappearance of these ova when the fish is taken on returning to the sea. Is the breeding-time of the sea-trout analogous; is it, too, on its first migration from the sea sufficiently advanced to propagate its kind? I believe not. From my own observations, and from all the information I have been able to collect, its ovaries on quitting the sea as a "finnick" (the designation applied to it in the north at this period of its growth) are little more than in a rudimentary state; and, further, that they advance very little towards maturity during the sojourn of the fish in river or lake. The following observations, taken from my note-book, are given in evidence, justifying, as it seems to me, the conclusion:—On the 27th of August, fishing in the river that flows out of Morsgael Lake, in the Lews, I took with the fly nineteen sea-trouts, varying in weight from half a pound to two pounds and a half. They were all fresh run from the sea. Many had the sea-louse on them. The larger fish were full of milt and roe, both nearly mature. The smaller had the roe and milt very small, and so not likely to breed that year. The males and females were nearly of the same number. The following year, fishing in the lake just mentioned, and in the same month, viz., August 31st, I took with the fly forty-four sea-trout. Of these, twelve were males, the rest females; of the latter, twenty-two had roe nearly full size. The other ten were much smaller fish; each was about a quarter of a pound, in excellent condition, and yet their ovaries were so very small that they might have escaped detection had they not been carefully sought for. Of the males, all but two had the milt large; these two were also fish of about a quarter of a pound. Their testes had the appearance of fine threads. The "finnick," such as I have seen it in the Lews of the Hebrides, and in the fresh rivers, and lakes of Kerry, Donegal, and Connamara, is the same, I believe, as the whiting of the Eden and the Solway and the smaller sewen of the Welsh rivers. It is a beautiful and bright fish, rarely exceeding half a pound in weight, and is of great delicacy of flavor as an article of food. The color of its muscles is light-pink, very much lighter than that of the muscles of the salmon or of the full grown sea-trout, when in its best condition. The light silvery lustre of its abdominal portion, equally remarkable in the adults when fresh from the sea, fairly entitles it to the name of white-trout, as it is called in Ireland, to distinguish it from the brown-trout. There seems to be as little reason to doubt that they spawn on their second advent from the sea, as that they are not sufficiently advanced to perform that office on their first arrival. Their spawning-time is believed to be earlier than that of the salmon, about three weeks or a month, and is mostly, at least in the Lews, late in September. There is a third question which I beg to propose respecting these fish,—the salmon, the sea-trout, the common trout, and, I may add, the charr. Do they breed yearly or in alternate years? The generally received opinion, I believe, is that their fertility is continuous from year to year. From such observations as I have made, I am disposed to doubt the correctness of this conclusion, and to infer that their breeding takes place rather in alternate years, or at least not in successive years. The facts on which this inference is founded, are, that in the instance of each of the fishes above named, a number of them are met with which have their ovaries and testes so small as to preclude the idea of their spawning during the season, the ova in the one being merely granules, the testes in the other little more than slender cords or threads. As regards the salmon and the charr, it is admitted by experienced fishermen that what they call "barren fish" are taken at the same times as those of the sea-trout and of the common trout. Of the last it is remarkable that in the Rathay, a tributary of Windermere, this fish, even in the spawning-month, and throughout the year, is found in good condition, its testes and ovaries little developed. I have numerous notes to this effect. I shall give only one. "October 25th, of four trout from the river in flood, two were males, two were females; they were beautiful silvery fish; their ovaries and milts very small." The breeding-fish, it may be inferred, at the breeding-season quit the main stream and ascend the smaller ones. The peculiarity of the trout being always in season in this river may be owing to this circumstance, and to another, that it flows out of one lake into another, and is consequently throughout the year nearly of the same temperature, and so favorable to the production of such food as is required to keep the trout in the condition mentioned. I shall give only one note from my note-book relating to the sea-trout. "On the 11th of September, about eighty sea-trout were taken in an estuary of the Lews, in one haul of the net. The largest weighed about four pounds and a half. About one-half of the whole number were called barren fish, their milts and roes being so very small as to preclude the idea of their breeding that season." Now, as it seems improbable that so large a proportion should be really barren, the other conclusion that they were in a fallow state for the season, seems, I cannot but think, most reasonable. To have strict proof, in would be necessary that a special enquiry should be instituted, and that fish should be marked after the manner of those on which observations have been made to determine the rate of growth of the young salmon. The points of difference in nearly allied species, such as the salmonidæ, are an interesting subject for enquiry; they are to be witnessed, not only in certain qualities of organization, but also in ratio of growth, and, as we have seen, of generative power, and likewise in habits of feeding and the effects of atmospheric influences. The growth of the sea trout in the sea is slow in comparison with that of the salmon; it is not uncommon to find food in the stomach of the former when in fresh-water, but it is rare that any food is found in the stomach of the latter after leaving the sea. The sea-trout, as is well known to the experienced angler, is more readily taken, using the artificial fly, under circumstances of weather differing from those most favorable to the capture of the salmon; a dark windy day being best for the latter, a warm cloudy day with gleams of sunshine for the former. One quality they have in common with river and lake trouts,—that their ova are capable of being hatched only in fresh and well-aërated water, leading to the conclusion that the migratory species must always have been migratory, unless indeed we suppose that there was a time when the seas were less salt than at present and the lakes and rivers less fresh, and that then the habits of the salmonidæ were formed, and they gradually became divided into the migratory and non-migratory species.

Sir W. JARDINE offered some observations on Dr. Davy's paper. In reference to the male parr or young salmon being endowed with the power of impregnating the ova of the adult fish, he said the same power had not been found in any other of the salmon species. He was not aware that experiments had ever been made with any other variety, the fish not having been found in a state fit for the purpose. With regard to the salmon breeding yearly, or in alternate years, that was a very difficult point to prove; but, as Dr. Davy had observed, the number of barren fish occasionally taken, was presumptive of their breeding in alternate years. If Dr. Davy would go to the river Tweed in the end of November, and fish with salmon roe (which was now forbidden), he might kill a basketful of the *Salmon eriox* all in a fit condition for the table. Last year he (Sir W. Jardine) went there to try experiments, believing that the fence-time was far too protracted, and that the salmon kind should not be taken so late in the year as November. They netted the river, and in three draughts took out between seventy and eighty salmon and bull-trout, not one of which was fit for the table. Nothing was fit for the table except the small *Salmo eriox*. As to the spawning-time, he had no doubt that the common trout spawned earlier than the other varieties of the salmon. There was a great many common trout of all sizes barren, and it was the common trout caught in January and February that were now coming, in beautiful condition, into the London market. In the beginning of the season they would probably have, out of fifty trout taken, not three or four that were fit for the table; but as the season advanced, the seasonable fish increased in number. Dr. Davy, referring to the experiments made by Sir W. Jardine, said there ought to be no difficulty in carrying out these experiments, inasmuch as the Act allowed the capture of salmon during the fence-term for scientific purposes.

TRANSPORT OF SALMON OVA TO AUSTRALIA.

Mr. T. JOHNSON read the following paper:—At one of the sectional meetings of the British Association last year, I had the honor to read a paper giving some account of the attempt which had been made to transport to Australia the ova of the most beautiful specimens of the finny race, the salmon. Upon that occasion the President of the Section hoped that at the next meeting of the Association an account of the success of the undertaking to transport the *Salmo salar* to Australia, would be given to the members of the Association. Having kept the president's suggestion in view, and the fourth attempt to transport the ova of the salmon to Australia having this year terminated successfully, I have prepared a short account of the plan adopted; the arrival of the expedition at Melbourne and Tasmania; the progress of the most critical part of the experiment,—the rearing of the fish; the temperature of the rivers intended for the reception of the fish, and the further prosecution of the plan of acclimatizing this noble specimen of the species.

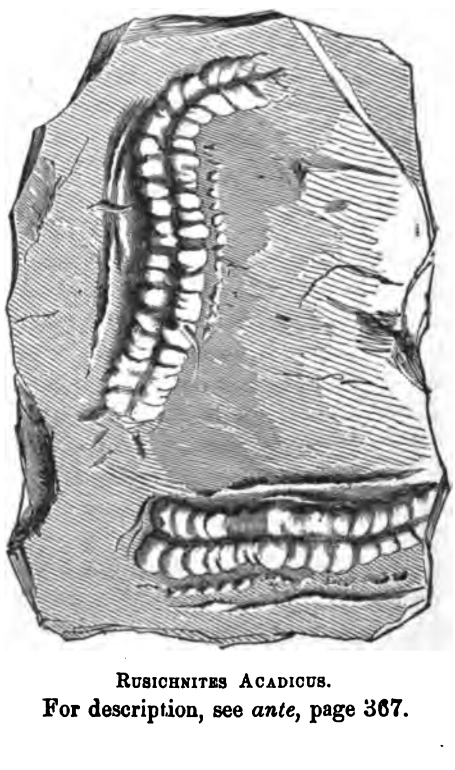
The plan of operations which has this time been crowned with success was confined to an ice-house, holding over thirty tons of Wenham Lake ice, which was built on board Messrs. Wigram's ship Norfolk, sailing from London on January 21st, and Plymouth on the 29th January, 1864. The ice-house was built of two thicknesses of three-inch deals, forming an open space of from seven to nine inches, which was filled-in with charcoal dust. The lining was of lead from seven to nine pounds per square foot, the watercourses and drain-pipes leading to the ship's timbers. In the ice-house, amongst the ice, were deposited 181 boxes of common deal, measuring twelve by nine inches by five inches deep, containing upwards of 100,000 salmon-ova, taken from English and Scotch rivers in the month of January, and 3000 trout-ova; all carefully packed amongst damp moss. One tier of boxes was placed upon the gratings at the bottom of the house, covered with ice, others about midway, and the remainder at the top of the ice-house. The Norfolk, after a fine passage of seventy-five days from Plymouth, arrived at Melbourne on the fifteenth of April last. Mr. Edward Wilson, president of the Acclimatization Society, and other gentlemen were soon in attendance, and examined eleven boxes containing the ova; every box of this number exhibiting its contents in a fine state of preservation. These boxes were detained at Melbourne, to form the nucleus of the salmon-supply for Melbourne. The remaining 170 boxes were then re-shipped, packed with the remainder of the ice, in large cases, on board H. M. C. steamship Victoria, and sent off to Tasmania. The Victoria arrived and anchored off Battery Point on the 20th of April, when the members of the Acclimatization Society boarded her. The following gentlemen composed the Committee of Management, viz.: Mr. Gibbon (officer), Mr. M. Allport, Mr. Falconer (Director of Public Works), the Hon. J. M. Wilson, Mr. Gould (the government geologist), and several others. The following plan was adopted as the means of transport to the breeding-boxes on the river Plenty: A considerable number of attendants were told off as carriers, the parties being again subdivided into two relays, destined to relieve each other from time to time on the way. The mode of carriage was that of the Chinese, and familiarly known as such to resident visitors to the neighboring colony of Victoria. Each case was provided with two handles of rope on either side, and through each pair was passed a bamboo-stick of some twelve feet in length, the extremities of which rested on the shoulders of bearers. On arriving at the pond some little delay was occasioned through a considerable accumulation of alluvial deposits on the gravel-beds which had to be removed before the ova could be deposited; this however, was soon done, and the ova afterwards speedily placed in the hatching-boxes. The analysis of the contents of the boxes at Melbourne and at Tasmania shows that out of the 103,000 ova transported, upwards of 31,000 were safely deposited in the prepared gravel-beds. We cannot but regret that out of 103,000 we should have so few left. Remarkable as the case appears, and considering the various and many precarious changes which the ova have been subjected to from the date of impregnation until the arrival at Melbourne and at Tasmania, we can scarcely fail to acknowledge that the experiment has been singularly successful. As it is intended to continue the transporting of salmon-ova during some years to come, and with the view of eliciting opinions or suggestions bearing upon the modes of transport, I may be allowed to state a few of the difficulties we have had to contend against. And let it be borne in mind that there are many dangers on board ship, such as we have not upon land. These difficulties may be gathered from the following extract from the letter of Mr. Joul. He says, " It is impossible to account for the difference, as it may arise from so many causes. Some of the ova was not in the best condition; it may be the moss, or the water it was washed with, or the water it was drenched with, or foul air in the ridge, or some of the ova got frozen before the Norfolk left the docks during the severe frost." To these probable causes I would add, the fish may have been partly or wholly diseased, or the impurities of the ice, or insect matter as it escaped through the melting of the ice, but more particularly, I should say, the bilge-water in the ship. In this opinion I am partly borne out by Dr. Officer, who, in a letter to Mr. Joul, dated 22nd of April, 1864, says—" Mr. Ramsbottom thinks that the boxes nearest the bottom were the least healthy." These causes, we may infer, are very serious drawbacks, and, in my opinion, the principal cause of destruction. Previous to the ice-house being commenced with, I proposed a plan of drainage to prevent the possibility of any bilge-water entering the ice-house, but could not have it carried out. Mr. Joul saw the necessity for such an arrangement, but the owners of the Norfolk refused permission, alleging that it would materially interfere with the stowing of the cargo. Mr. Joul gave way, although I could come to no such conclusion. The plan I proposed would have provided a thorough system of drainage, without being exposed to the evils attendant upon opening a communication with the ship's timbers. This could have been done by draining off the ice-water into two tanks, one on each side of the ice-house; having attached to each an ordinary pump, communicating with the upper deck. Had such an arrangement been carried out, a two-fold object would have been achieved, viz., there would have been no open channel, by which the bilge-water could have entered the ice-house; and the person in charge would have been enabled to pump up the ice-water and measure it off, showing correctly how much ice was being melted per diem. I should here observe, that as the owners of the Norfolk gave the space taken up by the ice-house gratis, and that, as it was very difficult to get a suitable ship, Mr. Joul had no other choice but to agree to the plan we worked out. The ova being safely deposited in the beds at Melbourne and Tasmania, we came to the next critical test—viz., the hatching-out, and the rearing of the young fry. The advices we have from Melbourne and Tasmania record the appearance of the ova when deposited, and when the fish were hatched, the last day of hatching, and the number of young fry they have at each place up to the 20th June, 1864. It appears at the time the ova were deposited in the hatching-boxes, the formation of the fish in many instances was so far complete that their eyes were plainly visible. This fact led Dr. Officer and other gentlemen of the Acclimatising Society to conclude that, before many days, numbers of the young fry would emerge from the shell. Such, however, was not the case, inasmuch as the first fish was not hatched until the 4th of May, and at Melbourne on the 7th of May. By the 11th as many as forty trout and nine salmon were hatched, the numbers increasing daily. Unfortunately during the hatching, the mortality of the ova and the fry reached to something like 100 per diem, which decreased as the season grew colder. The last fish, says Dr. Officer, hatched-out on the 8th of June, fifty-four days after the arrival at Tasmania, and 147 days after the date of impregnation. After this great success, a want of caution, probably from an over-desire to do more than nature will bear, seems to be one of the greatest disorders we have to contend against. The advices down to the 20th June show the ratio of mortality amongst the ova and the young fry to be so great, that the total number of fish, both at Melbourne and Tasmania, does not exceed 3,300. To what cause are we to attribute the fearful mortality among the young fish? Mr. Joul, writing upon the subject, says, "It is an established fact that salmon and trout ova can be sent to the antipodes, and hatched there; but as I am not satisfied with only about 3,000 fry being hatched from about 30,000 living healthy ova that were placed in the breeding-ponds in Tasmania, and about 300 from 1,200 healthy ova in Melbourne, I wish to call the attention of Mr. Buckland, Mr. Francis, Mr. Buist, and other artificial breeders, to these numerous deaths of the ova, after having advanced so far in hatching as to have the eyes well developed, and when they ought to be considered safe, with the view to elicit from these gentlemen an opinion of the probable causes, and to suggest a remedy. My own experience is that out of 100 healthy ova taken from the moss, which have not been more than 100 days in ice, I can hatch eighty; and there appears, from what I know of the river-water and climate of Tasmania, no reason why similar results should not be obtained there. I am the more anxious to obtain the opinions of these gentlemen, because I learn that for years to come further attempts are to be made to carry ova in ice to that colony."

NEW METHOD OF EXTRACTING GOLD FROM ORES.

Mr. Briggs read a paper from Mr. F. C. Calvert, of Manchester, on a New Method of Extracting Gold from Auriferous Ores. At the present time when the auriferous ores of Great Britain are attracting public attention, it may be advantageous to persons interested in gold-mining, to be made acquainted with a new and simple method of extracting gold from such ores, which presents the advantages of not only dispensing with the costly use of mercury, but of also extracting the silver and copper which the ore may contain. Further, it may be stated that the process can be profitably adopted in cases where the amount of gold is small, and the expense of mercury consequently too great. Without entering here into all the details of the numerous (about one hundred) experiments which I made some years since, before I finally arrived at the new method of extracting gold, which I have now the honor of communicating, allow me to state a few facts which are necessary to give a complete view of the subject. If 2.2 parts of pure and finely divided gold, obtained by the reduction of a salt of that metal, be added to 100 parts of pure sand, and placed in a bottle with a saturated solution of chlorine gas for 24 hours, only 0.5 of gold is dissolved. If the same experiment be repeated, but instead of chlorine water, a mixture of chlorine water and hydrochloric acid be used, 0.6 of gold is dissolved. If, instead of employing hydrochloric acid and chlorine gas, a mixture of sand, reduced gold, and peroxide of manganese, with hydrochloric acid, are placed in a bottle, 1.4 of gold is dissolved ; so that it would appear that, under the influence of nascent chlorine, the gold is more readily dissolved than when the same gas is mixed in solution with hydrochloric acid, previously to being placed in contact with the auriferous sand. Still these processes leave a great deal to be desired in a commercial point of view, as more than a third of the gold remains undissolved. The same results are obtained if the chlorine gas be generated by another method, viz., by adding to the auriferous sand a mixture of chloride of sodium, sulphuric acid, and peroxide of manganese. Being convinced, therefore, that nascent chlorine gas was a fit and proper agent for cheaply extracting gold from ores, and that it was probably only necessary to modify the method of operating, I allowed the mixture of hydrochloric acid and peroxide of manganese, or of sulphuric acid, peroxide of manganese, and chloride of sodium, to remain for twelve hours in contact with the auriferous sand ; and, then, instead of washing-out the solution of gold, I added a small quantity of water, which removed a part of the acting agent, and this was made to percolate several times through the sand ; by which method I succeeded in extracting from the sand, within a fraction the whole of the gold. I then repeated the last experiments with natural auriferous quartz, and easily extracted the two ounces of gold per ton which it contained. I therefore propose the following plan for extracting the gold on a commercial scale:—The finely-reduced auriferous quartz should be intimately mixed with about one per cent of peroxide of manganese ; and if common salt be used this material should be added at the same time as the manganese, in the proportion of three parts of salt to two of manganese. The whole should be then introduced into closed vats, having false bottoms, upon which is laid a quantity of small branches covered with straw, so as to prevent the reduced quartz from filling the holes in the false bottom. Muriatic acid should then be added if manganese alone is used, and diluted sulphuric acid if manganese and salt have been employed; and, after having left the whole in contact for twelve hours, water should be added so as to fill-up the whole space between the false and true bottoms with fluid. This fluid should then be pumped-up and allowed to percolate through the mass; and after this has been done several times, the fluid should be run off into separate vats for extracting the gold and copper that it may contain. To effect this, old iron is placed in it to precipitate the copper ; and after this has been removed, the liquor is heated to drive away the excess of free chlorine, and a concentrated solution of sulphate of protoxide of iron, or green copperas, must be added, which, acting on the gold-solution, will precipitate the gold in a metallic form. By this method, both gold and copper are obtained in a marketable condition. If silver is present in the ore, a slight modification in the process will enable the operator to obtain this metal also. It is simply necessary to generate the chlorine of the vitriol, manganese, and chloride of sodium process, taking care to use an excess of salt, that is, six parts instead of three, as above directed. The purpose of this chloride of sodium being to hold in solution any chloride of silver that may have been formed by the action of chlorine on the silver-ore, and to extract the metal, the following alteration in the mode of precipitation is necessary. Blades of copper must be placed in the metallic solutions, to throw down the silver in a metallic form, then blades of iron to throw down the copper, the gold being then extracted as previously directed. I think the advantages of this process are, 1st, cheapness ; 2nd, absence of injury to the health of the persons employed ; 3rd, that not only is the metallic gold in the ore extracted (as is done by mercury), but it attacks and dissolves all gold which may be present in a combined state, besides enabling the miner also to extract what silver and copper the ore may contain. I cannot, however, conclude without reminding you of what is generally underrated ; that is, the heavy expenses which attend the bringing of the ore to the surface of the ground, and crushing and preparing it for being acted upon by mercury or by any other agents.

MISCELLANEOUS.

ILLUSTRATION TO DR. DAWSON'S ARTICLE ON THE GENUS RUSOPHYCUS.



RUSICHNITES ACADICUS.

For description, see *ante*, page 367.

CALLUNA VULGARIS IN NEWFOUNDLAND.—Mr. Murray, late of the Geological Survey of Canada, and now engaged in a survey of Newfoundland, has brought to Montreal specimens of this plant, which were collected by Judge Robinson on the east coast of Newfoundland, near Ferryland (lat. 47°, long. 52° 50′), and which are stated to be from a small patch of the plant not more than three yards square. The locality is in the same part of the island to which the specimens collected by a Mr. Cormack (or MacCormack), and formerly in the collection of the Linnæan Society, are referred, (American Journal of Science, vol. xxxviii, p. 122,) namely the south-east peninsula; and two additional localities in this peninsula are noticed in Cormack's label, namely, the head of St. Mary's Bay and Trepassy Bay or Harbor. It is supposed that the Cormack who collected these specimens is the well-known explorer of the interior of Newfoundland; but we do not find any notice of the plant in his published narrative, although it contains many botanical notes.

De la Pylaie was no doubt the first to collect the plant in Newfoundland, since, though it is not in his herbarium, Prof. Brunet informs us that it is mentioned in his MS. notes.

We now have certain knowledge of localities of heather in Massachusetts, in Cape Breton (see *ante*, page 378), and in Newfoundland, to which may be added Giesecke's testimony that it occurs in Greenland.

THE GOLD OF NOVA SCOTIA OF PRE-CARBONIFEROUS AGE.—At Corbitt's Mills, about four miles north of Gay's River, Colchester County, Nova Scotia, auriferous clay-slates of the same character as those of the other Gold districts of the Province, are overlaid unconformably by nearly horizontal beds of grey and red conglomerate, grit, and sandstone, of Lower Carboniferous, probably Lower-Coal-measures age. At the mills these last are only a few feet in thickness. They, in turn, are overlaid by a mass of drift, and by beds of stratified sand and clay of variable thickness.

The little brook supplying the water-power to the mills, has cut through the Post-tertiary and Carboniferous beds, and in some places has worn for itself a channel in the slates, so that in the numerous excavations on its banks very good sections are exposed.

As to the Carboniferous age of the conglomerate and sandstones there can be no doubt. They cannot be Silurian, for they overlie uncomformably rocks of this age. They are totally unlike any Devonian rocks occurring in the Province, while they agree perfectly with the Lower Carboniferous conglomerates and sandstones of the Carboniferous basin on the margin of which they lie. They contain a few ill-preserved fossil plants like those found in similar Carboniferous beds. Between the Carboniferous and Drift, the only formation occurring in Nova Scotia is the New-Red-Sandstone, to the rocks of which the beds under consideration bear no resemblance. They cannot be of drift-age, for their fragments form rounded boulders in that deposit. They show no sign of having suffered from metamorphism. The lower part of the beds of conglomerate or grit at their junction with the slates, is richly auriferous, the gold occurring principally in the form of flattened scales, sometimes a quarter of an inch in diameter, disseminated through the rock. I have seen many fragments of the conglomerate, not a cubic inch in size, on the surface of which twenty or thirty scales of gold could be counted with the naked eye. Levels are driven into the banks of the brook, at the junction of the two formations: a foot or more of the lower part of the conglomerated bed is removed and washed in the common miner's cradle and pan, yielding rich returns. It is from this source that the greater part of the gold mined at the locality is obtained.

A machine is being erected on the spot to crush the conglomerate, in order that the gold may be more thoroughly extracted.

Gold has been washed from the drift overlying the conglomerate. The source whence the gold was derived, was, doubtless, quartz-veins in the clay-slates. Only one lead, about a quarter of an inch in thickness, has been discovered beneath the conglomerate. It is richly auriferous, and has a strike of about north and south, and a dip to the eastward of 70°. Non-auriferous quartz-veins are very numerous in the slate-hills of the vicinity. That this lead is older than the Carboniferous strata is plain from its ending abruptly at the junction with the slates.

From the above facts I think there can be no doubt that the gold of Corbitt's Mills is of Pre-Carboniferous origin; and since the gold of that locality was derived from strata precisely similar in character to those of the other gold-regions of Nova Scotia, and which strata are but the re-appearance northward of the gold-bearing rocks of the gold-fields of Renfrew and Oldham, and of the metamorphic band of the Atlantic coast, I think that the Pre-Carboniferous age of the gold of Nova Scotia is clearly indicated.

It is a very generally accepted theory, propounded by Sir Roderick Murchison, that, while gold is confined to Lower Silurian strata, it did not make its appearance therein until just before the time of the drift. As the gold of Nova Scotia was probably introduced into, or assumed its present form in the quartz-leads, at the time of the metamorphism of the Silurian rocks, which metamorphism was Pre-Carboniferous, I had doubted the correctness of this theory. The occurrence of gold in the Carboniferous rocks of Corbitt's Mills, shows that it is not to be applied to the Province of Nova Scotia.

G. Fred. Hartt.

Halifax, Oct. 27, 1864.

OBITUARY.

PROFESSOR BENJAMIN SILLIMAN.

Our honored associate, Professor Benjamin Silliman, the founder of this Journal (Silliman's Journal), whose name has appeared upon the title-page of every number, from the first until the present, is with us no more. He died at his residence in New Haven, early Thursday morning, November 24, 1864, (the day set apart for a national thanksgiving,) having reached the age of eighty-five years.

It becomes our duty to place on record in these pages, as an inscription to the monument which he has himself erected, an outline of his career and a tribute to his memory. Few men enter life with such promise as he; fewer still sustain themselves so evenly, and die so widely lamented.

Instruction in natural science has been his great work; and in it he was emphatically a man of the times. Beginning when almost nothing was known in this country of the departments to which he was especially devoted, he lived to see them carried forward to a high degree of progress, and their importance everywhere acknowledged. His life, which was one of few marked incidents, was passed in his native State, in connection with Yale College, the institution that early selected him as one of its faculty. Two or three times he was invited to become the president of colleges elsewhere, but New Haven continued his chosen home. Twice he visited Europe, first in 1805–6, in order to qualify himself for his work in life by attendance upon lectures in London and Edinburgh, and by observation of foreign institutions of learning; and again, near the close of his life, in 1851, when he was accompanied by his son, and made a more extended tour of observation and inquiry. Frequent journeys in his own country made him acquainted personally with the institutions and the men of every State, while his habits of prompt and friendly correspondence perpetuated the intimacies which he formed at home and abroad.

Without attempting a formal biography (which the late day of his decease renders impossible at this time), we propose to speak briefly of Professor Silliman's career as an officer of Yale College, and as a man of science, and then of his personal character and influence in the community.

The Silliman family has resided in Fairfield, Conn., since the early colonial days. Tradition says that Claudio Sillimandi, their earliest known ancestor, was driven, in 1517, from Lucca, Italy, to Switzerland, by religious persecution. The descendants resided in Berne, and afterwards in Geneva, whence they emigrated through Holland to this country about the middle of the seventeenth century. A worthy pastor of the name, living with his family near Neufchatel, was visited by Professor Silliman in 1851.

Ebenezer Silliman, the grandfather of Benjamin, graduated at Yale College in 1727, and Gold Selleck, the father, in 1752. The latter was a brigadier-general of militia in the Revolution, and was entrusted for a time with the defence of the Long Island coast. In 1775 he was married to Mary, the daughter of the Rev. Joseph Fish of Stonington, and the widow of the Rev. John Noyes. The two children of this marriage, Gold Selleck and Benjamin, became members of the same class in college, and have maintained through life an intimacy peculiarly fresh and cordial. The younger brother, Benjamin, was born in North Stratford, Conn., (now the town of Trumbull,) August 8, 1779. The elder, who was born in 1777, is still living in Brooklyn, N. Y.

Throughout his active life, Professor Silliman has been identified with Yale College. He entered the institution in 1792, graduated in 1796, became a tutor in 1799, was appointed professor of chemistry and natural history in 1804; and in 1853, having been relieved, at his own request, from further service as an instructor, he was designated, by the corporation, professor *emeritus*. Thus, during a period of nearly three-quarters of a century, his name has appeared as a student and a teacher successively on the catalogues of the college. He was a pupil of both Dr. Stiles and Dr. Dwight, and the colleague of the latter during eighteen years. With President Day and Professor Kingsley he was associated for half a century or more in the government of the institution.

In the capacity of a college-officer, he was pre-eminent as a teacher. The professor's chair, in the laboratory or in the lecture-room, was the place above all others in which his enthusiasm, his sympathy with useful aspirations, his varied acquisitions, his acquaintance with the world of nature and of art, and his graceful utterance, exerted their highest and most-enduring influence. The minds which he aroused to the study of nature have become investigators and teachers in every portion of the country; and all his pupils, whether devoted to science or to letters, will bear testimony to the interest which he awakened in these pursuits. They will never forget the admirable tact with which the manipulations of the laboratory were performed, or the brilliant experiments in chemistry which the lecturer seemed to enjoy, as if, like the class, he had never witnessed them before. The course in chemistry, in early years, extended through one hundred and twenty lectures. In later days it was not so long, but was followed by a course in mineralogy and another in geology. Here, too, Professor Silliman had the same magnetic influence on his students, sending them off on long walks about New Haven and at home to search for specimens, or to study the phenomena of geology. The third of these annual courses, that on geology, he gave with peculiar zest and eloquence. He delighted to depict the catastrophes of geological history, and to clothe the world with the plants and the animals of former days.

Professor Silliman was less concerned in the government of the students than some of his associates; but questions were continually arising in which his counsel was of weight. He was prompt in rebuking every form of youthful delinquency, yet was never harsh nor inconsiderate. No student ever left his presence feeling wronged or indignant. He would much rather sacrifice a rule than injure an offender. If he seemed sometimes to be lenient, it was the leniency of a father, for his mind regarded the improvement of his scholars rather than the enforcement of routine and discipline. His paternal lectures to the Freshman class on morals and manners were admirable in their influence; and many a graduate of the college will acknowledge that his habits for life were affected by the judicious hints which he received from his kind and sympathising teacher.

Mr. Silliman's labors began with instruction; but they did not end there. His active and versatile disposition led him to become interested in and to help forward whatever would contribute to the welfare of Yale College. When he went abroad, in 1805, to fit himself for the duties of his professorship, the purchase of books for the library was one of the duties with which he was especially charged. He was one of the library committee until his retirement. In his own departments, not only the Chemical Laboratory, but also the Cabinet of Minerals, owed its existence to his energy. This collection is indeed so important, that something more than the mere mention of it seems due. About the time when Mr. Silliman was appointed a professor, the entire mineralogical and geological collection of Yale College was transported to Philadelphia in one small box, that the specimens might be named by Dr. Adam Seybert, then fresh from Werner's School at Freiberg, the only man in this country who could be regarded as a mineralogist scientifically trained. From this small beginning grew the present cabinet. In 1810, owing to personal regard for Professor Silliman, Col. George Gibbs deposited with Yale College his valuable collection of minerals; and after it had remained open to the public fifteen years, various friends of the college, chiefly through the instrumentality of Professor Silliman, subscribed for its purchase the sum of $20,000. Other important accessions were also secured through his influence, not only from college graduates and other American gentlemen, but from various foreign collectors.

The Clark telescope is another of the donations to Yale College due to Professor Silliman. This excellent glass, the best in the country at the time of its purchase, was the means of exciting among the students of the college unusual attention to astronomical pursuits for many years after its reception. The liberal donor, a farmer near New Haven, by this and other more important gifts, placed himself foremost among all the benefactors of the college up to that time, and Prof. Silliman was the medium through whom his benefactions were bestowed. The Trumbull Gallery of Paintings, a collection of priceless value, not only as works of art, but also as illustrations of American history and biography, was secured to the college through the same enlightened instrumentality. The Medical Institution of Yale College and the Sheffield School of

Science, important branches of the University, were both greatly aided in their beginnings by the influential exertions put forth by Professor Silliman. He was one of the chief founders of the Alumni Association of the college; and at their anniversaries and on other occasions, he was, as another has said, "the standing 'orator' of the college; the principal medium between those who dwelt in the academic shade and the great public." Not unfrequently he was the college solicitor, asking funds for the expansion of the institution, and never asking in vain.

Although his services as a college-officer were great, Professor Silliman's strongest claim to the gratitude of men of science rests upon the establishment, and the maintenance, often under very discouraging circumstances, of the American Journal of Science. The history of this undertaking has already been given, in his own words, in the introduction to the fiftieth or index volume of the first series of the Journal; and it is for others, rather than for us, to give an estimate of his editorial services. It is but just, however, to call attention to a few circumstances, which all will regard as creditable to its founder.

He had the sagacity to foresee, as long ago as 1818, the scope which such a magazine should take. The prospectus which he then wrote is applicable almost exactly to our pages to-day. Experience has established the wisdom of the course which he marked out.

He maintained the Journal, from the beginning, at his own pecuniary risk. Its publication-has often been a serious financial burden, and in its most prosperous days has not yielded a fair return for editorial labor. But it has been continued, at this personal inconvenience, for the sake of American science, that the labors of our countrymen might be made known abroad, and the labors of Europeans understood in this country.

The Journal has never been used for the benefit of any party or individual, but solely for the advancement and diffusion of scientific truth. Its pages have been always open to free scientific discussion, with truth as the single end in view.

The original investigations of Prof. Silliman are not numerous. In the early part of his career he began with energy some important experiments and researches. He undertook a geological survey of Connecticut; he published a paper in conjunction with Prof. Kingsley on the famous Weston meteorite; he applied the newly-invented blowpipe of his friend, Dr. Hare, to the fusion of a variety of bodies, which were before regarded as infusible; he demonstrated in the galvanic battery the transfer of particles of carbon from one charcoal-point to the other; he made scientific examinations of various localities interesting in their geological or mineralogical aspects. But he was too much needed elsewhere to be allowed to remain a close student in the laboratory, or to engage with constancy as an explorer in the field of geological research. He has probably been a more useful man in the wider spheres of influence to which he was called, than he could have been in a life devoted to scientific investigation.

During a considerable part of his life, he was one of the few men in the country who could hold a popular audience with a lecture on science. The public early knew of his capabilities; and for many years he yielded to invitations from various parts of the country to deliver lectures on Geology and on Chemistry. In 1833 he gave his first popular course on Geology at New Haven, which was repeated in 1834 at Hartford and Lowell, and in 1835 at Boston and Salem. At Boston, the audience desiring to attend was so much larger than the largest hall would hold, that each lecture was given twice, for the accommodation of the public. From 1840 to 1843 inclusive, he gave four successive courses of the Lowell Lectures in Boston. Besides various other engagements in the Northern and Eastern States, he went in 1847 by invitation to New Orleans, and on his way appeared before crowded audiences in other cities of the South; and five years after the resignation of his professorship in college, when he had passed his 75th year, he made the long journey to St. Louis, in obedience to a call for a course of lectures from the citizens of that place.

In lecturing, his language was simple; his flow of words easy, generous and appropriate; his style animated, abounding in life-like and well-adorned description, often eloquent, and sometimes varied with anecdote running occasionally into wide digressions. His manner was natural, and every feature spoke as well as his mouth. His noble countenance and commanding figure (he was nearly six feet in height, with a well-built frame) often called forth, as he entered the lecture-hall, the involuntary applause of his audience.

In his popular courses he often lectured on the subject of Geology and Genesis; and as he was widely known not only as a man of science, but also as a sincere believer in the sacred Scriptures, he greatly aided in removing from the religious world the apprehension that science and religion were hostile in their teachings.

Mr. Silliman found great pleasure in helping forward other men of science. He rejoiced heartily in their progress; his house and his laboratory were always open to receive them, and if a friendly word or letter from him could advance their interests, he was ever ready to bestow it. He also felt a deep concern for the advancement of scientific investigations in every part of the country; and whenever, in halls of legislation, or before the public, the name of Benjamin Silliman would advance a useful project, it was not withheld. In more than one instance, the foreigner or the exile remembers his kindness with almost filial devotion.

Prof. Silliman's scientific publications, apart from his contributions to this journal, were chiefly text-books. He edited Henry's Chemistry and Bakewell's Geology, for the use of his pupils; and also published a work on Chemistry, in two volumes.

His long labors for science brought him honors from all parts of the world. His name is on the roll of several of the principal scientific Academies or Societies of Europe, and of those of his own country. He was one of the original members of the National Academy of Sciences, and a Regent of the Smithsonian Institution.

Aside from Professor Silliman's influence as an officer of Yale College, and as a well-known man of science, his personal hold upon the community at large was remarkably strong. This was due somewhat to the favor with which his popular lectures were received, and to the wide circuit over which he had journeyed. It was also owing in part to the pleasure and instruction which were afforded by his books of travel. Twice, as we have stated, Professor Silliman visited Europe, the interval between his journeys being nearly fifty years. Both these visits led to the publication of his observations in volumes which were widely read. The narrative of his earlier journey especially was received by the public with great delight. Few Americans then went abroad; and hardly any had published narratives of what they had seen. Mr. Silliman's volumes were fascinating to young and old,—and many were the testimonials which he received of the interest thus awakened in European institutions and manners. His Journal of a Tour to Canada was another contribution to the literature of the day.

But the general influence of Mr. Silliman must be attributed to his personal character, rather than to any of what may be termed the accidental circumstances of his life. He was a man of vigorous understanding and sound judgment, led on, but never carried away, by an enthusiastic disposition, glowing and constant. With this was associated sterling integrity, which never harbored a selfish or dishonorable purpose, but rejoiced in doing and encouraging whatever was right. Every one could trust him. These fundamental traits were adorned by the outward qualities of affability and courtesy, or rather were expressed in manners at once so dignified and so kind that all with whom he came in contact were charmed at once, and on closer intercourse were bound to him as friends for life. Such friendships he never neglected or forgot. Even the sons and the grandsons of his early associates inherited a share in the regard which he had bestowed upon their parents. Blending with and ennobling all these virtues, was the child-like simplicity of his Christian faith.

A character like this shines the brighter the nearer it is seen. In his own family circle, Mr. Silliman has moved for years as a patriarch, surrounded by his descendants to the third and fourth generation. The very house which he occupied has become historic, reflecting in its arrangements, its family portraits, its interesting mementoes of absent friends, and its long shelves of books, the controlling mind which has dwelt there.

In the neighborhood and town where he resided, Mr. Silliman was peculiarly beloved and respected. "New Haven will not be New Haven without him," said more than one of his associates, as he heard of his death. His hand was always open to the needy; he was given to hospitality. He frequently took part in public meetings, and was actively concerned in all questions of local improvement. He rarely, if ever, failed to discharge his duties as a citizen at the polls, and was always ready to express his opinions on questions of public policy.

A whole-souled patriot, he viewed with the deepest interest the complications brought into the affairs of the country by the system of slavery. His general benevolence ever led him to sympathize with the oppressed, and the wrongs of the African touched him deeply.

As soon as the atrocities in Kansas revealed the determination of the advocates of slavery to perpetuate and extend that institution, even if they dissevered or destroyed the nation, Mr. Silliman came out with all his youthful ardor, and with the influence of his years and reputation, as the opponent of the slave-power. He thus became the object of personal defamation, even in the Senate-chamber at Washington; but he still remained firm, for he recognized in this war a slaveholder's rebellion. All the lofty sentiments of patriotism which were awakened in childhood as he witnessed the commencement of national life, were intensified by this struggle to maintain the Union. He was sure that the nation would be purified by the conflict, and liberty established throughout all the land.

Mr. Silliman has always been remarkable for uniform good health, and in his later years but slightly manifested the encroachments of age. To the last, his form was as erect, his brow as serene, and his features as full of life and cheerfulness, as in his earlier days; and his gait was only a little slower and more cautious.

He continued as usual until the middle of November just past, when he was for a few days quite unwell, probably as an immediate consequence of exposure to cold when attending an evening meeting in behalf of the Sanitary Commission. He had gradually, to appearance, regained nearly his former strength during the following week, and on Wednesday was intending to join the family Thanksgiving festival the next day at the house of his son-in-law, Prof. Dana. On the morning of that day (November 24), he awoke early, after a night of quiet rest, feeling stronger, as he said, than he had done for some days. He spoke with his wife of the many reasons there were for thankfulness, both public and private; dwelling at length upon the causes for national gratitude, especially in the recent re-election to the Presidency of a man who had proved himself so true, so honest, so upright in conducting the affairs of the governmemt as Mr. Lincoln. As was his custom, he offered up, while still in his bed, a short prayer, and repeated a familiar hymn of praise. In resuming his conversation, before rising, he spoke of the possibility of his attending the public services of the day, of the happiness of his home, of the love of his children, and, in strong terms of endearment, of his wife. Just as these his last words of love were uttered, there was a sudden change of countenance, a slightly heavier breath, and he was gone. At the advanced age of eighty-five, life to him was still beautiful; and not less so was its close. His sun set in the blessedness of the Christian's faith, to rise on a brighter morrow.—*From Am. Jour. Sci.* [2], vol. xxxix, No. 115.

REVIEW.

THE BOSTON SOCIETY OF NATURAL HISTORY has issued the following circular:—

"On account of the gradual diminution of the number of subscribers, the increased cost of publication, and the limited income of the Boston Society of Natural History, it has been necessary to suspend the publication of its Journal and Proceedings.

"This suspension is a serious injury to the Society, as it cuts off the means of making its labors public, and deprives it of the material for exchange with other scientific bodies for the increase of the Library. The Publishing Committee, with the consent of the Council, have therefore deemed it advisable to invite its Patrons and Members, and the friends of Science, to subscribe for these works, so that their publication may at once be resumed.

"The Society has already published seven volumes in 8vo of the Journal, illustrated with many plates; and nearly nine volumes in 8vo of the Proceedings. The former will hereafter be issued in 4to, under the style of Memoirs; the latter will be published as heretofore, in monthly sheets, but will not any longer be furnished free of cost to members.

"PRICE.—The Memoirs will be furnished to members and patrons at $3.50 per number; to the public, at $4. A number, averaging 125 pages and four plates, will be published about once a year, four numbers completing a volume.

"The Proceedings will be furnished to members and patrons at $3 per volume; to the public, at $4. They will be issued in sheets of 16 pages each, averaging 24 sheets to a volume, the volume being completed in about two years. Payment—for Memoirs will be due on the presentation of each number; for the Proceedings, on the issue of the first sheet.

"Boston, December 1, 1864."

Signed by the Publishing Committee.

We are indebted to the author for the first part of the Memoirs above alluded to, being a "Revision of the Polyps of the Eastern Coast of the United States," by A. E. Verrill, and consisting of 45 pages of quarto letter-press, and one lithographic plate illustrating five species. The author, after noticing the imperfection of some and the inaccessibility of much of the available material necessary to the study of these animals, adds, "It was for the purpose of supplying in some measure the deficiency in these respects, and to establish a basis for future investigations, rather than to present anything new, that the present work was undertaken; but on account of the constant accessions of new materials, it has now become necessary to present quite a number of undescribed species, and it is very probable that many more remain to be hereafter discovered." The fringed actinia figured in this Journal, vol. iii, pages 401–2, as *Actinia dianthus*, is here named *Metridium marginatum* (of Milne-Edwards), and, though closely allied to the *M. dianthus* of Europe, is said to be a "perfectly distinct" species. Mr. Verrill says of it—"It is the most abundant species along the whole coast of New England and of the provinces of New Brunswick and Nova Scotia.* * * In the Bay of Fundy it is particularly abundant, and grows to a very large size. At Mount Desert, on the coast of Maine, I have seen, during a very low tide, a rocky bottom completely covered for acres with this species, from low-water mark to a depth of two fathoms or more." We have found it equally abundant on the north shore of the St. Lawrence a few miles below the Saguenay; the specimens in form and color agreeing exactly with Dr. Landsborough's figure of *A. dianthus*, save that the column was proportionally more slender than shown by him. We may add that we have found the Bell-anemone (*Lucernaria auricula*) plentiful at Metis on the south shore, where it occurs in rocky pools, adhering to the fronds of sea-weeds, and is easily found during low tide.

These Memoirs are from the Riverside Press, Cambridge, Mass., and are in the usual excellent style of that establishment.

W.

Published, Montreal, January 11, 1865.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ *N. Longitude,* 4*h.* 54*m.* 11*s. W. of Greenwich. Height above level of the Sea* 182 *feet. For the month of October* 1864.

BY CHARLES SMALLWOOD, M.D., LL.D., D.C.L.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F.			Reading of Thermometer.			Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Highest	Lowest.	Mean.	Max.	Min.	Mean									
	Inches.	Inches.	Inches												
1	30.200	30.139	30.179	66.1	36.7	52.5	.369	.869	W	152.40	3.6	. . .	....	1.0	
2	.100	.008	.069	54.6	50.2	51.8	.366	.935	N E	70.10	10.0	6.272	....	2.0	Rain.
3	.067	.023	.047	67.3	50.8	57.6	.450	.906	N E	91.08	9.6	....	....	2.6	
4	.000	29.929	29.968	67.9	47.8	59.9	.462	.893	W	11.52	5.8	....	....	2.0	
5	29.930	.904	.920	78.2	43 5	61.6	.501	.853	W	31.61	1 3	....	....	1.6	Rain.
6	.622	410	.546	56.2	54.0	58 2	.439	.903	W	29.64	10.0	0.076	....	1.6	Rain. [Snow
7	.384	.260	.334	69.8	50.0	59.8	.447	.861	S W	59.91	6 6	0.320	....	1.6	Rain — First
8	.302	.300	.300	43.4	19.1	39.8	.227	.870	N E	267.25	10.0	0.041	Inapp	2.3	Rain.
9	.491	.462	.475	48.0	29.2	39.1	.217	.852	N E	122.00	9.6	0.497	...	1.6	Rain.
10	.514	.479	.491	48.1	36.0	43.0	.256	.868	W by S	221.00	3.3	0.146	....	1 3	
11	.891	.759	834	53.3	35 6	45.5	.279	.864	W by N	154.35	4.6	..	....	1.6	
12	.793	.649	.715	47.3	33.2	43 1	.270	919	S W	47 26	10.0	0.046	....	2.0	Rain.
13	.519	477	.504	45.2	37 4	42.3	.271	.981	N E	31.52	10.0	0.114	....	2.0	Rain.
14	.413	301	.312	47.0	38.5	44.0	.297	.985	N E	107.96	10.0	0.210	....	2.8	Rain.
15	.653	.357	.442	48.1	42.4	46.0	.319	.999	N E	192 75	10.0	0.117	....	2.6	Rain.
16	.674	.504	.561	46.9	45.2	46.1	.315	.989	N E	64.00	10.0	0.052	....	2.0	Rain.
17	.600	.523	.565	46.3	39.7	43.7	.273	.928	W by N	54.60	9 6	0.024	....	2.3	Rain.
18	.654	.627	.641	52.0	39.7	45.6	.285	.885	W	79.90	5.3	. . .	....	2.0	
19	.671	.663	.667	52.2	39.3	45.6	.293	.912	W	47.70	6 0	....	....	1.3	Au Borealis.
20	.597	.304	.537	49.8	33.1	44.2	.282	.918	W	57.49	7.6	0.018	....	2 0	Rain.
21	.767	.752	.759	58.1	35.3	46.8	311	.910	N N W	191.69	2.6	....	....	1.6	
22	.759	.667	.685	54.0	36.4	47.7	.308	.891	W by N	97.60	8 0	Inapp	....	2.0	Rain.
23	.604	.597	.600	51.0	44.2	48.1	.310	.892	W	97.08	10.0	Inapp	....	1.0	Rain.
24	.724	.608	.658	58 0	38.7	47.2	.309	.893	N E	110.90	4.6	....	....	1.3	Au. Borealis.
25	.829	.809	.818	49 7	34.1	44.5	272	.897	N N E	117.20	8.6	....	....	1.6	
26	.764	.506	.646	61.3	33.2	47.2	.308	.863	N W	185.90	1.8	....	....	1.6	
27	.784	.573	.700	48.0	32.0	41.5	227	812	N by W	116.29	8.0	....	....	1.6	Rain.
28	.369	.270	.325	42.1	33.6	39.0	.229	.900	N E	17.21	10.0	0.420	....	3 0	Rain.—Snow.
29	.654	.472	.557	49.7	28.5	40.3	.244	.900	W N W	407.42	1.3	0.941	....	3 6	
30	30.000	.724	.841	50.1	34.7	42.1	.243	.857	W	113.22	0.3	...	...	2.0	
31	29.847	.705	.758	50.9	31.2	41.4	.238	.870	N W	225.55	8.0	....	....	1.6	

Remarks for the Month.

Barometer.. { Highest, the 1st day, 30.200 inches. Lowest, the 7th day, 29.260 " Monthly Mean, 29.534. Monthly Range, 0.940.

Thermometer { Highest, the 5th day 78°.2. Lowest, the 29th day, 18°.5. Monthly Mean, 48°.24. Monthly Range, 46°.60.

Greatest intensity of the Sun's rays, 92°.2.
Lowest point of Terrestrial radiation, 24°.0.
Mean of Humidity, °.894
Rain fell on 17 days, amounting to 8.794 inches.
Snow fell on 2 days, amounting to 0.10 inches.
Most prevalent wind, N E,
Least prevalent wind, S. W.
Most windy day the 8th day, mean miles per hour, 11.13.
Least windy day, the 4th day, mean miles per hour, 0 7.
Amount of Evaporation 2.14 inches.
Aurora Borealis visible on 2 nights.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ *N. Longitude*, 4*h.* 54*m.* 11*s. W. of Greenwich. Height above the level of the Sea* 182 *feet. For the month of November* 1864.

BY CHARLES SMALLWOOD, M.D., LL.D., D.C.L.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F.			Reading of Thermometer.			Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Highest	Lowest.	Mean.	Max.	Min.	Mean									
	Inches.	Inches.	Inches.												
1	30.005	29.609	29.867	44.8	25.5	36.0	.205	.881	W	96.81	4.0	....	....	1.6	
2	.051	30.018	30.038	38.0	26.0	32.5	.178	.879	W	125.11	5.3	....	....	1.0	
3	29.890	29.834	29.856	50.1	21.2	36.3	.217	.871	W	69.91	0.6	....	....	1.6	
4	.412	28.668	.883	39.2	23.9	35.2	.198	.901	N E	153.14	10.0	1.260	....	3.0	Rain.
5	.611	29.114	.019	59.4	30.4	32.6	.184	.903	W	87.60	9.6	..	....	1.6	
6	.914	.841	.837	51.3	31.1	41.1	.247	.985	W	184.24	0.0	....	....	2.3	
7	.948	.714	.853	58.4	39.4	48.0	.311	.889	S W	99.76	4.6	Inapp	....	2.6	Rain.
8	30.004	.863	.948	51.2	34.7	46.2	.292	.887	W by S	97.47	7.6	Inapp	....	2.6	Rain.
9	29.594	.847	.480	56.4	48.4	59.9	.472	.908	W b S	86.67	10.0	0.902	....	3.0	Rain.
10	.279	.080	.183	50.2	50.1	50.9	.364	.889	W by S	217.44	8.0	0.210	....	2.6	Rain.
11	.449	.296	.362	43.0	35.7	39.9	.224	.858	W	146.89	6.6	....	....	2.0	
12	.547	.501	.520	43.4	29.7	38.9	.224	.895	W	179.70	8.8	....	....	1.8	
13	.674	.614	.631	40.9	29.4	35.3	.300	.899	N N E	179.40	6.6	...	....	1.8	
14	.994	.880	.931	51.8	23.0	36.5	.213	.890	N W	211.22	2.6	....	....	2.6	
15	.917	.771	.581	38.8	28.1	31.7	.177	.904	N E	110.00	10.0	....	....	3.0	
16	30.255	30.022	30.154	33.8	20.4	28.9	.130	.869	W	87.69	7.6	....	3.10	3.0	Snow.
17	.105	29.764	29.949	36.3	22.0	32.1	.179	.888	S E	46.27	9.6	....	....	2.8	
18	29.820	.764	.795	50.3	32.0	39.6	.236	.892	W	152.72	2.6	0.300	....	3.0	Rain.
19	.986	.916	.948	40.2	25.1	33.9	.191	.872	W	179.42	6.0	....	....	2.6	
20	.904	.709	.828	55.0	34.7	43.9	.269	.875	W	79.47	3.3	....	....	2.8	
21	.585	.377	.486	46.1	33.1	40.4	.244	.912	S by W	124.71	10.0	0.182	....	3.0	Rain.
22	.411	.090	.247	48.2	31.2	36.4	.222	.924	W by N	57.80	10.0	0.288	....	3.6	Rain.
23	.998	.447	.747	38.1	29.4	31.7	.180	.890	W	44.71	5.3	....	0.90	2.8	Snow,
24	30.267	30.228	30.248	31.4	9.8	23.8	.139	.865	W S W	71.46	7.6	....	...	2.0	
25	.300	.264	.285	35.5	30.4	33.2	.180	.871	W by S	94.72	10.0	....	Inapp	3.0	Snow.
26	.097	29.946	.018	41.8	31.4	35.7	.302	.867	S E	24.21	8.0	Inapp	....	3.6	Rain.
27	29.863	.800	29.835	36.0	33.4	34.8	.189	.881	N E	111.42	10.0	0.246	....	4.0	Rain.
28	.900	.504	.706	42.2	31.6	37.6	.221	.914	S E	22.19	10.0	Inapp	....	2.6	Rain.
29	.577	.397	.408	46.1	41.1	44.1	.281	.925	W S W	17.70	10.0	0.543	....	3.3	Rain.
30	.442	.414	.425	44.0	38.4	42.1	.255	.911	N E	13.49	10.0	0.500	....	3.3	Rain.

Remarks for the Month.

Barometer:
- Highest, the 25th day, 30.300 inches.
- Lowest, the 4th day, 28.668 "
- Monthly Mean, 29.720. "
- Monthly Range, 1.632. "

Thermometer:
- Highest, the 7th day, 58°.4.
- Lowest, the 24th day, 9°.8.
- Monthly Mean, 38°.11.
- Monthly Range, 48°.6.

Greatest intensity of the Sun's rays, 78°1.
Lowest point of Terrestrial Radiation, 7°.4.
Mean of Humidity, 0.899.
Rain fell on 13 days, amounting to 2.360 inches.
Snow fell on 3 days, amounting to 4 inches.
Most prevalent wind, W.
Least prevalent wind, S. E.
Most windy day, the 10th day, mean miles per hour, 10.31.
Least windy day, the 30th day, mean miles per hour, 0.56.
Aurora Borealis visible on 2 nights.
Lunar Corona, visible on 1 night.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ *N. Longitude,* 4*h* 54*m.* 11*s. W. of Greenwich. Height above the level of the Sea* 182 *feet. For the month of December* 1864.

BY CHARLES SMALLWOOD, M.D., LL.D., D.C.L.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F.			Reading of Thermometer.			Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in Inches.	Depth of Snow in Inches.	Ozone in 10ths.	Weather, &c.
	Highest	Lowest.	Mean.	Max.	Min.	Mean									
	Inches.	Inches.	Inches.												
1	30.000	29.562	29 812	49.7	34.7	41.1	.245	.882	W S W	104.40	6.0	0.060	....	2.0	Rain.
2	.184	.972	30.075	37.2	24.0	31.8	.174	.870	N E	84.26	6.6	....	0.70	2.6	Rain.
3	29.489	.304	29.385	44.5	35.2	40.5	.257	.900	N E	94.70	10.0	0.412	....	3.0	Rain.
4	.607	.451	.506	42.8	29.7	34.6	.195	.901	W	114.90	2.0	....	....	2.8	
5	800	.617	.753	31.4	19.0	27 8	.152	.899	W	232.40	7.6	Inapp	....	3.0	Rain.
6	.774	.495	.593	40.2	30.4	35.8	.205	.899	N E	47.70	10.0	0.441	....	3.0	Rain.
7	.582	28.948	.247	38.4	35.1	37.5	.308	.885	W	47.10	10 0	0.211	....	2.6	Rain.
8	29.874	29.342	29.579	32.0	18.9	25.3	.141	.889	W	272.40	6.0	....	Inapp	3.8	Snow.
9	30.492	30.262	30.410	29.5	8.2	18.6	.106	.863	W	371.14	0.0	....	....	2 8	Lunar Halo.
10	.231	29.900	.072	22.4	18.0	31.8	.109	.848	N E	51 74	10 0	....	0.64	3.0	Snow.
11	29.747	.279	29.524	26.0	18.4	23.0	.129	.894	N E	114.14	8 6	....	1.30	3.3	Snow.
12	.752	28 964	.362	22.4	2.5	11.9	.083	877	W	111.14	9.8	....	5.34	3.0	Snow.
13	30.142	29 799	30.011	9.0	–9.0	0.3	.045	.876	W by N	142.71	6.8	....	Inapp	3.0	Snow.
14	29.800	.364	29.670	20.5	10.6	13.9	.089	.864	N E	94 10	8.6	....	3.50	3.0	Snow.
15	30.101	30.024	30.061	17.0	–0.5	7.4	.065	.877	W	97.64	0.0	....	....	2.6	
16	29.994	29.987	29.990	22.1	9.5	17.1	.096	.895	N E	57.89	10.0	....	....	2.0	
17	.894	.797	.851	32.0	18.0	25.7	.144	.896	N E	47.70	6.6	....	....	2.6	
18	30.311	30 241	30.264	22.2	13.6	17.6	.101	.862	W	104.71	0.0	....	Inapp	3.0	Snow.
19	19.401	19.317	29.349	20.2	14.7	18.4	.108	.844	N E	74.44	3.8	....	3.14	3.0	Snow.
20	.797	.602	.711	16.8	8.1	12.5	.076	.853	W	87.64	0.0	....	....	2.0	
21	.416	.249	.311	13.4	9.8	11.6	.083	.885	N E	59.74	10.0	....	4.75	3.3	Snow.
22	29.804	29.304	29.511	16.0	–6.1	5.7	.058	.874	N E	117.11	4 0	....	1.20	3.0	Snow.
23	.847	.787	.795	–2.5	-14.9	–7.2	.031	.862	W by N	146.61	10.0	....	....	1.1	
24	.742	.644	.689	10.0	–4.6	4.02	.060	.911	N E	207.40	10.0	....	Inapp	2.0	Snow.
25	.861	.679	.795	36.6	24.0	31.0	.169	.885	W	188.10	8.0	....	....	2.0	
26	.671	.637	.650	40.2	33.0	34.4	.197	.904	W	71.11	6.6	....	Inapp	2.0	Snow.
27	.490	.379	.427	40.0	31.0	36.0	.192	.874	N E	79.10	10.0	Inapp	....	2.6	Rain.
28	.411	.407	.409	38.4	32.6	35.7	.199	.887	S W	49.90	8.6	0.197	....	3.0	Rain.
29	29.270	29.199	29.224	32.0	31.6	31.8	.184	.935	W	24.70	10.0	....	2.50	3.0	Snow.
30	.400	.279	.350	26.4	15.1	22.0	.126	.899	W	207.41	6.6	....	Inapp	2.0	Snow.
31	.817	.602	.737	20.2	3.5	13.9	.117	.867	W	74 60	8.6	...	....	3.0	

Remarks for the Month.

Barometer.. { Highest the 1st day, 30.311 inches. Lowest the 12th day, 28.964 " Monthly Mean, 29.934 " Monthly Range, 1.357 " }

Thermometer { Highest the 1st day, 49°7. Lowest the 23rd day, -14°9. Monthly Mean, 22°.28. Monthly Range, 64°.6. }

Greatest intensity of the Sun's rays, 69.7.
Lowest point of Terrestrial radiation, -16°.1.
Mean of Humidity, °.880.
Rain fell on 7 days, amounting to 1.301 inches.
Snow fell on 15 days, amounting to 22.97 inches.
Most prevalent wind, W.
Least prevalent wind, S. W.
Most windy day the 9th day, mean miles per hour, 15.47.
Least windy day, the 29th day, mean miles per hour, 1.02.
Aurora Borealis visible on 1 night.
Lunar Halo visible on 1 night.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ N. Longitude, 4h. 54m. 11s. W. of Greenwich. Height above level of the Sea 182 feet. For the month of July, 1864.

BY CHARLES SMALLWOOD, M.D., LL.D., D.C.L.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F.			Reading of Thermometer.			Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Highest	Lowest.	Mean.	Max.	Min.	Mean									
	Inches.	Inches.	Inches.												
1	29.774	29.761	29.766	82.1	63.1	72.1	.632	.804	W	46.70	6.9	....	....	0.6	
2	.624	.502	.562	68.2	64.2	66.9	.591	.897	N E	120.98	6.0	0.047	....	0.1	Rain.
3	.579	.571	.574	77.4	61.4	71.7	.648	.849	S W	46.60	6.0	....	....	1.0	
4	.724	.578	.674	76.7	56.2	68.6	.868	.809	W by S	102.09	2.6	....	....	0.6	
5	.802	.677	.757	80.1	57.2	71.2	.614	.791	W	81.37	1.3	....	....	0.1	
6	.760	.698	.724	87.9	59.1	70.2	.580	.789	W	176.39	3.3	....	....	1.0	
7	.747	.679	.715	84.2	59.2	76.3	.668	.758	W	21.91	0.6	0.052	....	0.5	Rain.
8	.821	.741	.778	89.4	58.0	71.3	.664	.763	N E	180.30	0.6	....	....	0.0	
9	.887	.800	.843	90.4	59.0	78.9	.763	.749	W	126.33	1.3	....	....	0.1	
10	.750	.572	.674	92.1	64.2	79.7	.764	.756	S W	100.76	6.6	Inapp	....	0.6	Rain.
11	.564	.541	.535	89.7	66.0	77.4	.733	.802	W S W	93.06	6.6	0.864	....	1.3	Rain.
12	.722	.655	.682	75.2	65.2	70.7	.610	.819	W S W	363.97	8.0	0.211	....	0.6	Rain.
13	.898	.840	.865	93.4	61.2	78.7	.705	.696	W	48.64	0.0	....	....	0.1	
14	.998	.950	.973	94.1	64.2	83.5	.782	.679	W S W	30.06	2.6	....	....	0.5	
15	.958	.942	.949	96.4	68 2	84.7	.786	.649	S W	53.82	1.3	....	....	0.0	
16	.874	.800	.847	86.8	64.9	78.8	.715	.748	S E by E	89.08	0.0	....	....	0.0	
17	.994	.872	.925	95.9	63.4	82.0	.761	.698	N E	120.20	0.0	....	....	0.0	
18	30.062	.954	30.004	91.0	63.6	81.6	.750	.684	W	217.74	0.0	....	....	0 0	
19	29.976	.879	29.917	96.3	64.1	85.1	.784	.647	S E	45.89	0.0	....	....	0.0	
20	.680	.533	.597	88.2	70.1	80.5	.728	.713	S W	173.81	0.0	....	....	0.0	
21	.818	.796	.808	75.2	55.4	67.3	.503	.752	N by W	180.05	6.6	0.037	....	0.8	Rain
22	.799	.766	.785	64.3	49.7	60.8	.441	.767	W by N	196.67	7.6	....	....	0.6	
23	.751	.711	.730	80.0	49.7	71.1	.881	.749	S W	215.87	0.0	....	....	0.1	
24	.782	.764	.772	84.6	64 1	76.5	.681	.762	W S W	111.00	0.0	....	....	0.0	
25	.852	.789	.812	79.3	53.2	70.0	.506	.770	N E	241.28	0.0	....	....	0.1	
26	.674	.547	.613	79.8	58.0	71.2	.581	.768	N by W	74.30	10.0	0.084	....	1.0	
27	.802	.676	.754	87.7	59.9	76.7	.666	.736	S W	172.54	3.3	....	....	0.3	
28	.808	.600	.719	82.1	58.2	77.8	.636	.727	S W	73.30	10.0	....	....	0.3	
29	.617	.572	.594	78.4	58.0	69.8	.535	.749	N W	120.18	3.3	....	....	1.6	
30	.555	.547	.551	91.4	58.4	79.6	.767	.770	S W	65.98	0.5	....	....	0.3	
31	.690	.577	.646	94.3	62.1	82.5	.790	.708	S W	14.71	0 0	....	....	0.0	

Remarks for the Month.

Barometer.. { Highest, the 18th day, 30.062 inches. Lowest, the 2nd day, 29.502 " Monthly Mean, 29.782 " Monthly Range, 0.560 "

Thermometer { Highest, the 19th day 96°3. Lowest, the 22nd day, 49°4. Monthly Mean, 75.19. Monthly Range, 46°9.

Greatest intensity of the Sun's rays, 112°9.
Lowest point of Terrestrial radiation, 47°4.
Mean of Humidity, .766.
Rain fell on 6 days, amounting to 1.295 inches, it was accompanied by Thunder on 2 days.
Most prevalent wind, S. W.
Least prevalent wind, S. E.
Most windy day the 12th day, mean miles per hour, 15.17.
Least windy day, the 31st day, mean miles per hour, 0.61.
Amount of Evaporation 3.46 inches.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS,

Taken at the Montreal Observatory, Latitude 45° 31′ N. Longitude, 4h. 54m. 11s. W. of Greenwich. Height above the level of the Sea 182 feet. For the month of August, 1864.

BY CHARLES SMALLWOOD, M.D., LL.D., D.C.L.

Day of Month.	Reading of the Barometer, corrected, and reduced to 32° F.			Reading of Thermometer.			Mean Tension of Vapor.	Mean Humidity of the Atmosphere.	General direction of Wind.	Horizontal movement in 24 hours in miles.	Mean extent of Clouds in 10ths.	Depth of Rain in inches.	Depth of Snow in inches.	Ozone in 10ths.	Weather, &c.
	Highest	Lowest.	Mean.	Max.	Min.	Mean									
	Inches.	Inches.	Inches.												
1	29.583	29.539	29.534	96.2	74.4	85.0	.803	.667	s by E	120.71	4.6	Inapp	....	0.3	Rain.
2	.582	.568	.573	86.0	68.2	76.4	.728	.807	Nbyw	73.59	4.6	....	....	1.0	
3	.660	.591	.625	72.8	58.2	67.9	.489	.729	N E	211.41	8.0	Inapp	....	1.1	Rain.
4	.589	.564	.574	68.2	59.0	64.8	.502	.823	N E	173.70	6.6	0.043	....	1.0	Rain.
5	.765	.653	.697	86.7	58.4	76.6	.747	.822	S W	50.28	6.0	....	....	1.0	
6	.846	.702	.799	89.8	62.2	76.2	.695	.765	S W	86.91	8.0	....	....	0.3	
7	.712	.700	.705	90.2	61.1	77.1	.734	.785	S W	56.20	4.6	....	....	1.0	
8	.834	.714	.786	79.1	62.0	71.2	.558	.800	W	95.20	5.3	....	....	1.0	
9	.546	.506	.537	89.2	62.4	81.5	.844	.801	N N W	65.54	3.3	....	....	2.0	
10	.501	.474	.483	84.6	60.0	79.1	.776	.800	S E	269.89	0.0	....	....	1.0	
11	.611	.599	.640	95.1	67.0	80.8	.775	.802	Nbyw	111.52	0.0	....	....	0.3	
12	.704	.672	.692	85.1	58.9	72.9	.640	.742	Nbyw	48.74	5.3	....	....	1.0	
13	.588	.529	.534	94.2	64.7	78.2	.705	.716	S W	167.93	6.0	....	....	1.3	
14	.741	.600	.650	87.2	63.2	77.4	.761	.807	W	124.40	1.3	....	....	1.3	
15	.812	.761	.749	94.2	61.0	77.6	.694	.716	W	187.21	0.3	....	....	0.3	
16	.891	.871	.878	87.2	66.4	78.7	.726	.730	W	10.13	6.0	....	....	1.0	
17	.719	.715	.717	74.1	68.1	70.9	.596	.802	N E	77.16	10.0	Inapp	....	0.3	Rain.
18	.874	.798	.825	81.6	56.0	69.1	.516	.781	N E	162.96	0.0	....	....	0.3	
19	30.014	.928	.979	82.3	55.4	70.9	.525	.702	N W	130.08	8.0	....	....	0.3	
20	29.990	.984	.973	78.9	58.4	69.7	.568	.785	W	58.38	10.0	....	....	1.0	
21	.987	.770	.899	76.0	65.0	73.0	.624	.792	N E	27.00	8.0	....	....	0.3	
22	.734	.542	.636	82.4	60.0	74.8	.646	.760	S W	96.07	3.3	Inapp	...	0.5	Rain.
23	.647	.548	.609	74.1	66.0	70.3	.603	.816	W	120.47	8.0	0.962	....	1.3	Rain.
24	.737	.714	.750	84.4	63.0	74.7	.671	.791	W	170.61	6.3	....	......	1.3	
25	.519	.423	.488	88.2	65.2	79.0	.753	.816	W	94.02	7.6	....	....	1.0	
26	.571	.424	.814	83.2	62.6	72.1	.675	.889	W	36.56	6.6	0.815	....	1.3	Rain.
27	.311	.254	.281	75.9	61.1	68.7	.628	.799	S E	18.40	5.6	0.216	....	1.3	Rain.
28	.524	.424	.486	75.0	60.0	66.9	.546	.826	W	122.00	1.6	....	....	1.0	
29	.847	.424	.494	74.0	58.1	65.7	.539	.871	wbyN	223.42	6.6	Inapp	.. .	1.3	Showers.
30	.796	.616	.677	69.4	56.0	59.1	.429	.874	wbw	128.91	6.0	Inapp	....	1.0	Rain.
31	.829	.811	.819	74.9	53.2	65.0	.510	.811	N W	78.80	0.0	....	....	0 0	

Remarks for the Month.

Barometer … { Highest, the 19th day, 30.014 inches. Lowest, the 27th day, 29.281 " Monthly Mean, 29.604. " Monthly Range, 0.833. " }

Thermometer { Highest, the 1st day, 96°2. Lowest, the 30th day, 55°0. Monthly Mean, 71.17. Monthly Range, 41°2. }

Greatest intensity of the Sun's rays, 114°0.
Lowest point of Terrestrial radiation, 51°4.
Mean of Humidity, .748.
Rain fell on 10 days, amounting to 2.126 inches, and was accompanied by Thunder on 4 days.
Most prevalent wind, W.
Least prevalent wind, N. by W.
Most windy day, the 10th day, mean miles per hour, 11.24.
Least windy day, the 16th day, mean miles per hour, 0.42.
Amount of Evaporation, in inches, 2.24.
Aurora Borealis visible on 1 night.

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