THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science,

WITH THE

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

CONDUCTED BY A COMMITTEE OF THE SOCIETY.

NEW SERIES—Vol. 4.

(WITH TWO PLATES AND A MAP.)

MONTREAL:
DAWSON BROTHERS, 55 TO 59 ST. JAMES STREET.
1869.

MONTREAL: PRINTED BY THE MONTREAL PRINTING AND PUBLISHING COMPANY.

CONTENTS.

THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

NOTES OF A VISIT TO SCIENTIFIC SCHOOLS AND MUSEUMS IN THE UNITED STATES.

By Principal DAWSON, LL.D., F.R.S., &c.

Away from snow and frost, on the rail, rapidly sweeping through New England villages with their snug homes and busy factories, we approach the great western emporium, the lesser London, the commercial capital of the "greater Britain" of the western world—already numbering its million and a half of people, and rivalling old London in all the higher and lower phases of a city life. Our business is not with either its trade or its gaiety. We have first to tell to such of its people as care to know of such old world things, our story about "Primeval Forests," and then to scrutinise, under the guidance of our friend Dr. Newberry, the class-rooms, laboratories and museums of Columbia college, a workshop of mind, aiming to train young men to that practical grasp of science which shall enable them to apply its principles to the better extraction and working into useful purposes of the dark treasures of mother earth. Columbia College is a brick building in a quaint old fashioned square, once out of town, but overgrown by the rapid increase of the great city, which swallows up farms, estates, and country houses as if they were mere morsels to its voracious appetite. The building, which was intended for an asylum, forms three sides of a quadrangle, and has many long narrow rooms well lighted by windows in the sides. It is regarded as merely a temporary residence for the college, whose large endowment of nearly $1,500,000 is being in great part retained by its trustees as a basis for more extended operations than those of the present "School of Mines." Still it is well adapted to its use, and has been admirably arranged. Three of its long rooms, like the wards of a hospital, but with tables and shelves instead of beds, are fitted up as working laboratories in which a hundred and twenty students may at once pursue qualitative and quantitative analysis. Another room in the basement is furnished with furnaces and other appliances for assaying in the dry way. Another is arranged for drawing, and there are several plainly furnished but commodious class rooms. One of the rooms is devoted to the collection of minerals, which is very neatly arranged in flat cases, with abundant illustrations of crystalline forms interspersed. Another contains the collections of geology and palæontology, in great part consisting of the private cabinet of Professor Newberry, and especially rich in the flora of the coal period, and in illustrations of the ores and other economic products of America.

The staff of Columbia College consists of eighteen Professors, lecturers, and assistants, representing the subjects of mineralogy, metallurgy, chemistry, botany, mathematics, mechanics, physics, geology and palæontology, assaying and drawing. Its course extends over three years, and embraces the work necessary to qualify for practical operations in mineral surveying, mining, metallurgy and practical chemistry. Students are required on entrance to pass an examination in algebra, geometry and trigonometry. Though it has been in operation on its present basis only for a few years, it had in its last catalogue 109 students, the greater part of whom, on attaining to the degree of "Engineer of Mines" or "Bachelor of Philosophy," will go out as practical workers in mines and manufactories. An important feature of the course is that students are expected in the vacation to visit mines and metallurgical and chemical establishments, and to report thereon and make illustrative collections; while during the session short excursions are made to machine shops and metallurgical establishments in and near the city. It is probable that Columbia College is little cared for or thought of by the greater part of the busy multitudes of New York; yet if a map of the city were made on the principle of the missionary maps, but illustrating the places where true industrial progress is being provided for, it would be a very white spot, though but a very small one, in the great Babel.

From New York to New Haven is from a great city with small science to a small city in which science bulks relatively larger. On Christmas Day we looked in upon Professor Marsh, almost buried among all that is richest and rarest in new scientific literature and choice specimens, and enjoyed again the genial look and kindly greeting of our friend Silliman, and chatted for a little with the keen philosophic Dana, shattered indeed in health, but still growing inwardly in spirit. The Sheffield Scientific School is a modern outgrowth of the old University of Yale College; and originated in 1847 in the organization of the "Department of Philosophy and Arts," under Professors Silliman and Norton, representing respectively the subjects of Applied Chemistry and Agriculture. The scheme seems to have been devised by the elder Silliman, and to have had its birth in his private efforts in previous years to give practical instruction to special students. This department was maintained with moderate success for several years; but at length in 1860 Mr. Sheffield, a wealthy citizen of New Haven, came forward to its aid with the handsome gift of a building and apparatus valued at over $50,000 and a fund of $50,000 more to endow Professorships of Engineering, Metallurgy and Chemistry. This enlightened benefaction at once placed the school on a respectable footing, and in 1863 it was further enlarged by the application to its use of the share of the State of Connecticut in the large grants of land made by Congress in that year for purposes of scientific education,—grants which have borne similar good fruit in many other States. The Sheffield School will also be a large sharer in the benefits which the University will derive from the great Museum founded by Mr. Peabody, and endowed by him with the sum of $150,000. The present extremely valuable collections of Yale College are stored in rooms of quite inadequate dimensions, and are being rapidly augmented and improved. Prof. Marsh and Prof. Verrill alone have vast stores of fossils, corals and other specimens, in basements and cellars; and when the whole shall be arranged in Mr. Peabody's Museum, Yale College will be inferior to few Academic institutions in the world in regard to its facilities for teaching the science of nature through the eye. A special collection in the Sheffield School, very valuable and well worthy of study, is that of economic geology. It is admirably arranged, and gives at one view an idea of nearly all the sources of the mineral wealth of the United States from the Atlantic border to the Pacific.

The building of the Sheffield School is better than that of Columbia College, though it is an old medical school adapted to its present use; and the scope of the institution is wider, including six distinct courses, any of which may be followed by the student. These are: 1st, Chemistry and Mineralogy; 2nd, Engineering and Mechanics; 3rd, Mining and Metallurgy; 4th, Agriculture; 5th, Natural History and Geology; 6th, A Select Scientific and Literary Course. The class-rooms and laboratories struck me as remarkably ingenious and neat in all their arrangements, and combining in a great degree all possible contrivances for the convenience of Professors and students. The bungling and uncomfortable arrangements too often seen in Academic rooms had evidently here been replaced by the exercise of some engineering and mechanical skill and contrivance, and by a combination of lecture room and cabinet the means of illustration had been rendered extremely accessible. In token that the Sheffield School is not altogether a school of mines looking down into the bowels of the earth, its liberal founder has presented it with an Equatorial Telescope, made by Clark, with an object glass having an aperture of nine inches. It is placed in a tower constructed for it; and with a meridian circle and other instruments, enables students to learn all the work of a regular observatory, as well as the operations of astronomical geodesy. Any one interested in the training of the young men of Canada can scarcely avoid a feeling of envy in visiting such an institution as this, furnished with so many facilities for enabling the active mind of youth to grasp all that is of practical utility or provocative of high and noble thought in the heaven above and in the earth beneath. At this moment a Canadian Sheffield, judiciously aiding any University having an adequate and permanent basis, would do more to promote the trade and manufactures of this country, and its scientific reputation, than can be done by any other agency.

The faculty of the Sheffield School includes twenty-three names, and its roll of students numbers one hundred and forty. It is scarcely necessary to say that several of the Professors at Yale are active and successful original workers, and that the place is not only an effective scientific school, sending out each year a large corps of trained men into the higher practical pursuits connected with science, but also an important centre of discovery and original investigation, further materials for which are being constantly accumulated. More especially in geology, mineralogy, palæontology, zoology and chemistry, are such men as Dana, Silliman, Marsh, Brush and Verrill adding to the stock of knowledge for the whole world, as well as training their students. And this one of the results in all cases of a well appointed and efficient school of science.

Crossing the dark harbour of New York, cumbered with cakes of ice; and rapidly rolling over flat New Jersey, interesting for its curious deposits of the green-sand of the old Cretaceous Sea, now quarried as a manure, and to be seen in heaps green almost as grass, by the roadside, we reach pleasant, quiet Philadelphia, in which among chief objects of interest to a scientific traveller, are the collections of its old and useful Academy of Sciences, a scientific workshop as vigorous in its age as any of its more youthful rivals, though sadly in want of enlarged apartments for its collections. Hawkins had just been setting up here the skeleton of the Hadrosaurus of the New Jersey green-sand, one of the most portentous of those old reptiles of that Mesozoic age, when the giant "tanninim" were the lords of creation. It must have been a creature four-fifths reptile and the rest bird, standing upright twenty feet in height, on two enormous legs with three-toed feet, and an immense pillar-like tail, while its small fore feet were used as hands to aid it in obtaining the fruits or other vegetable substances on which it fed. It might be described as a gigantic reptilian kangaroo with the toes of a bird; and were it not for the actual bones proving that it had existed, a zoologist would scarcely have the hardihood to imagine such a creature in his dreams. We stand amazed beside the skeleton of the Mastodon or the Megatherium, but not with the feeling almost of disbelief in our senses excited by the strange combination of characters in this wonderful animal, which among other things shows how the apparent bird-tracks of the Mesozoic rocks, or some of them, may have been made by biped reptiles, strange and gigantic anticipations of the attitude of man himself. As a companion, or rather a formidable enemy, to this animal, Mr. Cope, who is studying these remains, showed me portions of the skeleton of a gigantic carnivorous reptile of the same age, with formidable teeth like those of Megalosaurus, and hooked eagle-like claws which must have been ten inches in length. The collections of the Academy are of immense value, and its Scientific Library is very complete, but it greatly lacks room and light. Efforts are now being made to secure a better building. Among other things it possesses an extremely valuable and very complete collection of American skulls, which have afforded materials to Morton, Wilson and Meigs for elaborate investigations on the cranial characters of races, and which are scarcely yet exhausted as sources of information on this very important subject.

Two works are now in progress in Philadelphia, which will be of great value to students of American Palæontology. One is a monograph on American fossil mammals, by Leidy; the other a monograph on American fossil reptiles, by Cope. One of these is to be published in the Transactions of the Philosophical Society; the other in those of the Academy,—both active Societies and fellow-workers in the cause of science.

Baltimore, though a queenly city, does not stand so high as Philadelphia in scientific work. It has, however, its Academy with a band of zealous naturalists, of whom Tyson, Morris and Dalrymple were old friends, and others I was glad to meet for the first time. The vicinity of the city presents a strange association of old and new rocks, characteristic of that line of junction of the more recent formations of the coast with old metamorphic rocks, on which so many American cities have been placed. In the quarries near the town are gneiss, hornblende schist and granite, which have much of the aspect of Laurentian rocks, and according to Mr. Tyson's sections may be of that age. To a northern visitor they are remarkable for the depth to which they have been decomposed by the weather. Similar rocks in Canada usually present a hard polished surface, as if incapable of decomposition; here there are many feet of "rotten rock" at the surface. The causes may be: 1st, the more rapid waste of felspathic rocks under a warmer climate and a larger rain-fall; 2nd, the want of a tenacious clay covering; 3rd, the absence of the great Northern drift and its ice-striation and polishing. There does not seem to be any evident difference in the composition of the rocks to account for it. Another point of interest is the extremely red colour of the sand formed from the decomposition of the hornblendic portions of the rock. The oxide of iron resembles anhydrous peroxide in its colour; and the sand formed from it would give a very good red sandstone. Many ages of subaerial decomposition of rocks like these, followed by rapid denudation, would give red sandstone rocks like those which appear in so many geological periods.

Among these ancient rocks, there appear beds of white, red and dark gray clay. In the latter there are numerous trunks of trees converted into lignite, and layers of nodules of carbonate of iron, which are extracted in large quantities as an ore of the metal. It appears that in the lower beds of this formation well preserved trunks of Cycads are found, and the whole are regarded by Mr. Tyson as possible representatives of the Wealden. In one of the fossil trunks I observed a portion of charcoal perfectly representing the mineral charcoal which occurs under similar con ditions in the coal formation; and in this comparatively modern formation, deposited probably in a lagoon or estuary, the conditions of deposition of the clay-ironstones of the coal-measures are perfectly reproduced.

The Peabody Institute at Baltimore is a remarkable monument of the generosity of a man celebrated for his princely munificence. Mr. Peabody resided for some time in Baltimore, and, as an evidence of his regard for its welfare, he has presented to it the sum of one million of dollars, for the establishment of an Institute, the primary objects of which are stated to be—1st, an extensive library; 2nd, the delivery of lectures in science and literature, and in connection with this the provision of prizes and medals for competition in the high schools in the city; 3rd, an Academy of Music, and 4th, a Gallery of Art. In pursuance of these objects a plain but substantial and commodious building of white marble has been erected, and a library of the greatest possible excellence is rapidly being accumulated, while progress is being made in all the other objects contemplated. The Institute is already, in its Library, Lectures and Academy of Music, an inestimable boon to the city, and must speedily have a marked effect on the interests of literature and science. A museum is not at present contemtemplated; but if not otherwise provided for, it would be a worthy object to attempt, in such an institute, a representation at least of the geology and natural history of the State, which might do much to promote the development of its resources, as well as the education of its young men. The Provost, Mr. Morrison, is evidently earnest and enthusiastic in the good work in which he is employed, and the Librarian, Mr. Uhler, from his knowledg cf

Natural Science, is specially fitted to take a practical view of the scientific part of the Library, and to be of service in the organization of a Museum should this be undertaken.

Such endowments as this of Mr. Peabody give to the United States an enviable eminence among the nations of the earth, in the promotion of popular culture and scientific progress. They constitute an unmistakeable evidence of the wisdom of the early American colonists in making provision for the general diffusion of education, and they show that in the future this great country is destined to be unrivalled in its means, whether in books, apparatus, collections, or teachers, for the development of the greatest of all the resources of nations—mind. Already it is outbidding the old world in the market of teaching labour, and of rare and costly specimens and books; and the growth, side by side, of its wealth and culture, must accelerate this more and more.

More fortunate than the belligerent Southerners, I found means to extend my peaceful raid into the heart of Washington itself; which, in a scientific sense, is the Smithsonian Institution, and in that of hospitality and kindly greeting, nowhere warmer than in Prof. Henry and his family. Washington seems to have grown and thriven on the war, but still presents the old contrast of massive and impressive public buildings with comparatively plain and even mean private residences, a point in which it differs from all the other great cities of America; but the reason readily appears from a consideration of its political circumstances. The Smithsonian Institution is cosmopolitan in its aims—its object being "the increase and diffusion of knowledge among men." This object, as wisely interpreted by Prof. Henry, is not to promote local ends, but those in which the world is interested; not to do that which any one can profitably do, but that which, while important in itself, cannot be done by other means. Thus peculiar in its aims, the Institution has to forego many tempting roads to popularity, yet like other good things it seems to be popular in spite of itself. Practically, as the great current of science on this continent necessarily runs much in the channel of discovery in Geology and Natural History, the work of the Institution lies much in this direction, and no institute in America has rendered more important aids to the prosecution of Natural Science. Its collections, under the skilful superintendence of Prof. Baird, are a marvel of system and careful arrangement; and are open to the inspection and study of naturalists from any part of the world; who are in some cases accommodated with rooms for their work as well as access to specimens. Its publications have given to the world a great mass of matter which would otherwise have been inaccessible to students. Its facilities for intercommunication and exchanges between scientific men, involving an immense amount of detail, have been of the utmost service, and its liberal disposal of duplicate specimens has strengthened the hands of students and teachers far and wide.

Prof. Henry and his assistants are at present giving much attention to the collection of American antiquities, and have accumulated a very large and instructive assemblage of objects of aboriginal art from all parts of the continent. The effort is a most important one. America, with its modern stone age, must eventually furnish the clue to the right interpretation of the immense quantity of facts as to the stone and bone age of Europe now being accumulated, and of which the chronology is at present so strangely, and even absurdly, exaggerated by the majority of European archæologists.

It is a wide leap to pass from the arrow-heads and stone axes of the Aboriginal Indians to the multitudinous inventions of the modern Americans, but the transition is easily made by passing from the Smithsonian to the noble white marble building designated by the humble name of Patent Office, and inspecting its thousands of feet of glass cases crammed with machines and models, ingenious and stupid, useful and useless; but all monuments of the many inventions of scheming minds. The Patent Office is a vast and well arranged museum of useful art, but its cases are so numerous and so crowded with objects, that a non-professional visitor is simply bewildered, and contents himself with a general glance at the whole. In the lower hall there stands an object suggestive in several ways. It is the marble statue of Washington by Powers, sent during the late war by General Butler from Baton Rouge, in imitation, perhaps, of certain Generals of ancient Rome and modern France, in their treatment of works of art. It is a fine figure, somewhat idealised perhaps, but giving a far better conception of the temperament and aspect of the great American General than the current portraits.

A very interesting collection, known as the Army Medical Museum, has been formed in Ford's theatre, the building in which Lincoln was assassinated. It is a marvel of careful mounting and preparation, and in this respect alone is well worthy of a visit from any one interested in the best mode of exhibiting objects in a museum. It is of great professional value; and independently of this, it possesses a melancholy interest in its profuse exhibitions of the effects of shot, shell and other implements of destruction, on the poor human frame. Almost every conceivable form of injury received in war is here exhibited by preparations, every one of which tells not only the history of a surgical case, but a tale of suffering and death. A strange commentary it is on the humanity of a christian and civilized age to see these beautifully fashioned and fitted human bones, splintered by the rude violence of deadly missiles, and now mounted with all the dainty skill of the anatomical preparator. In flat cases, where they are much better seen than as ordinarily arranged in wall cases, are a few interesting American skulls—some of supposed mound-builders of the West, others of rude Indian tribes, and a few Mexican and Peruvian. One cannot fail to be struck, even on a cursory inspection of these skulls, as well of as the larger series in the Academy of Sciences in Philadelphia and in the Smithsonian, with such general views as the following;—1st. That there is one prevalent and somewhat long-headed form of skull very generally distributed in America; 2nd. That there are occasional and peculiar short-headed forms; 3rd. That some of the latter, as well as some of the long and narrow forms, are the results of artificial compression; 4th. That the skulls of the more civilized races are of a finer and more delicate type; 5th. That there is a strong resemblance between the ordinary American forms and those of the skulls of ancient and rude European and African tribes. These are general truths which rise out of the mass of details noticed by craniologists, and which are eminently suggestive as to the relationships and affiliations of men.

In leaving the museum I paused to look at two little glass cases containing two modern mummies of Indian children, in excellent preservation. One is a Flathead child, its skull compressed in the strange fashion of that tribe—its feet gathered up to its chest, its shrunken frame carefully wrapped in cloth, and on its breast bearing a necklace of beautiful Dentalium shells, the most precious treasure of the west coast, mixed with a few glass beads, perhaps almost as precious. The other is a Dakotah child, in full dress, with neatly made coat and leggins, and prettily worked mocassins, and a broad collar of white and blue beads and brass buttons neatly strung on leather. These, though quite modern, reminded me of the quantities of precious strings of wampum laid up in some ancient graves of Indian babes in British America, and which remain after the furs, no doubt clothing the bodies, have decayed. A higher phase of our humanity is represented by these remains than by the inventions of the Patent Office—the love that survives the death of its object, and which, in the absence alike of human philosophy and Divine revelation, preaches with a force stronger than sense and mere reason, that the loved one "is not dead but sleepeth," and will awake in another world, whither affection can follow it only by decking its poor remains in the best robe and burying it with the most costly treasures. Such faith in the Indian mother may be very simple and ignorant; but it is surely a better and holier thing than that cold skepticism which, while grovelling in a base selfishness, looks up in its higher flights of reason and imagination to tell us that man is but a better kind of brute, an aggregate of blind material forces.

NOTES ON THE GEOLOGY OF SOUTH-WESTERN ONTARIO.*

By T. Sterry Hunt, LL.D., F.R.S., of the Geological Survey of Canada.

The paleozoic strata of the southwestern portion of the province of Ontario (late Upper Canada), are generally covered by a considerable thickness of clay, which has made their study extremely difficult. During the last few years, however, numerous borings have been made over a wide area in this region, in search of petroleum, and have disclosed many facts of geological interest. By frequently visiting the localities, and carefully preserving the records of these borings, I have been enabled to arrive at some important conclusions as to the thickness and the distribution of the underlying Upper Silurian and Devonian strata, to which I now beg to call the attention of the Association.

The rocks of the New York series, from the Oriskany sandstone to the coal, which are regarded as the equivalents of the Devonian of the old world, were shown by Prof. James Hall, in 1851, to constitute three natural groups. Of these, the first and lowest, some-

---

* Read before the meeting of the American Association for the Advancement of Science, at Chicago, August, 1868.

times called the Upper Helderberg, and consisting of the Oriskany, with its overlying Corniferous limestone (embracing the local subdivision known as the Onondaga limestone) constitutes what may be provisionally called the Lower Devonian. The second group has for its base the black pyroschists known as the Marcellus shale, followed by the Hamilton shale, with the local Tully limestone, and terminated by another band of black pyroschist, the Genesee slate ; the whole constituting what may be termed the Middle Devonian. The third group, embracing the Portage and the Chemung shales and sandstones, with the local Catskill sandstone, makes the Upper Devonian. (*)

The black Genesee slate, according to Mr. Hall, is paleontologically related to the Hamilton slates, and by him included as part of the Hamilton group, as recognized in the Geology of Canada. Similar black slates, though thicker, less fissile, and interstratified with greenish arenaceous beds, occur at the base of the Portage formation, marked by the remains of land-plants and of fishes which characterize the Upper Devonian. The black slates of this horizon thus constitute, as it were, beds of passage. The thickness of the lower and more fissile black beds, recognized by Mr. Hall as belonging to the Hamilton group, is, according to him, only twenty-four feet at the eastern end of Lake Erie.

There exists in south-western Ontario, along the River St. Clair, an area of several hundred square miles underlaid by black shales, in the counties of Lambton and Kent, of which only the lower part belongs to the Hamilton group. These strata are exposed in very few localities, but the lower beds are seen in Warwick, where they were, many years since, examined by Mr. Hall, in company with Mr. Alexander Murray of the Geological Survey of Canada, and were by the former identified with the Genesee slate forming the summit of the Hamilton group. They are in this place, however, overlaid by more arenaceous beds, in which Prof. Hall at the same time detected the fish remains of the Portage formation. The thickness of these black strata, as appears from a boring in the immediate vicinity, is fifty feet, beneath which are met the gray Hamilton shales. A similar section occurs at Cape Ipperwash or Kettle Point in Bosanquet, on Lake Huron, where bands of alternating greenish and black arena-

(*) James Hall, in Foster & Whitney's Geology of Lake Superior, ii, 386.

ceous shales, holding Calamites, are met with. They strata also were recognized by Mr. Hall, who examined them, as belonging to the Portage formation; and abound in the large spherical calcareous concretions which occur at the same horizon in New York. The entire thickness of the black shales at this point has not been determined, but in numerous borings throughout the region under notice, they are easily distinguished both by color and hardness, from the soft gray Hamilton shales which underlie them. At Corunna, near Sarnia, a thickness of not less than 213 feet of hard black shales, interstratified towards the top with greenish sandstone, were met with. In the northern part of Enniskillen, near Wyoming, they are about fifty feet in thickness; at Alvinstone, eighty feet; in Sombra, on the Sydenham river, 100 feet, and in two borings in Camden, 146 and 200 feet. A little to the north of Bothwell, on the Thames, their thickness was found to be seventy-seven feet, while southward, along the shore of Lake Erie, about sixty feet of the hard black slate overlie the soft gray Hamilton shales.

From these, and a great many similar observations, which are detailed at length in the Report of the Geological Survey of Canada, published in 1866, it has been possible to determine with considerable accuracy the distribution of these black strata beneath the thick covering of clay which conceals them through the greater part of the region. It being impossible, under the circumstances, to distinguish between that lower portion of the black strata which belongs to the Hamilton group or Middle Devonian, and the overlying Portage formation, the whole of these strata, down to the summit of the soft gray shales, are included with the Portage. In Michigan, according to Prof. Winchell, the whole thickness of the Portage (Huron) group, as just defined, including twenty feet of black shale at its base, is only 224 feet, which are represented in Ontario by 200 feet on the Sydenham river, and by 213 feet at Corunna on the St. Clair. Yet, Prof. Winchell, for some reason, doubts the existence of the Portage formation in Ontario.

The Hamilton shale, which in some parts of New York attains a thickness of 1,000 feet, but is reduced to 200 feet in the western part of the state, consists in Ontario chiefly of soft gray marls, called soapstone by the well-borers, but includes at its base a few feet of black beds, probably representing the Marcellus shale. It contains, moreover, in some parts, beds of from two to five feet of solid gray limestone, holding silicified fossils, and in one instance impregnated with petroleum, characters which, but for the nature of the organic remains, and the underlying marls, would lead to the conclusion that the Lower Devonian had been reached. The thickness of the Hamilton shale varies in different parts of the region under consideration. From the record of numerous wells in the south-eastern portion, it appears that the entire thickness of soft strata between the Corniferous limestone below and the black shale above, varies from 275 to 230 feet, while along the shore of Lake Erie, it is not more than 200 feet. Further north, in Bosanquet, beneath the black shale, 350 feet of soft gray shale were traversed in boring, without reaching the hard rock beneath, while in the adjacent township of Warwick, in a similar boring, the underlying limestone was attained 396 feet from the base of the black shales. It thus appears that the Hamilton shale (including the insignificant representative of the Marcellus shale at its base) augments in volume, from 200 feet on Lake Erie to about 400 feet near to Lake Huron. Such a change in an essentially calcareous formation, is in accordance with the thickening of the Corniferous limestone in the same direction.

The Lower Devonian in Ontario is represented by the Corniferous limestone, for the so-called Onondaga limestone has not been recognized, and the Oriskany sandstone, always thin, is in some places entirely wanting. The thickness of the Corniferous in western New York is about ninety feet, and in south-eastern Michigan is said to be not more than sixty, although it increases in going northward, and attains 275 feet at Mackinac. In the townships of Woodhouse and Townsend, about seventy miles west from Buffalo, its thickness has been found to be 160 feet, but, for a great portion of the region in Ontario underlaid by this formation, it is so much concealed that it is not easy to determine its thickness. In the numerous borings which have been sunk through this limestone, there is met with nothing distinctive to mark the separation between it and the limestone beds which form the upper part of the Onondaga Salt-group or Salina formation of Dana, which consists of dolomites, alternating with beds of a pure limestone, like that of the Corniferous formation. The saliferous and gypsiferous magnesian marls, which form the lower part of the Salina formation are, however, at once recognized by the borers, and lead to important conclusions regarding this formation in Ontario. In Wayne county, New York, the Salina formation has a thickness of from 700 to 1,000 feet, which, to the westward, is believed to be reduced to less than 300 feet, where the outcrop of this formation, crossing the Niagara river, enters Ontario.

At Tilsonburg, ninety miles west from Buffalo, borings have shown the existence of the Corniferous limestone directly beneath about forty feet of clay, while two miles to the south-west it is overlaid by a few feet of soft shales, probably marking the base of the Hamilton. From a depth of 100 feet in the limestone, at Tilsonburg, a flowing well was obtained, yielding an abundance of water, and a considerable quantity of petroleum. This boring was subsequently carried 854 feet in the rock, which at that depth was a dolomite. Numerous specimens from the upper 196 feet were of pure non-magnesian limestone ; but below that depth dolomites, alternating with pure limestones, were met with to the depth of 854 feet, from which salt water was raised, marking, it is said, from 35° to 50° of the salometer. The well was then abandoned. We have here a boring traversing 854 feet of solid strata, from what was, probably, near the summit of the Corniferous, without reaching the marls which form the lower part of the Salina formation.

In a boring at London, where the presence of the base of the Hamilton was marked by about twenty feet of gray shales, including a band of black pyroschist, overlying the Corniferous, 600 feet of hard rock were passed through before reaching soft magnesian marls, which were penetrated to the depth of seventy-five feet. Specimens of the boring from this well, and from another near by, carried 300 feet from the top of the Corniferous, show that pure limestones are interstratified with the dolomites to a depth of 400 feet. At Tilsonburg a pure limestone was met with at 524 feet from the top.

At St. Mary's, 700 feet, and at Oil Springs in Enniskillen, 595 feet of limestone and dolomite were penetrated, without encountering shales, while in another well near the last, soft shaly strata were met with at about 600 feet from the top of the Corniferous limestone, there overlaid by the Hamilton shales. It thus appears that the united thickness of the Corniferous formation and the solid limestones which compose the upper part of the Salina formation, is about 600 feet in London and Enniskillen, and farther eastward, in Tilsonburg and St. Mary's, considerably greater, exceeding by an unknown amount, in these localities, 854 and 700 feet. The Corniferous at its outcrop in Woodhouse, twenty-five miles to the east of Tilsonburg, measures only 160 feet thick, so that there is evidently, in the localities just mentioned, a great increase in the volume of the Salina formation from the 300 feet observed in western New York. At Goderich, on Lake Huron, the thickness of this formation is much greater. Here are found non-fossiliferous strata, having the character of the so-called Water-lime beds, which belong to the summit of the Salina formation, and are immediately overlaid by fossiliferous strata belonging to the Corniferous formation. At this point a boring in search of petroleum penetrated not less than 775 feet of solid white, gray and blue limestones, chiefly magnesian, with occasional thin beds of sandstone. Below this depth the strata consisted chiefly of reddish and bluish shales, with interstratified beds of gypsum, sometimes ten feet in thickness. After the 164 feet of these, rock-salt was met with, interstratified with clay, through a distance of forty-one feet, beneath which the boring was carried five feet in a solid white limestone, probably belonging to the underlying Guelph formation. We have thus, for the entire thickness of the Salina formation at Goderich, 980 feet, of which the upper 775 are hard strata, chiefly magnesian limestones, and 205 feet gypsiferous and saliferous shales. Several wells since sunk in this vicinity, one of them twelve miles to the south-westward, have given almost identical results, including the mass of rock-salt at the base. These borings now yield, by pumping, a copious supply of brine, nearly saturated and of great purity, so that this newly discovered saliferous deposit has already attracted the attention of salt manufacturers, both in Ontario and New York. A detailed description of the first well, with an analysis of the brine, will be found in the Geological Report for 1866, already referred to.

Brines are said to have been met with at this horizon in Michigan, where the formation will probably be found to have a much greater thickness than that hitherto assigned to it.

It thus appears that the Salina formation, after being reduced to less than 300 feet at the Niagara river, again assumes, to the north-westward, a thickness of nearly 1,000 feet, and becomes once more salt-bearing, as in the State of New York. The increased thickness of the formation, in these two regions, connected with accumulations of salt at its base, would seem to point to ancient basins, or geographical depressions in the surface of the underlying formation, in which were deposited these thicker portions. The existence of these Upper Silurian salt lakes, whose evaporation gave rise to the rock-salt, gypsum and dolomite of the Salina formation, shows a climate of great dryness to have then prevailed in this region. A similar conclusion is to be drawn from the more or less gypsiferous dolomites of the Calciferous and Niagara formations, the magnesian limestones at other horizons, and the gypsum and salt deposits of the Carboniferous period,—leading us to infer a very limited rain-fall over the north-eastern portion of this continent, throughout the Paleozoic period.

In this connection, a few remarks with regard to the horizon of the petroleum which issues from the Devonian rocks of Ontario, may not be out of place. In opposition to the generally received view, which supposes the oil to originate from a slow destructive distillation of the black pyroschists belonging to the middle and upper divisions of the Devonian, I have maintained that it exists, *ready formed*, in the limestones below.*—In addition to the well known fact of its frequent occurrence in the Corniferous limestone, I have cited the observations of Eaton, Hall and myself, as to the existence of both solid and liquid bitumen in the Niagara limestone, and even in the massive beds of the Hamilton. A remarkable example is afforded in the oleiferous beds of the Niagara formation in the vicinity of Chicago, † and still another in similar strata belonging to the Lower Helderberg period, in Gaspé. The deep borings already mentioned in Tilsonburg, St. Mary's and Enniskillen, showed in each case small quantities of petroleum in strata of the Salina formation, and the same was observed at considerable depths in the Goderich well already described.

Apart from the chemical objections to the view which supposes the oil to be derived from the pyroschists above the Corniferous limestone, it is to be remarked, that all the oil wells of Ontario have been sunk along denuded anticlinals, where, with the exception of the thin black band sometimes met with at the base of the Hamilton formation, these so-called bituminous shales are entirely wanting. The Hamilton formation, moreover, is never oleiferous,

---

* Canadian Naturalist, June, 1861, and Silliman's Journal, March, 1863

† It is proposed to give, in a subsequent communication, the results of an examination of this remarkable limestone.

except in the case of the rare limestone beds already referred to, which are occasionally interstratified. Reservoirs of petroleum are met with, both in the overlying quaternary gravels and in the fissures and cavities of the Hamilton shales, but in some cases the borings are carried entirely through these strata, into the Corniferous limestone, before getting oil. Among other instances cited in my Geological Report for 1866, may be mentioned a well at Oil Springs, in Enniskillen, which was sunk to a depth of 456 feet from the surface, and seventy feet in the solid limestone beneath the Hamilton shales, before meeting oil, while in adjacent wells supplies of petroleum are generally met with at varying depths in the shales. In a well at Bothwell, oil was first met with at 420 feet from the surface, and 120 feet in the Corniferous limestone, while a boring at Thamesville was carried 332 feet, of which the last thirty-two feet were in the Corniferous limestone. This well yielded no oil, until, at a depth of sixteen feet in this rock, a fissure was encountered, from which, at the time of my visit, thirty barrels of petroleum had been extracted. At Chatham, in like manner, after sinking through 294 feet of shales, oil was met with at a depth of fifty-eight feet in the underlying Corniferous limestone.

We also find oil-producing wells sunk in districts where the Hamilton shale is entirely wanting, as in Maidstone, on the shore of Lake St. Clair, where, beneath 109 feet of clay, a boring was carried through 209 feet of limestone, of which the greater part consisted of the Water-lime beds of the Salina formation, overlaid by a portion of the Corniferous. At a distance of six feet in the rock a fissure was struck, yielding several barrels of petroleum. Again at Tilsonburg, where the Corniferous limestone is covered only by quaternary clays, natural oil springs are frequent, and, by boring, fissures yielding petroleum were found at various depths in the limestone, down to 100 feet, at which point a flowing well was obtained, yielding an abundance of water, with some forty gallons of oil daily. The supplies of oil from wells in the Corniferous limestone are less abundant than those in the overlying shales, and even in the quaternary gravels, for the obvious reason that both of these offer conditions favorable to the retention and accumulation of the petroleum escaping from the limestones beneath.

The presence of petroleum in the Lower Silurian limestones, and their probable importance as sources of petroleum, was first pointed out by me in 1861. The conditions under which oil occurs in these limestones in Ontario are worthy of notice, inasmuch as they present grave difficulties to those who maintain that petroleum has been generated by an unexplained process of distillation going on in some underlying hydrocarbonaceous rock. Numerous borings in search of oil on Manitoulin Island, have been carried down through the Utica and Loraine shales, but petroleum has been found only in fissures at considerable depths in the underlying limestones of the Trenton group. The supplies from this region have not hitherto been abundant, yet from one of the wells just mentioned, 120 barrels of petroleum were obtained. The limestone here rests on the white unfossiliferous Chazy sandstone, beneath which are found only ancient crystalline rocks, so that it is difficult to avoid the conclusion that this limestone of the Trenton group is, like those of Upper Silurian and Devonian age, already noticed, a true oil-bearing rock.

In concluding these observations on the geology of Ontario, it may be remarked that throughout the south-western counties, the distribution of the Middle and Upper Devonian rocks has been determined almost wholly from the results of borings undertaken in search of petroleum. From these it appears that the wide spread of these rocks in this region is connected, first, with a transverse north and south synclinal depression, which traverses the peninsula, and has been noticed in the Geology of Canada, p. 363, and secondly, with several small undulations, running north-east and south-west, on the north west side of the anticlinal of the Thames; which is a prolongation of that passing by Cincinnati, and may be regarded as part of the main anticlinal of the great axis of elevation which divides the coal field of Pennsylvania from that of Michigan.

The Devonian rocks are found, in the region under consideration, at depths not only far beneath the water-level of the adjacent lakes of Erie and St. Clair, but actually below the horizon of the bottom of those shallow lakes. Thus at Vienna, in Bayham, at a point said to be about forty feet above the level of Lake Erie, the underlying rock was met with beneath 240 feet of clay, while at Port Stanley, twenty feet above the lake, the Hamilton shale was struck beneath 172 feet of clay, and at the Rondeau, just above the level of Lake Erie, the clay was 104 feet thick. A similar condition of things exists on the south side of the lake, at Cleveland, where no rock is encountered at a depth of 100 feet below the water-level. Again in Sombra, on the banks of the Sydenham river, which is very little above the level of Lake St. Clair, a well ten feet above the river passed through 100 feet of clay before meeting the black shales of the Portage group, while in Maidstone, on the shore of Lake St. Clair, and a very few feet above its level, 109 feet of clay were found overlying the Corniferous limestone. The greatest depth of Lake St. Clair is scarcely thirty feet, and that of the south-western half of Lake Erie does not exceed sixty or seventy feet, so that it would seem that these present lake basins have been excavated from the quaternary clays which, in this region, fill a great ancient basin, hollowed out of the paleozoic rocks, and including in its area the south-western part of the peninsula of Ontario.

ON THE CHOICE OF A MICROSCOPE.

By J. Baker Edwards, P.H.D., F.C.S.

Much excellent advice has been given in English scientific periodicals on this subject. Meanwhile manufacturers have been improving the instrument in many respects, and probably a larger class now exists who desire assistance in the choice of a Microscope than could be found 20 years ago, when the variety of choice was less embarrassing. Since that period,—when the Exhibition of 1851 proved the superiority of our leading English makers over their foreign competitors—great improvements have been introduced and a large variety of forms have been strongly recommended as possessing peculiar advantages, such as the elegant light tube frame, and magnetic stage of Mr. Ladd, the solid body and elliptical stage of Mr. Pillischer, the useful and cheap instruments of Mr. Highley, and the Universal Microscope of Smith & Beck. These varieties are, however, rather curious and ingenious than desirable, and must be left to individual taste to select. I shall not, therefore, dwell upon their peculiar excellences, but describe only such general typical forms as may probably be obtained or easily procured in this country; and I shall address my remarks according to the probable requirements of my readers, as :—

1st. Young beginners.

2nd. Professional students.

3rd. Advanced students or Naturalists.

4th. Professors or wealthy amateurs.

I recommend the beginner to choose a light, portable but steady instrument with a good open stage and low powers. Let his first object be to prepare and mount objects and let him confine himself to those adapted for his instrument, such as organs of plants and insects, sections of wood and bone, etc. Let his first book be "Half hours with the Microscope," and when he has mastered this, let "Carpenter on the Microscope" be his constant work of reference. Now for the instrument to be chosen :—

The compound body should have two eye-pieces and two object glasses, the range of power should be from 25 to 250 diameters. The body should have two adjustments—coarse by rack work, and fine by lever—the stage as free and open as possible, the hole not less than 1 inch in diameter. The body should hinge upon its centre so as to balance into a favorable position for the sitter, and the mirror be both plane and concave. The bull's eye condenser should be on a separate stand, and a stage forceps and live box are necessary additions. This, in a box with lock and key, is worth from $15 to $20.

Nothing less than this is worth calling a "Microscope," and with such an instrument as this a large variety of objects may be mounted and good work done. The round boxed French Microscopes are mere toys, and no perpendicular Microscope will advance the student in the knowledge of the science for reasons which will hereafter appear. Should your local opticians not be able to fulfil all the conditions of the above instrument, I advise you to order a "Society of Arts prize Microscope," from Field & Son or from S. H. Parkes, Birmingham. Either firm will supply for £3 3s. a good useful instrument, giving full value for the money. To the professional student I should recommend something better than the above, both in stand and powers. The student's Microscope, made by Mr. Pillischer, New Bond St., London, price £5, is the best and cheapest I know of this class. It consists of a good steady well finished brass stand, the body tube screwing off so as to pack into a small case. Two eye pieces and a compound object glass—divisible into 1 in., ½ in. and ¼ in. powers—giving a range from 40 to 400 diameters. An opaque condenser on separate stand, stage forceps and live box are also packed in a neat mahogany box with lock and key. A polariscope is added for £2 extra and the whole is a thoroughly good working instrument. I have used one for years as an extra laboratory instrument, and have been well satisfied with a large number which I have examined and recommended to students.

Similar instruments for about the same price may be obtained from J. B. Dancer, Manchester, or Abraham & Co., Liverpool; but in the choice of such an instrument I call the attention of the student to certain requirements:—

1st. Steadiness of the instrument combined with inclined position.

2ndly. Correction and definition of object glasses.

3rdly. Enlarged field of view.

4thly. Free stage movement.

5thly. Good illumination above and below the stage.

6thly. Smooth rack work adjustments.

A few words on each of these points may be useful to the inexperienced.

The steadiness of your instrument and of the table or floor upon which you are working is essential to accurate observation, round stands are generally unsteady, and the tripod should therefore have the preference. Inclination of the Microscope has a tendency to increase any vibration, but it is a valuable motion which the student's Microscope should always possess. The upright position is not only fatiguing, but a source of error from the specs which float upon the watery humour of the eye and collect over the pupil, disturbing correct vision. All perpendicular stands should therefore be rejected by the student, and for prolonged work the Microscope should be inclined at the most convenient angle for the height of the sitter.

The definition of the object glasses is the test of their value. Probably the student must take them on the faith of the manufacturer; but if he has the judgment to select, he will give the preference to the glass which in its highest power will give him a good stereoscopic view of a raised object such as the pollen of mallow or hollyock, and which will define the markings upon starch granules, such as arrowroot and tous les mois, without coloured fringes or distortion of the forms; at the same time it is desirable to have as much light and as large a field of view as possible, and plenty of room upon the stage, to manipulate or dissect an object laid upon it.

The student can never be satisfied with mounted objects, he must dissect a tissue, a flower, or an insect upon the stage, and educate his hand to work his delicate mounted needles, (which look under the powers like flag-staffs),—with the greatest precision and nicety. This cannot readily be done with a contracted stage.

The illumination of the object above and below the stage, in the absence of costly apparatus, may be skilfully accomplished provided only that the stage is thin and the aperture large. Oblique light may be obtained by direct lamp light or by the opaque condenser, so as to give the most delicate effects.

Lastly, a rack work adjustment is always to be preferred to a sliding one, and the opaque condenser is most useful on a separate stand.

Thoroughly worked and studied, the instrument I have described will fulfil all the requirements of the medical student and practitioner; but the instrument implies *work*, *study*, and *perseverance*, and is not designed to be a mere library ornament. I am aware that in many English and Scotch Schools of Science, German and French Microscopes are imported for the use of medical students and recommended for excellence and economy, and no doubt Chevalier, Oberhauser, and Nachet turn out excellent work at a moderate cost. Yet I prefer the build of the English instrument, especially for room upon the stage and good rack movements. Dr. Lawrence Smith's inverted Microscope as made by Nachet, is however a very excellent form of working instrument, and with many useful accessories, is sold at the moderate price of £14 sterling.

Now I shall address the advanced student, the Naturalist: who says perhaps " I have deferred getting a Microscope until I could afford a really good one, and I should like to add to a first rate stand, various powers and accessories as I can afford or happen to meet with them." While I sympathise with these views and acknowledge that this was the plan upon which I started in 1851, yet I think upon the whole it is not the wisest one, especially if it should delay, even for a single year, the possession of an instrument which you can call your own. Not that I regret it in my own case, for I regard with peculiar pleasure the big baby which has grown up under my parental care for 18 years. It has been altered and adapted and improved in almost all its parts, but like our growing selves there it is, the good steady well finished stand of Pillischer, No. 2, first-class. I have learned a great deal in pursuit of improvements upon the instrument, and though probably, it has proved the most expensive way of procedure, yet I feel grateful for the experience it has brought me during the process.

But of late years the requirements of the Naturalist have been so well studied by the leading English manufacturers, that every essential is comprised in moderately priced instruments. Amongst these, I should select for a friend a Smith & Beck's popular Microscope. I have had several through my hands on the way to friends to whom I have recommended them, and I have been more than satisfied with their excellency. The stand and the powers are alike deserving of the highest praise.

The stand is of peculiar construction, having a hinged or folding foot attached to a triangular base, with studs to fix the instrument steadily in the perpendicular position for dissection, three positions of inclination for the sitter, and the horizontal for drawing or for direct illumination. It has excellent rack work and lever adjustments, and may be fitted with all the modern valuable accessories for varied illumination. With 1 in. and $\frac{1}{4}$ in. object glasses, 2 eye pieces, concave mirror and condensing lens, diaphragm, stage forceps, glass plate and pliers, in mahogany case, this instrument is sold at £10 sterling.

The same, with Wenham's binocular, 3 object glasses, 2 in., 1 in. and $\frac{1}{4}$ in., two sets of eye pieces, etc., etc., £15.

The whole complete, with binocular arrangement, Lieberkuhns, dark wells, aeromatic condenser, parabolic reflector, polarizing apparatus, camera lucida, micrometer, live box, zoophyte trough, and an excellent $\frac{1}{8}$th objective, £25 sterling.

I should strongly advise any friend who was tired of a plain instrument, and who wished to get some of these charming accessories, to s ll it, and invest in the above very complete set, and I am sure if he works the instrument tl oroughly he need not envy the happy possessor of a "first c'ass Microscope," three times its value.

I must now, in accordance with my plan, address myself to the fortunate man who wants a "first class instrument," or who, having a good stand and glasses wi hes to know what he should add thereto. To the first I would say, you may, with equal confidence, purchase from the three great makers, Ross, Smith & Beck, or Powell & Lealand, and you will probably be equally satisfied with your instrument. For portability and extreme neatness and perfection you may prefer Powell & Lealand's stand. For rare excellence and brilliancy of illumination you may prefer Ross's lenses, and for general excellency and ready adaptation of accessories, you may give the palm to Smith & Beck. But the difference is one of taste rather than excellence when all are so good and about equally costly. I must say I have a strong leaning towards the Binocular, the best effects of which I have seen in those made by Smith & Beck, and I do not think their first class Binocular Microscope has been surpassed.

As great weight is to be avoided, I should prefer the second sized stands of either of these makers to the largest, and the cost of a complete instrument would be about £60 sterling.

I have a word to say to my friend who is already supplied with a Monocular instrument, and it is to the effect that a good Binocular becomes a necessity to the man who has studied its value, and therefore I would advise him to add this great improvement to his instrument, which will cost about £3 sterling.

This is not a mere luxury or toy but an agent of research of great value, in addition to which it possesses the great recommendation of relieving the strain upon the vision which has so often seriously affected the eyes of microscopists. By its aid prolonged investigation can be carried on without fatigue.

With regard to the discussions which have been carried on in the highest circles of the science in respect of the value of extreme apertures in the object glasses of high power, and the comparative defining power of such glasses as the $\frac{1}{12}$, $\frac{1}{20}$, $\frac{1}{25}$, and $\frac{1}{50}$, I must say that my experience leads me to rely on the general excellence of the glass rather than upon its angular aperture. Comparing a very fine $\frac{1}{20}$ (which is more properly a $\frac{1}{25}$) of Smith & Beck with a $\frac{1}{12}$ made some years ago by Mr. Ross, senr., which he considered the finest $\frac{1}{12}$ he had ever made, I have been unable to chose between them. The latter has much less angle of aperture, but such brilliancy and excellency of definition that it appears to me to leave nothing to be desired, and I have yet to meet with the object glass at all a rival to it. Again I have worked with an $\frac{1}{8}$ of Smith & Beck which seemed perfection and was of very easy manipulation. I think a man who has a first rate glass whether it be $\frac{1}{8}$, $\frac{1}{12}$, $\frac{1}{20}$, or 1/[illegible], may be well content. But I never yet saw a $\frac{1}{4}$ in. or a $\frac{1}{5}$, or a $\frac{1}{6}$ (although wonderful for excellence and definition in their way) which would come up to the analytical standard of these high powers.

Finally, I may say that I have never seen any French combinations above $\frac{1}{4}$ in. worth much. French opticians produce high powers but a good English quarter will surpass them altogether. Mere amplification is of no benefit in the microscope without corresponding definition. I entertain also a decided prejudice against a "thin skinned" glass. That is, one whose corrections require the utmost nicety for the refraction of glass covers. In my experience I have not found these the best glasses, and all other things being equal I would reject a glass which was *too particular*. Perhaps the class of work upon which I have been engaged (crystals and tissues in fluid) has given me a strong bias, but it is one which becomes strengthened by time, and which the following incident will illustrate. Having a good Ross $\frac{1}{4}$ and $\frac{1}{6}$, I wrote to Smith & Beck asking them to make for me a student's $\frac{1}{4}$, corrected to go through an ordinary round test tube. They sent me a glass so corrected, for which they charged £2 15s., one half the price of Ross' quarter with the adjustments. I found it in every respect an excellent power. It would go through the back of the slide and show the markings on a pleurosigma hippocampus or formosum, just as well as through the thin glass. It would dip into a water cell, and for no purpose for which I ever wanted a $\frac{1}{4}$ in. did I find it deficient. Again, when I acquired my old Ross' $\frac{1}{12}$ I had a fashionable new Ross' $\frac{1}{8}$, 152° angular aperture in my possession. I found by frequent comparison that in the former glass I had not only a higher power with better definition, but also a glass *much easier to work*, so I parted with my fashionable friend and held on to my second treasure. I would therefore counsel my friends who wish for satisfactory high powers, not to follow the fashion, but to give the preference to glasses of deep penetration and good definition, and which work without very nice adjustment.

In conclusion, I would take exception to the remarks of Mr. Plumer at the close of an excellent article on this subject in the Microscopic Journal, N.S., Vol. 4, page 167, viz., that his readers "may reap by a short and royal road, all the benefits that it had cost him years to acquire." I must confess my disbelief in this "royal road." The royal road to microscopic or to all other science is comprised in three words—work, work, work. Moreover, it is open to a doubt whether a man who starts as a Microscopist with a perfect instrument and all accessories, will ever become an accomplished manipulator. His royal road will probably be too easy to call his skill into exercise, and he may be outstript in the race by the student who, with a plain stand and good glasses, has had to exercise his ingenuity in the illumination of objects with the simple mirror and bull's eye condenser. The pleasure and satisfaction derived from a study of the instrument itself, more than repays the labour expended thereon, and is a necessary element in a sound Microscopic education.

ON THE COLEOPTERA OF THE ISLAND OF MONTREAL.

By A. S. Ritchie.

The list of Coleoptera appended to this paper, has involved considerable labour, mostly on account of the bulkiness of the nomenclature, a prevailing fault in this as in most other branches of Natural History. Calling the same species by many names leads to great confusion; some of these insects have as many as six or seven synonyms.

I am indebted to Dr. Leconte, and to Dr. Horn, of Philadelphia, for their very kind assistance in the preparation of this list. Leconte's classification of the beetles of North America is the most authentic known to me for the simple reason that all his species are named from some special characteristic, as, structure, habits, or food, and not on tradition. His classification has therefore been adopted. The few remarks I propose to make on the Coleoptera of Montreal may be set forth under the heads of Nomenclature, Classification, and general remarks on the several families.

Nomenclature.—Insects are named from specific or generic characteristics of structure, or colour, from the particular food they live on, or from some other material characters—so that they may be readily identified. The confusion which often arises from so many names, may be illustrated by an example. Olivier finds an insect about the year 1789, and after describing it, calls it *Leptura Vittata*; Kirby finds the same species about 1828, and he calls it *Leptura semivittata* ; finally, Germar about 1834 has another *alias* for the same species, *Leptura Abbreviata*. These names are all very good in their way, the creature may be known by any one of them,—but why change the original? The name given by the person who first described the species, certainly has the preference, provided the insect can be identified by it, and should be the only one retained. Nor does the trouble end here; you may look over the drawers of fifty cabinets of insects without finding any two of them to agree, as to what is the correct name for a particular species.

It would be a great matter if something could be done towards having an uniform nomenclature for Canadian insects.

The list contains twenty-nine families, one hundred and fifty-two genera and two-hundred and forty-eight species, collected chiefly on the Island of Montreal; all not collected here, are marked in the margin.

Classification —Entomologists and systematists have insisted on one or two peculiar characters, which they consider to be of primary importance and value, as the basis of classification. Swammerdam contended, that in the early, or preparatory states of an insect was to be discovered the solution of its natural position. His system was called the "Metamorphotic." Linnœus considered that in the structure of the wings, lay the basis of classification. His system was called the "Alary." Fabricius accepted neither of these views; and on the structure of the organs of the mouth created his system. His system was called the "Maxillary." Latreille, not knowing which to prefer, formed a fourth, combining the three, which he called the "Eclectic." The "Septenary system" is one which is followed by some to a great extent. According to this theory, "in every group of seven, whether the group be large or small, one of the seven is central, and the other six surround it and are each connected with it." All entomologists at the present day agree with these various systems to a certain extent as invaluable guides to classification. Leconte's classification comprises ten orders; this appears to be the most natural division. These orders are again divided into tribes, stirps, families, genera, and species.

The order Coleoptera (or beetles) contains, according to Latreille, not less than 25,000 species; the estimate was made about the year 1800, and included beetles from all parts of the world, as then known and described in European cabinets. Since then, according to the best modern authorities, the number has been more than doubled, and is now set down at 90,000 species. When we imagine each of these species differing in appearance and to a great extent in habits, the question naturally arises, what is the use of so many beetles ?

We may divide the whole order into two principal groups; the Carnivorous and the Herbivorous species, with certain modifications.

It would seem that a portion of almost every substance in the animal and in the vegetable kingdom is assigned as food for beetles.

Among the carnivorous species we have cannibals, which prey on their fellows; others enjoy a repast on the remains of some unfortunate field mouse, or small bird, that death has overtaken; some, as for instance the Dermestes, feed in our kitchens, on lard and bacon, and destroy preserved specimens of Natural History. The last trace of the carnivorous habits may be seen in the ravages of the little beetles which infest the leather binding of books.

The Herbivorous division comprises those species which feed on leaves, flowers, fruit, and vegetables. Members of the large family of the Capricornes, feed on the solid wood of our forest trees. The last trace of the herbivorous habit may be seen in certain Scarabœidœ which feed on the excrement of herbivorous animals.

I shall now briefly notice the several families represented in the list. The first in order are the Cicindelidae (or tiger beetles) and very tigers they are, both in their larval and perfect states. They live by stratagem, and as they run and fly well, are more than a match for most insects of their size. They are found in sandy situations, especially when the sun shines.

The next family Carabidae, is one of the largest in the order; beetles of this group are principally carnivorous, some, however, prefer vegetable diet. Calosoma Calidum (commonly known as the "copper spot") is a good example of this family; it feeds on caterpillars, which it hunts with great avidity. Beetles of the genus Harpalus and Amara feed on vegetables. The distribution of species is very wonderful; for instance along the stone wall at the quarries, under stones, individuals of the genus Harpalus prevail in great numbers. The genus Brachinus is rare near

Montreal; to this genus belongs those beetles called "Bombardiers." They have the faculty of emitting volatile discharges, having a very pungent odour, accompanied with a slight noise and with a bluish smoke. They are to be found plentifully at the Back River under stones and decaying trees; as many as six or seven specimens may be taken under one stone. Four or five discharges are the greatest number I have seen them emit; after this process the insect appears quite exhausted.

Examples of the genus Chlaenius are also very plentiful along the banks of the St. Lawrence; at the Victoria Bridge, I have secured twenty specimens under one stone, comprising three species. They have a very pungent odour which remains on the hands for some time after washing.

The next three families are aquatic, viz., the Dytiscidae (or diving beetles), the Gyrinidae (or whirlgigs), and the Hydrophilidae. Their food is aquatic larvae and plants; some of the larger species attack even frogs, and small fish. The foot of the male Dytiscus has long been admired as a microscopic object. The Gyrinidae have two pairs of eyes, which is one pair more than their congeners possess; they are largely represented in the ponds and streams near the city.

The Silphidae (or carrion beetles) may be found feeding in the bodies of dead animals; they are flat bodied insects and are very useful in removing putrid carcases.

The next family Staphylinidae (or rove beetles) contains a great variety of species; some are microscopic in their dimensions, and none exceed an inch or so in length. These beetles are omnivorous; some feed on decomposing animal and vegetable matter, some on fungi, and others on flowers. The small insects which annoy us by getting into our eyes belong to this family.

The *Histeridae*, or "mimic beetles," are the next in order, they are found in excrements, in carcases, and under bark. They have the power of folding their legs close to the body on being disturbed, so as to counterfeit death.

Examples of the family *Cucujidæ* are apparently rare on the Island of Montreal. They are usually found under bark, and some are of a bright scarlet colour. The two specimens I have of *Cucujus clavipes* were captured on the board walk in St. Urbain St.

The *Dermestidae*, or skin beetles, are a group of insects of small size, generally about three quarters of an inch long. They are very destructive to furs, and to preserved specimens of natural history.

The *Byrrhidae*, or pill beetles, are of an oval shape, and are found in excrement, also under stones and bark. They possess the faculty of drawing up the legs close to the body as in Histeridae, and they remain in this way perfectly quiet as if dead.

The *Lucanidae*, or stag beetles, come next. They are entirely vegetable feeders; the large species feed mostly on leaves, the smaller on leaves and sap. Some of our largest Canadian beetles belong to this family, as for instance, *Passalus cornutus*, *Lucanus dama*, and *Lucanus placidus*. Neither of these species are found on the Island of Montreal. They are plentiful in Ontario, flying about oak trees. The smaller species, *Platycerus quercus* and *P. depressus*, are found near the city.

Next come the *Scarabaeidae*, a very large group, which feed on almost every thing. Some authors divide this family into, 1st, the ground or true *Scarabs*, which feed on excrement, 2ndly, the chafers and rose beetles, which live on leaves, flowers and sap. The Hermit Beetle, *Osmoderma*, belongs to this group.

The two following families, *Buprestidae* and *Elateridae*, are well represented on the Island. Some of the exotic species are adorned with splendid metallic tints. The Brazilian Buprestidae are gorgeous insects, their wing cases or elytra being very hard. A great many are mounted and sold for breast pins and for other articles of jewellery. A little black insect, about three quarters of an inch long (*Melanophila Longipes*), belongs to this family. In the warm days of summer it runs about the side-walk, and flies at intervals, alighting generally on the neck, where it bites very keenly, the bite leaving a feeling as if the flesh was burnt with hot sealing wax. The large Elater, *Alaus oculatus*, has rarely been found here; one I picked up on the side-walk on St. Paul St.;—the other was captured on a tree on St. Helen's Island last summer, on the occasion of the field meeting of the Natural History Society.

The family *Lampyridae* includes the fire flies, a group well represented in the district in question. They occur in great numbers in the early summer, and feed on the mucus of the birch trees on the mountain.

Cleridae is the next family; it is composed of insects of small size, which are parasitic in their larval state on bees, and in bees and ants' nests. In their imago or perfect state they are found on flowers.

The family *Tenebrionidae* contains a number of species that live upon vegetable matter in various conditions. A very common insect, *Tenebrio Molitor*, called in its larval state the meal worm, belongs to this family.

Meloeidæ: to this group belongs the *Cantharis Vesicatoria*, or Spanish fly. Examples of the genus Meloe are called oil beetles, on account of a yellow oily substance exuding from their joints on their being handled.

The different species of weevils or snout beetles, belong to the *Curculionidæ.* They feed upon plants, fruits, nuts and seeds, and are peculiar for their having the wing-cases, in many instances, covered with beautiful scales. This family requires careful study, as but little is as yet known of the species belonging to this interesting section.

The *Longicornes* belong to the family *Cerambycidæ;* this is a very extensive group. They are principally lignivorous, and in their larval and perfect states feed on solid and decayed wood.

Members of the genus *Leptura* are mostly floral species, feeding in their grub state on wood, and in their perfect state on flowers.

The leaf-eaters come next; they include the two families *Chrysomelidæ* and *Cassididæ.* These insects feed entirely on the leaves of plants, and are very destructive in gardens.

The last family we will mention is the *Coccinellidæ* (or lady birds); they are carnivorous and are very useful in gardens, ridding plants of the small green insects called *Aphidæ* or plant lice.

I have cursorily glanced at some of the leading characters represented in the families contained in the list, as regards their habits and their food. In concluding these remarks, I would state that looking at the insect world from an economic point of view, they are worthy the attention of mankind. Insignificant though insects appear, the wondrous results they bring about, are well known; the number of hands they keep busy are exemplified by the productions of the silk worm. We are indebted to them for ink, dyes, and lac; to the bee for honey and wax. Who knows but that an insect may yet be found in Canada that will be the means of developing some sphere of industry? In medicine we have the blister beetle or *Spanish fly*; that our Canadian Meloe and *Epicauta* may secrete Cantharadine I have no doubt, as it is an ally of the blister beetle of commerce. The oily matter exuding from the joints of Meloe warms the tongue considerably on applying it to that member. Then look how nature apportions her work; how she uses her handmaids. Look at those dead trees that lie decaying in our forests, and see how the agency of these little creatures is called in. They bore into and channel their decaying trunks, and thus allow the action of the atmosphere to hasten their decay, animal matter of all kinds has also many busy little hands and mouths ready to act as scavengers in clearing it away. Lift that dead quadruped or bird that has lain in the sun for a day or two in our streets or fields, the little insects are our friends, for above it, below it, and within it, they are at work and it will soon be gone, thus preventing the spread of gases noxious to the health of man. Every creature has its use, and to know their use is man's province.

LIST OF COLEOPTERA TAKEN ON THE ISLAND OF MONTREAL.

The list comprises twenty-seven families, one hundred and thirty-three genera, and two hundred and seventeen species. Synonyms are also appended, taken from Le Conte. I am indebted to Dr. Le Conte, of Philadelphia, and through him to Dr. Horn, for his kindness in comparing species, and naming them, and otherwise assisting me in the compilation of this list.

CICINDELIDAE.

CINCINDELA, *Linn.*
patruela *Dej.*
(=consentanea *Dej.*)
sexguttata *Fabr.*
(=violacea *Fabr.*)
splendida *Hentz.*
(=limbalis var. *Lec.*
=marginalis var. *Dej.*)
purpurea *Oliv.*
(=marginalis *Fabr.*
var. audubonii *Lec.*)
vulgaris *Say.*
(=obliquata *Dej.*
tranquebarica *Herbst.*)

CARABIDAE.

NEBRIA *Latr.*
pallipes *Say.*

CALOSOMA *Fabr.*
calidum *Fabr.*
(=var. lepidum *Lec.*)

CYCHRUS *Fabr.*
SPHAERODERUS *Dej.*
Canadensis *Chand.*

HARPALIDŒ.

BRACHINUS *Weber.*
fumans *Fabr.*
(=librator *Dej.*)
conformis *Dej.*
(=patruelis *Lec.*)

LEBIA *Latr.*
fuscata *Dej.*

CYMINDIS *Latr.*
pilosa *Say.*
(=pubescens *Dej.*)

PLATYNUS *Bon.*
sinuatus *Lec.*
(=anchomenus sin. *Dej.*)
extensicollis *Lec.*
(=feronia exten. *Say.*
anch. exten. *Dej.*
melanarius *Lec.*
(=agonum melan. *Dej.*
agonum maurum *Hald.*)
frater *Lec.*
cupripennis *Lec.*
(=feronia cupr. *Say.*
agonum cupr. *Dej.*)
subcordatus *Lec.*
lutulentus *Lec.*
chalceus *Lec.*
(=agonum chalceus *Lec.*)

PTEROSTICHUS *Bon.*
POECILUS *Bon.*
chalcites *Lec.*
(=feronia chalcites *Say.*
=poec. Sayi *Brulle*
=poec. chalcites *Kirby.*
=poec. micans *Chand.*)
lucublandus *Lec.*
(=feronia luc. *Say.*
=poec. luc. *Kirby.*)
Omaseus *Ziegl.*
caudicalis *Lec.*
(=feronia caudicalis *Say.*
=stereocerus caud. *Lec.*)
Argutor *Meg.*
patruelis *Lec.*
=(feronia patruelis *Dej.*)
Pterostichus *Bon.*
stygicus *Lec.*
(=feronia stygicus *Say.*
=fer bisigillata *Harris.*
=omaseus rugicollis *Hald.*)

AMARA *Bon.*
fallax *Lec.*
CELIA, *Zimm.*
obesa *Say.*
(percosia obesa *Hald.*)

DIPLOCHILA *Brulle.*
laticollis *Lec.*
(=rembus laticollis *Lec.*
=r. assimilis *Lec.*)

ANOMOGLOSSUS *Ch.*
emarginatus *Chand.*
(=chlaenius emarg. *Say.*)

CHLAENIUS *Bon.*
sericeus *Say.*
(=carabus sericeus *Forster*)
chlorophanus *Dej.*
tricolor *Dej.*

AGONODERUS *Dej.*
pallipes *Dej.*
(=carabus pallipes *Fabr.*)

ANISODACTYLUS *Dej.*
discoideus *Dej.*
Baltimorensis *Dej.*
(=h. Baltimorensis *Say*)

BRADYCELLUS *Er.*
rupestris *Lec.*
(=trechus rupestris *Say.*
=acup. elongatulus *Dej.*
=trechus flavipes *Kirby.*

HARPALUS *Latr.*
viridiaeneus *Beauv.*
(=h. viridis *Say.*
=h. assimilis *Dej.*
Pennsylvanicus *Lec.*
(=o. pennsylvanicus *Degeer*
=c. bicolor *Fabr.*
=harp. bicolor *Say*)
compar *Lec.*
herbivagus *Say.*
(=ophonus mutabilis *Hald.*
=var. h. proximus *Lec.*)

STENOLOPHUS *Dej.*
ochropezus *Dej.*
(=t ronia ochropezus *Say.*
=var. s. convexicollis *Lec*)

BEMBIDIUM *Latr.*
nigrum *Say.*

PERYPHUS *Meg.*
striola *Lec.*
(=ochthedromus stri *Lec.*)
lucidum *Lec.*
(=ochthedromus luc. *Lec.*
=var. o. substrictus *Lec.*)
rupestre *Dej.*
(=c arabus rupestre *Latr.*
=bem. tetracolum *Say.*
=var. rupicola *Kirby.*)

NOTAPHUS *Meg.*
patruele *Dej.*

LOPHA *Meg.*
quadrimaculatum *Gyll.*
(=cicindela quadri. *Linn.*
=bemb. oppositum *Say.*)
pedicillatum *Lec.*

DYTISCIDAE.

HALIPLUS *Latr.*
immaculicollis *Harris.*
(=h. americanus *Aube.*

CNEMIDOTUS *Ill.*
edentulus *Lec.*

HYDROPORUS *Clairv.*
lacustris *Say.*
(=h. pulicarius *Aube.*)
modestus *Aube.*
(=h. ruficeps *Aube.*

LACCOPHILUS *Leach.*
maculosus *Say.*
(=dytiscus macu. *Germ.*)
proximus *Say.*
(=lac. americanus *Aube.*)

COLYMBETES *Clairv.*
CYMATOPTERUS *Esch.*
seminiger *Lec,*
exaratus *Lec.*
binotatus *Harris.*
(=macullicollis *Aube.*)

ACILIUS *Leach.*
praternus *Lec.*
(=dytiscus frater., *Harris.*
=ac. semisulcatus, *Aube.*)

DYTISCUS *Linn.*
anxius *Mann.*
fasciventris *Say.*
(=carolinus *Aube.*)

harrissii *Kirby.*
verticalis *Say.*

GYRINIDAE.

GYRINUS *Linn.*
—not determined.

DINEUTES *McLeay.*
—not determined.

HYDROPHILIDAE.

HYDROPHILUS *Geoffr.*
TROPISTERNUS *Sol.*
glaber *Herbst.*

HYDROCHARIS *Latr.*
obtusatus *Lec.*
(=hydrophilis obtu. *Say.*)

BEROSUS *Leach.*
striatus *Say.*

CERCYON *Leach.*
flavipes, *Er.*

CRYPTOPLEURUM *Muls.*
vagans *Lec.*

SILPHIDAE.

NECROPHORUS *Fabr.*
orbicollis, *Say.*
(=hallii *Kirby.*
=var. tibialis *Lec.*)
velutinus *Fabr.*
n tomentosus *Weber.*

SILPHA *Linn.*
NECRODES *Wilkin.*
surinamensis *Fabr.*

THANATOPHILUS *Leach.*
Lapponica *Herbst.*
(=caudata *Say.*
=tuberculata *Lec.*
=granigera *Cherr.*)
Marginalis *Fabr.*
(=nove boracensis *Forster.*)
inequalis *Fabr.*

NECROPHILA *Kirby.*
peltata *Lec.*
(=scarabeus pelt. *Catesby.*
=silpha americana, *Linn.*
=var. o. terminat. *Kirby.*
=var. o. affine *Kirby.*
=var. o. canadense *Kirby*

STAPHYLINIDAE.

ALEOCHARA *Grav.*
—undetermined.

COPROPORUS *Kraatz.*
ventriculus *Kraatz.*
(=tachinus ventriculus *Er.*
=var. t. punctulatus *Mels.*)

TACHINUS *Grav.*
fumipennis *Er.*
(=tachyporus fumip. *Say.*
=t. axillaris, *Er.*

TACHYPORUS *Grav.*
jocosus *Say.*
(=arduus *Er.*)

CONOSOMA *Kraatz.*
crassum *Lec.*
(=tach. crassum *Grav.*
=conurus crassus *Er.*)

QUEDIUS *Stephens.*
molochinus *Er.*
(=staph. molochinus *Grav.*
=s. laticollis *Grav.*)

CREOPHILUS *Stephens.*
(=staph villosus *Grav.*)
villosus *Kirby.*

LEISTOTROPHUS *Perty.*
cingulatus *Kraatz.*
(=staph. cingulatus *Grav.*
=s. chrysurus *Kirby.*
=s. speciosus *Mann.*)

STAPHYLINUS *Linn.*
cinnamopterus *Grav.*
badipes *Lec.*

PHILONTHUS *Curtis.*
debilis *Er.*
(=staph. debilis *Grav.*)

LATHROBIUM *Grav.*
—undetermined.
—undetermined.

CRYPTOBIUM *Mann.*
bicolor *Er.*
(=lathrobium bic. *Grav.*)

PAEDERUS *Grav.*
littorarius *Grav.*

OXYTELUS *Grav.*
sculptus *Grav.*
(=moerens *Mels.*)

HISTERIDAE.

HISTER, *Linn.*
foedatus *Lec.*

PLATYSOMA *Leach.*
Lecontei *Mars.*
coarctatus *Lec.*

NITIDULIDAE.

NITIDULA *Fabr.*
bipustulata *Fabr.*

OMOSITA *Er.*
colon *Er.*
(=silpha colon *Linn.*
=nitidula colon *Fabr.*)

IPS *Fabr.*
fasciatus *Say.*
(=nitidula fasciata *Oliv.*)
sanguinolentus *Say.*
(=nitidula sanguin. *Oliv.*)

CUCUJIDAE.

CUCUJUS *Fabr.*
clavipes *Fabr.*

DERMESTIDAE.

DERMESTES *Linn.*
lardarius *Linn.*

ATTAGENUS *Latr.*
megatoma *Er.*
(=dermestes megat. *Fabr.*

BYRRHIDAE.

CYTILUS *Er.*
varius *Er.*
(=byrrhus varius *Fabr.*
=b trivattatus *Mels.*
=var. b. alternatus, *Say.*)

BYRRHUS *Linn.*
Americanus *Lec.*

LUCANIDAE.

PLATYCERUS *Geoffr.*

quercus *Sch.*
(=lucanus Quercus *Weber.*
=pl. securidens *Say.*
depressus *Lec.*

SCARABAEIDAE.

ONTHOPHAGUS *Latr.*

latebrosus *Sturm.*
(=copris latebrosus *Fabr.*
=scar. he. ate *Panzer.*)

APHODIUS *Ill.*

TEUCHESTES *Muls.*

fossor *Fab.*
(=scarabaeus fossor *Linn.*)
fimetarius *Ill.*
(=scar. fimetarius *Linn.*
=aph. nodifrons *Randall.*)

EUPARIA *Lep.*

—undetermined.

GEOTRUPES *Latr.*

semiopacus.
similis.

MELOLONTHIDAE.

HOPLIA *Ill.*

trifasciata *Say.*
(=prima ia *Burm.*
=helvola *Mels.*
=tristis *Mels.*)

DICHELONYCHA *Kirby.*

elongatula, *Fitch.*
(=melo. elongatula *Schonh.*
=melo. hexagona *Germ.*
=dich. elonga a *Burm.*)

SERICA *McLeay.*

CAMPTORHINA *Kirby.*

vespertina *Lec.*
(=melolontha vesp. *Schonh.*
=omaloplia vesp. *Harris.*
=c. atricapilla *Kirby.*
sericea *Burm.*

LACHNOSTERNA *Hope.*

fusca *Lec.*
(=melolontha fusca *Frohl.*
=mel. quercina *Kroch.*
=mel. fervens *Gyll.*
=l. quercina *Lec.*)

LIGYRUS *Burm.*

relictus *Lec.*
(=scarabaeus relictus *Say.*
=heteronychus rel. *Burm.*
=bothynus rel. *Lec.*)

XYLORYCTES *Hope.*

satyrus *Burm.*
(=geotrupes satyrus *Fabr.*
=scarabaeus satyrus *Ol.*
=s. nasicornis am. *Beauv.*)

OSMODERMA *Lep.*

eremicola *Dej.*
(=cetonia eremicola *Knoch.*
=trichius eremicola *Say*)
scabra *Dej.*
trichius scabra *Beauv.*
(=gymnodus fov. *Kirby.*
=gym. rugosus *Kirby.*)

TRICHIUS *Fabr.*

affinis *Gory.*
(=assimilis *Kirby.*
=bistriga *Newman.*
=var. viridans *Kirby.*)

BUPRESTIDAE.

DICERCA *Esch.*

divaricata *Lec.*
(=bup. divaricata *Say.*
=dicerca dubia *Mels.*
=di. auricalcea *Mels.*
=d. parumpunctata *Mels*)
tenebrosa *Lec.*
(=bup. tenebrosa *Kirby.*

ANCYLOCHIRA *Esch.*

fasciata *Dej.*
(=bup. fasciata *Fabr.*
=bup. 6 maculata *Herbst.*)
consularis *Dej.*
(=bup. consularis *Gory.*)
maculiventris *Lec.*
(=bup. maculiventris *Say.*
=bup. sexnotata *Lap.*
rusticorum *Lec.*
(=bup. rusticorum *Kirby.*)

MELANOPHILA *Esch.*

longipes *Gory.*
(=bup. long pes *Say.*
=apatura append. *Lap.*
=mel. immaculata *Gory.*

CHRYSOBOTHRIS *Esch.*

dentipes *Lec.*
(=bup. dentipes *Germ.*
=b. characteristica *Harris*)

ELATERIDAE.

ADELOCERA *Latr.*

marmorata *Germ.*
(=elater marmorata *Fabr.*)
obtecta, *Lec.*
(=elater obtectus *Say.*)

ALAUS *Esch.*

oculatus *Esch.*
(=elater oculatus *Linn.*)

ELATER *Linn.*

linteus *Say.*
(=ampedus lugubris *Germ*)
vitiosus *Lec.*
carbonicolor *Mann.*

DRASTERIUS *Esch.*

dorsalis *Lec.*
(=elater dorsalis *Say.*
=monocrepidius dor. *Lec.*
=aeolus dorsalis *Cand.*)

DOLOPIUS *Esch.*

pauper *Lec.*

MELANOTUS *Esch.*

fissilis, *Lec.*
(=cratonychus laticollis *Er.*
=cr. ochraceipennis *Mels.*
=cr. spheroidalis *Mels.*)

ATHOUS *Esch.*

cucullatus *Cand.*
(=el. cucullatus *Say.*
=ath. hypoleucus *Mels.*
=ath. procericollis *Mels.*
=ath. strigatus *Mels.*)

CORYMBITES *Latr.*

aeripennis *Lec.*
(=el. aeripennis *Kirby.*
=el. appropinquans *Rand.*)
cylindriformis *Germ.*
(=el. cylindriformis *Herbst.*
=el. appressifrons *Say.*
=el. brevicornis *Say.*
=cor. parallelop. *Germ.*)
vernalis *Germ.*
(=Elater vernalis *Hentz.*)

tarsalis *Lec.*
(=athous tarsalis *Mels.*)
spinosus *Lec.*
sagitticollis *Lec.*
(=pristilophus sag. *Esch.*)

ASAPHES *Kirby.*

baridius *Lec.*
(=elater baridius *Say.*
=hemic. thomasi *Germ.*)

LAMPYRIDAE.

PHOTINUS *Lap.*

ELLYCHNIA *Lec.*

corruscus *Lec.*
(=lampyris corrusca *Linn.*
=el. atipennis *Motsch.*)

TELEPHORIDAE.

CHAULIOGNATHUS *Hentz.*

Pennsylvanicus *Lec.*
(=telephorus penn *DeGeer*
=canth. rmer *Forster.*
=canth. bimaculata *Fabr.*
=cha. bimaculatus *Hentz.*)

PODABRUS *Westw.*

BRACHYNOTUS *Kirby.*

rugosulus *Lec.*

TELEPHORUS *Schaffer.*

Curtisii *Kirby.*

RHAGONYCHA *Esch.*

Carolinus *Lec.*
(=cantharis carolinus *Fab.*
=rha. carolinus *Motsch.*)

CLERIDAE.

TRICHODES *Herbst.*

Nuttalli *Klug.*
(=clerus nuttalli *Kirby*)

CLERUS *Geoffr.*

THANASIMUS *Spin.*

nubilus *Klug.*

TENEBRIONIDAE.

BLAPSTINUS *Waterh.*

metallicus, *Lec.*
(=blaps. mellicus *Fabr.*
=opatrum interrupt. *Say.*
=b. aeneolus *Mels.*
=b. interruptus *Lec.*
=b. luridus *Muls*)

HAPLANDRUS *Lec.*

femoratus *Lec.*
(=trogosita femorat. *Fabr.*
=tenebrio femorat. *Beauv.*
=upis fulvipes *Herbst.*)

UPIS *Fabr.*

ceramboides *Fabr.*
(=ten. ceramboides *Linn.*
=u. reticulata *Say.*)

NYCTOBATES *Lec.*

Pennsylvanica *Lec.*
(=ten. pennsylva. *DeGeer.*
=upis chrysops *Herbst.*
=ten. subiaevis *Beauv.*)

IPHTHIMUS *Truqui.*

opacus *Lec.*

TENEBRIO *Linn.*

molitor *Linn.*

BOLETOTHERUS *Cand.*

cornutus *Candéze.*
(=boleotophagus cor. *Fabr.*
=opatrum cor. *Panzer.*)

DIAPERIS *Geoff.*

hydni *Fabr.*
(=maculata *Oliv.*)

MELANDRYIDAE.

MELANDRYA *Fabr.*

striata *Say.*
(=var. excavata *Hald.*)

MELOIDAE.

MELOE *Linn.*

rugipennis *Lec.*
augusticollis, *Say.*

MACROBASIS *Lec.*

Fabricii *Lec.*

OEDEMERIDAE.

NACERDES *Schmidt.*

melanura *Schmidt.*
(=cantharis melanura *Linn*
=necydalis notata *Fabr.*
=oed. analis *Oliv.*
=oed. apicalis *Say.*)

CERAMBYCIDAE.

CRIOCEPHALUS *Muls.*

agrestis *Kirby.*

ARHOPALUS.

speciosus *Say.*
pictus *Drury.*

CALLIDIUM *Fabr.*

janthinum *Lec.*

CLYTUS *Fabr.*

undulatus *Say.*
ruricola *Oliv.*
campestris *Oliv.*
erythrocephalus *Fabr.*
muricatulus *Kirby.*

ENDERCES.

picipes *Fabr.*

GRAPHISURUS.

pusillus *Kirby.*
fasciatus *DeGeer.*

MONOHAMMUS, *Latr.*

scutellatus *Say.*
confusor *Kibry.*

SAPERDA, *Fabr.*

calcarata *Say.*
lateralis *Hald.*
vestita *Say.*

DESMOCERUS *Serv.*

palliatus *Forster.*

ACMEOPS *Lec.*

proteus *Kirby.*

TYPOCERUS.

sinuatus *Newman.*

LEPTURA *Linn.*

canadensis *Fabr.*

TRIGONARTHRIS.

proxima *Say.*

CHRYSOMELIDAE.

DONACIA *Fabr.*

subtilis *Kunze.*

LEMA.

trilineata *Oliv.*

CHELYMORPHA.

cribraria *Fab.*

CASSIDA *Herbst.*

bicolor *Fabr.*
guttata *Fabr.*

DIABROTICA *Chev.*

vittata *Fabr.*

OEDIONYCHIS *Latr.*

thoracica *Fabr.*

DORYPHORA.

trimaculata *Say.*

CHRYSOMELA *Linn.*

scalaris *Lec.*
labyrinthica *Lec.*
bigsbyana *Kirby.*
trivittata *Say.*
polygoni *Linn.*

PARIA.

4-notata *Say.*

CHRYSOCHUS.

auratus *Fabr.*

CRYPTOCEPHALUS, *Geoff.*

mucoreus *Lec.*

COCCINELLIDAE.

HIPPODAMIA.

13-punctata *Linn.*
parenthesis *Say.*

COCCINELLA *Linn.*

9-notata *Herbst.*
lecontei (var).
bipunctata *Linn.*

MYSIA *Muls.*

15-punctata *Oliv.*

CHILOCORUS *Leach.*

bivulnerus *Muls.*

PSYLLOBORA.

20-maculata *Say.*

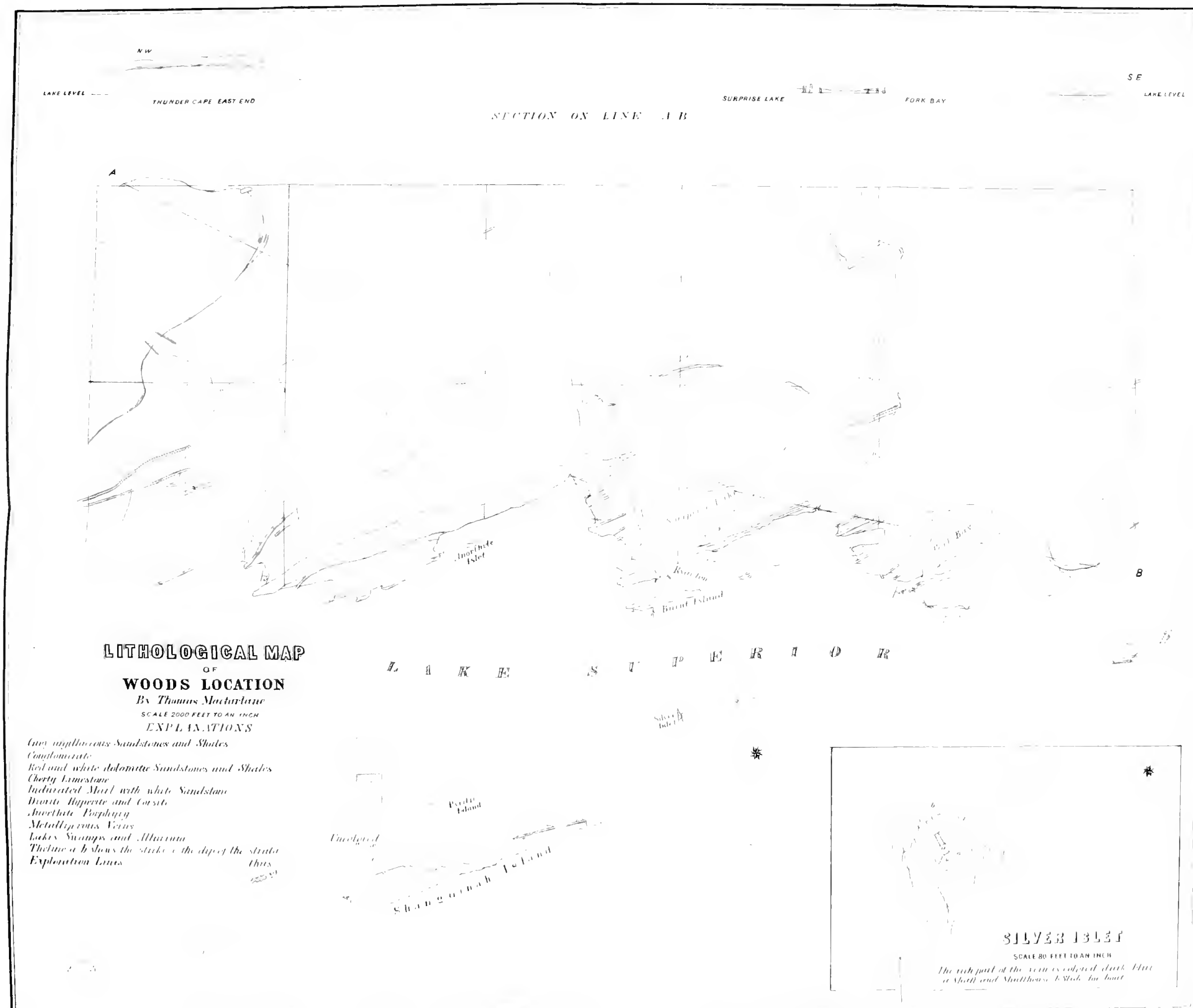
BRACHYCANTHA.

ursina *Fabr.*

EROTYLIDAE.

ENGIS.

4-maculata *Say.*



NW
SE
LAKE LEVEL
THUNDER CAPE EAST END
SURPRISE LAKE
FORK BAY
LAKE LEVEL
SECTION ON LINE AB
A
B
LAKE SUPERIOR
LITHOLOGICAL MAP
OF
WOODS LOCATION
By Thomas Macfarlane
SCALE 2000 FEET TO AN INCH
EXPLANATIONS
Grey argillaceous Sandstones and Shales
Conglomerate
Red and white dolomitic Sandstones and Shales
Cherty Limestone
Indurated Marl with white Sandstone
Diorite Hyperite and Corsite
Amethite Porphyry
Metalliferous Veins
Lakes Swamps and Alluvium
Explanation Lines
Burnt Island
Silver Islet
Shangoinah Island
SILVER ISLET
SCALE 80 FEET TO AN INCH

ON THE GEOLOGY AND SILVER ORE OF WOODS LOCATION, THUNDER CAPE, LAKE SUPERIOR.

By Thomas Macfarlane.

Part I.*

During the summer of 1868, an exploring party, under my charge, was sent by the Montreal Mining Company to examine their mineral lands on Lake Superior. On one of their properties, Woods Location, near Thunder Cape, a silver vein of some promise was discovered, and a good deal of attention was paid to the geology of its neighbourhood. The results of my observations are, with the permission of the Directors of the Company, made the subject of the present paper.

The accompanying map shews the geology of that part of the location lying nearest the lake.

The stratified or derived rocks which are found upon it, and which are indicated by the five first colours under the word "Reference," belong to Sir W. E. Logan's Upper Copper-bearing rocks of Lake Superior, the age of which is, perhaps, still a matter of doubt. The lowest group of this series found upon the location consists of grey argillaceous sandstones and shales, coloured lilac on the map. A general description of these will be found on page 68 of the Geology of Canada, to which I have to append the following additional particulars. The sandstone layers, varying in thickness from a few inches to several feet, are invariably small or fine-grained, and occasionally shew narrow, indistinctly limited bands of light and dark grey, running in planes parallel with the stratification. A specimen from Location Bay, more closely examined, yielded the following results. Before the blow-pipe it fuses at the edges to a greyish white enamel, and the adjacent parts become lighter coloured and slightly brownish. Hydrochloric acid causes a very slight effervescence. The powder is slightly reddish, or brownish grey, and on being examined chemically, gave the following results:—

Silicious matter (insoluble in Hydrochloric Acid and dilute Potash ley).	80·09
Matrix—	
Protoxide of Iron	4·08
Alumina	4·86
Carbonate of Lime	1·15
Carbonate of Magnesia	0·56
Silica	4·80
Carbonaceous matter and water (loss on ignition)	1·75
Alkalis, etc. (by difference)	2·71
	100·00

Interstratified with such sandstones, there are sometimes found

* The map will appear with the second part of this paper.—Ed.

beds of a more calcareous nature, but, as Sir W. E. Logan remarks, "few of them pure enough to be entitled to the appellation of limestone." A specimen from a bed of this nature yielded the following results :—

Silicious matter	57·30
Soluble in Acid—	
Protoxide of Iron	3·45
Alumina	2·36
Carbonate of Lime	19·88
Carbonate of Magnesia	11·45
Soluble in Alkali—	
Silica	3·44
Carbonaceous matter and water (by difference)	2·12
	100·00

With the sandstones there are frequently interstratified shaly layers, generally of a darker colour, which behave before the blow-pipe like the sandstone above mentioned, but never shew the slightest effervescence with acid. On analysis, a specimen gave:—

Carbonaceous matter (loss on ignition)	2·04
Silicious matter	65·71
Soluble in Acid—	
Protoxide of Iron	7·20
Alumina	8·58
Magnesia	0·43
Soluble in dilute Potash ley—	
Silica	11·56
Alkalis, etc. (by difference)	4·48
	100·00

These sandstones and shales are, for the most part, very evenly and regularly stratified, and only in the neighbourhood of the intersecting dykes are they at all contorted. In some places they appear almost horizontal, but they generally shew a dip of from 3° to 6° to the east or south of east. Nothing resembling transverse cleavage was found in these sandstones or shales, and, even in the latter, the schistose structure, which is developed by weathering, is more of a flaggy than of a slaty nature. The vertical jointing, mentioned by Sir W. E. Logan, is visible at almost every exposure of these sandstones and shales on the location. In this respect, and in general lithological characters, they much resemble the sandstones which occur to the north and south of Point aux Mines, on the east shore of the lake, and which, there, appear to overlie unconformably the traps and conglomerates of Maimanse.

Immediately and conformably overlying the sandstones and shales just mentioned, there is found a conglomerate bed from two to six feet thick (marked on the map yellow, with brown spots). The pebbles are generally quartzite, red coloured and jasper-like, and the matrix consists of coarse-grained red coloured sand. Red and white sandstones, coloured yellow on the map, succeed the conglomerate. The white sandstones make up the greater part of this group, but in many parts of its thickness, and especially in the part immediately overlying the conglomerate, layers of red sandstone are interstratified with the white beds, and the latter frequently shew spots and irregular patches of red. Sometimes, similar spots of white are observed in the red sandstone layers. The colouring matter of the red sandstone is peroxide of iron, and the difference in composition between it and the white is shewn in the following analysis. I. is the composition of a red-coloured, and II that of a white portion of a specimen, from a ridge of sandstone lying between Camp and Fork Bays:—

	I.	II.
Silica, insoluble in Hydrochloric Acid	73·45	72·89
Peroxide of Iron, with a little Alumina	2·41	0.91
Carbonate of Lime	12·54	13·04
Carbonate of Magnesia	10·94	11·94
	99·34	98·78

It will be observed that the cementing material of these sandstones has almost exactly the composition of dolomite. Sandstones of this composition are probably not unfrequent among the Potsdam and Calciferous rocks of Canada, but, in Europe, they are described as belonging exclusively to the Buntsandstein formation (Zirkel, Petrographie, ii., 581). In the upper part of the group, red shales are found in great quantity, interstratified with the sandstone, and apparently approaching in composition to the indurated marl hereafter to be described. This group of "red and white dolomitic sandstones and shales" has a general dip of 7° to 15° eastward. The sandstones very frequently shew ripple marks on the surfaces of the beds.

A bed of limestone, from two to six feet thick, coloured blue on the map, overlies conformably the group first described. In the upper part, it appears brecciated from intermixed cherty fragments, but in the lower part it is more crystalline.

Immediately overlying the limestone, and beautifully exposed on the shore eastward from Red Bay, there comes a considerable development of the indurated marl mentioned by Sir W. E. Logan on page 70 of the Geology of Canada. This rock is fine-grained and compact, generally of a yellowish grey colour, with red patches. Where the latter colour predominates, the rock assumes a slaty structure. The reddish-coloured spots or patches have generally a rounded contour, and although they sometimes resemble rounded fragments or boulders, it is found, on breaking them, that they consist of the same fine-grained material as the marl itself, differing from it only in colour. Occasionally, other enclosures occur in this rock, which seem more distinctly separated from it, some of them resembling pieces of the shaly sandstones of the lower group, but purple coloured. They are doubtless of a fragmentary nature. Specimens of indurated marl from Island No. 6 were subjected to analysis, the light coloured (I) and reddish portions (II) being examined separately.

	I.	II.
Silica (insoluble in Hydrochloric Acid and Potash lye)	50·77	53·27
Peroxide of Iron and Alumina	2·48	5·78
Carbonate of Lime	34·43	21·00
Carbonate of Magnesia	7·68	13·43
Silica	3·28	3·48
Water	1·79	2·04
	100·43	99·00

On the eastern extremity of the location, the indurated marl is overlaid by white sandstone again, and this rock appears to be the highest in geological position upon the property.

These stratified rocks are intersected by numerous dykes of various thicknesses, running generally parallel with each other in a north-east and south-western course. Their outcrops are most numerous in the western part of the location, where they, and the enclosing argillaceous sandstones and shales, have been so acted on by the waters of the lake as to expose plainly their mutual relations. The dykes are coloured green on the map, and it will be plainly seen from it, that they, to a very considerable extent, determine the outline of the shore. The longer lines upon the coast run generally parallel with the strike of these dykes; the hard rocks of the latter invariably form the projecting points and headlands, while the bays are cut out of the softer stratified rocks. Although the dykes are best exposed among the grey sandstones, many of them can be followed into the area occupied by the red and white sandstones, where they are found to intersect these also. They are always either vertical or inclined at high angles, the dip in the latter case being generally to the south-east, but sometimes also to the north-west. They vary in thickness from a few feet to nearly a hundred, and they sometimes exhibit interesting phenomena as to joints of separation. Irregular columnar separation at right angles to the inclination is frequently observed, but it is on a ponderous scale, and although it reminds one of trappean jointing, it is not at all so regular. Sometimes the dykes are split up into large square blocks, or into large flat pieces, with their planes parallel to the sides of the dyke. Although the direction above given for these dykes is the prevailing one, it will be seen from the map that some of them have courses more or less divergent from this strike; indeed, some small dykes are to be seen branching off from the main ones. The rocks which constitute these dykes belong to the diorite family, but are capable of being subdivided into several species, according to the nature of the felspar they contain. The recognition of their constituent minerals is a matter of some difficulty, as they are, for the most part, small, or fine-grained. No instance was observed of a coarse or large-grained rock among these dykes, although a very distinct porphyritic rock was met with. As examples of the various species of rocks constituting these dykes, the three following may be particularized.

DIORITE.—The nearest approach to this species is the rock constituting Silver Islet. It is distinctly composed of a greenish black and a white mineral, the former being, however, duller in lustre and less hard than the hornblendic constituent of the rocks of many of the other dykes. Quartz is occasionally detected, copper and iron pyrites and a grain or two of schiller spar, also. Its specific gravity is 2·713 to 2·711. Its powder is greenish grey, changing on ignition to leather-brown, and yielding water. On digestion with hydrochloric acid, and then with weak potash ley, 52·6 per cent. of a residue is left, which is almost pure white in colour. The following is an analysis of the rock, shewing the composition both of the soluble and insoluble part:—

Water		5·02
SOLUBLE PART—		
Silica	15·11	
Alumina	5·82	
Ferrous Oxide	18·17	
Lime	1·07	
Magnesia	1·50	41·67
		46.69

INSOLUBLE PART—		46.69
Silica	38·23	
Alumina	9·65	
Ferric Oxide	2.83	
Lime	0·57	
Magnesia	0·33	
Alkalis (by difference)	0·99	52·60
		99·29

From this analysis it would appear that almost the whole of the hornblende has been converted into a chloritic mineral. The insoluble, probably, consists of the felspathic constituent mixed with the quartz contained in the rock. The small rocky island called Pyritic Island, lying to the north of Great Shaginah Island, consists of diorite. In the centre, and running along its length, is a band of the same rock about thirty feet wide, more or less impregnated with copper, magnetic and iron pyrites.

CORSITE.—By far the greater number of the rocks forming the dykes consist of a small-grained mixture of glittering hornblende in large quantity, with felspar, which, being easily decomposable by acids, is probably anorthite. The specific gravity of these rocks varies from 2·934 to 3·085. They sometimes shew a warty appearance on the surface, especially when much weathered, and, occasionally, they are found to break up entirely into small friable pebbles. Islet No. 5, although it seems to be part of the same intrusive mass as Silver Islet, consists of a rock with the mineralogical composition of corsite. It is small-grained and crystalline, shewing abundance of small glittering faces, belonging to its black-coloured constituent, which preponderates over the lighter-coloured felspathic grains. Its specific gravity is 2·916 to 2·933. Its powder has a slate-grey colour, which, on ignition, changes to dark brown. On digestion with hydrochloric acid, and afterward with dilute potash ley, it leaves 43·64 per cent. insoluble matter of a dark grey colour, and having a specific gravity of 2·955. The following is an analysis of the rock, the compositions of the soluble and of the insoluble portions having been separately ascertained:—

		46.69
SOLUBLE PART—		
Silica	21·77	
Alumina	11·69	
Ferrous Oxide	13·50	
Lime	3·99	
Magnesia	1·75	52·70

		52.70
INSOLUBLE PART—		
Silica	24·39	
Alumina	3·78	
Ferrous Oxide	11·38	
Lime	3·42	
Magnesia	0·67	43.64
Water	3·15	3·15
		99.49

The composition of the insoluble portion, calculated to 100 parts, is as follows:—

Silica	55·88
Ferrous Oxide	26·09
Alumina	8·66
Lime	7·84
Magnesia	1·53
	100·00

Judging from these figures, and the appearance of the black constituent in the rock itself, it would appear reasonable to regard it as basaltic hornblende. The large quantity of mineral present, decomposable by acid, would lead to the inference that the felspathic constituent is anorthite, although, doubtless, some chloritic substance is decomposed and dissolved with it. The presence of anorthite in these fine-grained rocks is confirmed by its occurring in some of them in well-developed crystals, constituting the rock which is referred to on page 72 of the Geology of Canada, and which is next described.

ANORTHITE PORPHYRY.—The dyke which forms the rocky islets, marked 1, 2, and 3 on the map, and which runs along the south-east side of Burnt Island, consists of this rock, although the anorthite crystals are but sparingly distributed. The most characteristic development of this porphyry occurs on the shore between Location Bay and Perry's Bay, constitutes Anorthite Islet, and then joins the mainland on the east side of Perry's Bay. The size of the crystals varies from one-quarter-inch to several inches in diameter; they are beautifully striated, and aggregations of them, two or three feet in diameter, are of frequent occurrence on Anorthite Islet. Indeed, at a distance, the rock of this islet resembles a breccia, so great is the number and size of the masses of anorthite. These masses seem to have been formed by the crowding together of numbers of anorthite crystals, and some of the spaces between these seem to have been subsequently filled up by quartz. The specific gravity of the mineral from these masses is 2·737. It was analysed by digestion with hydrochloric acid, which separated silica, which was afterwards dissolved out from the insoluble by weak potash lye. It was found to contain:—

Silica	45·13
Alumina	33·92
Lime	17·02
Insoluble	4·46
	100·53

The mineral probably contains also a small quantity of soda, as it colours the blow-pipe flame strongly yellow. The anorthite crystals frequently contain small brownish specks, and the matrix of the rock consists of a small-grained mixture of these with the anorthite. Sometimes a larger individual is perceived with a brownish black colour and glittering faces, and, besides such, there are dark green grains of chlorite, and occasional specks of iron pyrites. A piece of the rock, weighing 30·455 grammes, had a specific gravity of 2·806.

The influence of these dykes upon the bedded strata which they intersect is very marked. Both the argillaceous and the dolomitic sandstones become hardened and silicified, and enabled much more effectually to resist disintegrating influences. In many places, where they have been much acted on by the waters of the lake, the altered part of the sandstones is found remaining and adhering to the dyke, while traces of the unaltered strata are visible only among the debris on the shore. Instances are also to be found where the bedded strata have been much contorted in the neighbourhood of the dykes. One instance was observed of the rock of a dyke enclosing fragments of granite and quartzite, the longer dimensions of which run parallel with the side of the dyke. This dyke is the first one met with on the shore to the west of Boulder Point.

There are numerous veins on the location, connected, for the most part, with the dykes which have just been described. It may be doubted whether these veins, the most of which are indicated upon the map, possess in every case the characters of true metalliferous veins. Some of them appear to be mere fillings up of the separation joints in the rock of the dyke. Others, which appear more promising, are of greater width, and run parallel with the dykes, but were not observed to contain anything more valuable than specks of iron and copper pyrites. A third variety of vein, which is perhaps the most important, crosses the general course of the dykes, and it is to this class that the vein belongs in which silver, to a considerable extent, was discovered.

This vein occurs on a small island, marked Silver Islet on the map, and distant about a mile from the main shore. This islet (No. 4), the reef and larger island (No. 5) to the eastward, and the still larger island to the south-westward, marked Pyritic Island, appear to be all that remains of a large dyke or mass of diorite, which in all likelihood intersected the sedimentary strata which, in former times, occupied the space between the islet and the mainland. The width of this intrusion of diorite is at least 100 feet, but may be more in depth, as a good part of its thickness must have been worn away by the action of the waves of the lake. The nature of the rock of the islet has been already described. It differs from most of the rocks of the other dykes, not only mineralogically, but, also, in being destitute of the divisional jointing which so frequently characterizes them. A few square yards only of the islet, at its highest part, six feet above the level of the lake, shew any traces of vegetation. The remainder has been smoothed and rounded off by the action of the water, and here the rock seems exceedingly compact, no fissures being perceived. On the map will be found a plan, on a larger scale, of this islet, shewing the position and course of the vein which traverses it. The course of the vein is N. 32° to 35° W., and it dips to the eastward at an angle of about 80°. It has a width of about twenty feet on the north side of the island, and to the southward divides into two branches, each seven to eight feet wide. It consists mainly of calcspar and quartz. Galena, in little cubes, is visible in almost every part of it, and blende, iron and copper pyrites are not uncommon. The native silver, accompanied by silver glance, was only found in the west branch. It was first noticed by Mr. John Morgan, one of the exploring party, in the shape of small nuggets, on the east side of the vein. It was then traced to the water's edge, and out into the water for some distance, where, instead of merely scattered nuggets of native silver, large patches of veinstone, rich in galena, are visible, which galena, on closer examination, is found to be intermixed with small particles, and some large nuggets of silver. The thickness of the rich part of the vein varies from a few inches to two feet, and it keeps to the east or hanging side of the vein. By working in the water with crow-bars, some loose pieces of rich veinstone were detached, and in this way, as well as from one blast on the island, 1,336 lbs. of ore were obtained. This quantity of ore was sent to Montreal, where, in the month of December, it was carefully weighed and sampled. The richest pieces, varying in weight from a few ounces to 41 pounds, were picked out, weighing in all 93¼ lbs. Eight of these, supposed to represent the average, were placed in sealed bags and marked sample No. 1. A large piece of veinstone, measuring three feet by twelve to sixteen inches by six to twelve inches, and weighing 481 lbs., was sampled by drilling six holes through it at points as nearly as possible equidistant from each other. The borings, quartered down in the usual manner and then ground and well mixed together, constituted sample No. 2. The fragments of ore of ordinary quality, weighing 250¾ lbs., were sampled by chipping off pieces from them. The pieces, ground to powder and quartered down, made sample No. 3. The remainder of the ore was broken down into small pieces and well mixed with the ore which had broken off the larger fragments. It weighed 511 lbs., and was regularly quartered down, the resulting sample being ground fine, well mixed, and marked No. 4. Eight portions of each of the powdered samples were placed in sealed bottles, all properly labelled. The following table gives the results obtained by Professor Chapman, Dr. Hayes, and myself in assaying the various samples, the ton being taken at 2240 lbs., and the value of silver at $1.24 per ounce troy. This value is based upon the price recently quoted in England for bar silver, namely 5s. 0¾d. per oz. :—

PER CENTAGES.

	No. 1.	No. 2.	No. 3.	No. 4.	Average.
Professor Chapman	14·96	7·88	5·27	1·71	5·523
Dr. Hayes	41·17	11·26	5·82	1·18	8·471
T. Macfarlane	13·14	7·3	4·94	1·82	5·168

OUNCES PER TON.

	No. 1.	No. 2.	No. 3.	No. 4.	Average.
Professor Chapman	4,886	2,574	1,721	558	1,804
Dr. Hayes	15,064	3,678	1,901	385	2,767
T. Macfarlane	4,292	2,384	1,613	594	1,690

SILVER VALUES PER TON.

	No. 1.	No. 2.	No. 3.	No. 4.	Average.
Professor Chapman	$ 5,058	$3,191	$2,134	$691	$2,236
Dr. Hayes	18,679	4,560	2,357	477	3,431
T. Macfarlane	5,332	2,956	2,000	736	2,095

If the average of these amounts be taken, it amounts to 6·387 per cent. silver = 2087 ounces, or $2,587.88 per ton of 2,240 lbs. The following experiments on samples Nos. 2 and 4 are confirmatory of the results of the assays:—1000 parts of No. 2 yielded, on being washed on the German 'Sicher trog,' 275 parts of ore, containing 24·82 per cent. silver; 1000 parts of No. 4, yielded on similar treatment, 87 parts washed ore, assaying 15·9 per cent. silver.

On the strike of the vein of Silver Islet, to the north-westward, two veins are seen to intersect the argillaceous sandstones which form the projecting part on the south-east side of Burnt Island. These sandstones are here much harder than usual, having resisted well the action of the waves. This is owing to their being penetrated by numerous thin veins of quartz, which mineral appears also to have permeated and hardened the side rock. The dip of the sandstones is 9° towards N. 58° E. Generally the veins are mere coatings of quartz on the vertical joints, but sometimes they are about an inch, and even three inches thick, showing cavities lined with quartz crystals. The most western of the large veins shews sometimes a thickness of seven or eight inches of quartz, but consists on the whole of a network of quartz veins enclosing fragments of the hardened sandstone. Galena, blende and iron pyrites are observed accompanying the qnartz, but, although native silver was diligently sought for, none was found. On washing the galena from 1000 parts of this veinstone, 181 parts were obtained, containing 0·04 per cent. silver, or 13·052 oz. per ton. This quantity is of course too small to pay for working the vein. The strike of the latter is about S. 30° E., which direction points straight to the west side of Silver Islet. Its dip is 80° N.E. The eastern vein is filled mostly with calespar, and contains galena also, 106 parts of which were washed out of 1000 of veinstone. The washed ore contained only a trace of silver. These veins seem to continue across Burnt Island, and are met with on the mainland, where small grains of galena are seen in them. They are more likely to be argentiferous where they intersect the dykes; but at these points large crevices filled with large stones and earth are invariably found.

With regard to the agricultural capabilities of the location, they are not very extraordinary. A large part of its area is occupied by the red sandstones, having only a covering of moss and scarcely any soil upon them, neither is there any soil upon the rocky ridges formed by the dykes. The indurated marl and the grey sandstones yield here and there some land which, on cultivation, might supply a few of the wants of a mining population. The lake itself, however, with its abundant supply of beautiful fish, would do far more to furnish food for the miners than any farms which it might be possible to establish on shore. The timber upon the location, although seldom of a size to furnish good saw-logs, would nevertheless be abundant for mining purposes. Balsam, spruce, cedar, and birch predominate. There are a few pines and poplars, and in the north-east part some tamarac. Maple is absent altogether. Since, therefore, the location is comparatively valueless for farming and lumbering purposes, it is to be hoped that the development of its mineral wealth will be taken in hand in a vigorous but judicious manner and carried to a successful issue. The only considerable mining settlement yet made in the district of Algoma—that of Bruce Mines—owes its establishment to the enterprise and money (however injudiciously expended) of the Montreal Mining Co. May their exertions towards creating a remunerative industry in this barren region be, in the future, attended with more substantial rewards to the adventurers than heretofore.

Actonvale, February 20th, 1869.

ON THE MARINE MOLLUSCA OF EASTERN CANADA.

By J. F. Whiteaves, F.G.S., etc.

Our knowledge of the distribution of the marine mollusca in Lower Canada is still very limited. In 1858 Principal Dawson published in this Journal (vol. iii., p. 329) a list of shells collected by him in Gaspé Bay ; the number of species recorded is thirty-eight. In 1859 Prof. R. Bell gave a list of sixty-seven marine molluscs, collected in various parts of the Gulf of the St. Lawrence (see vol. iv., p. 197) ; a few of these were procured in New Brunswick. Since that time some additional species have been collected by other observers. In August, 1867, through the kindness of Messrs. John Luce and G. De Carteret, of the firm of W. Frewen & Co., I was enabled to carry on careful dredging operations at Grande Grève, in Gaspé Bay. In this paper it is proposed—1st, to give a list of the species dredged by myself at Grande Grève, and, 2nd, a catalogue of all the marine mollusca known to inhabit Lower Canada at the present date.

Grande Grève is a fishing station on the North-east side of Gaspé Bay, and is sheltered by the narrow strip of land of which Cape Gaspé is the extremity. The rocks of Oriskany sandstone here dip slopingly towards the sea, which deepens very rapidly from the shore, so that but few shells can be collected unless the dredge is used. A fortnight was devoted to a careful examination of this particular spot, and seventy-five species were procured, as follows:—

PALLIOBRANCHIATA.

Rhynchonella psittacea Gmelin :—Frequent, alive on stones in from 10 to 20 fathoms.

LAMELLIBRANCHIATA.

Anomia ephippium Linn.—On stones and shells with the above; the var. *aculeata* frequent.

Amusium tenuicostatum Mighels (= *Pecten Magellanicus* Lam.):—Alive in 1 to 10 fathoms.

Pecten Islandicus Chemnitz :—Living in from 5 to 40 fathoms water.

Nucula tenuis Montagu, and var. *expansa* (= *N. expansa* Reeve) :—Alive in 40 to 50 fathoms mud. The *Nucula inflata* of Hancock, from Greenland, etc., is apparently only a variety of this species, and is probably the same as *N. expansa* Reeve.

Nucula delphinodonta Migh. :—With the above, but much more abundant. The shell is covered with a ferruginous coat like the British *Lucina ferruginosa.*

Leda pernula Müller :—Six fine living specimens in 50 fathoms mud.

Leda minuta Müll.—One, living, with the above.

Yoldia myalis Couthuouy :—Rare, with the two preceding; but not infrequent in the stomachs of flat fish caught off Grande Grève.

Crenella glandula Totten :—A few taken living in from 20 to 40 fathoms.

Crenella decussata Mont. (= *C. cicercula* Möll.)—Abundant, living in mud, in from 20 to 60 fathoms. Quite distinct from the preceding, but larger than the average of British specimens.

Modiolaria discors Linn. and var. *lævigata* Gray:—Rare, living with the above.

Modiolaria nigra Gray:—One fine living specimen on a stone, in about 20 fathoms.

Modiola modiolus Linn.—Fragments of large specimens in shingle at 20 fathoms.

Mytilus edulis Linn.—Common on the beach and in shallow water.

Cardium Islandicum Linn.—In sandy mud, at 30 to 50 fathoms, and abundantly from fishes' stomachs.

Cardium pinnulatum Conrad:—Alive, with the preceding.

Serripes Grœnlandicus Chemn.—Large and fine, in mud, at 20 to 50 fathoms. Found in the English Red-Crag deposits.

Astarte striata Leach, and var. *globosa*:—In 20 to 60 fathoms mud.

Astarte Banksii Leach:—With the preceding, but rarer. This species and the foregoing are barely specifically distinct from the *A. compressa* of English authors. They exactly correspond with the two so-called species from Greenland.

Astarte undata Gould (= *A. latisulca* Hanley):—Large and fine, in 50 to 60 fathoms mud. Very variable in sculpture. The New England variety, with prominent and distant ribs, which some of the Gaspé examples approach, can hardly be separated from the *Astarte Omalii* var. *undulata* of Searles' Wood's Crag Mollusca.

Astarte semisulcata Leach:—With the preceding a few specimens occurred, which I refer, with doubt, to this species.

Cardita borealis Conrad:—Living, at various depths.

Axinus Gouldii Philippi:—A few living, at 20 to 60 fathoms.

Venus fluctuosa Gould, sp.—Extremely abundant, living in 20 to 50 fathoms.

Macoma sabulosa Spengler (= *Tellina proxima* and *calcarea*, auct.):—Scarce, in 20 to 50 fathoms; also from stomachs of fishes.

Macoma Grœnlandica Beck, sp.—Scarce, in shallow water. Probably conspecific with the *Sanguinolaria fusca* of Say from New England, with the West Coast *Macoma inconspicua* of Brod. et Sow, and with the European *Tellina Balthica* of Linnæus.

Mya arenaria Linn.—Occasional, on the shore.

Mya truncata Linn.—One dead but fresh adult, and living fry taken in 10 to 20 fathoms.

Saxicava (*Panopæa*) *Norvegica* Spengler :—Six dead but fresh specimens, in 50 fathoms mud.

Saxicava rugosa Linn. and var. *arctica* :—Common, burrowing into stones in from 10 to 20 fathoms.

Anatina papyracea Say :—One alive, in 50 fathoms mud.

Thracia myopsis Möller :—A few taken with the above.

Lyonsia (*Pandorina*) *arenosa* Möll.—Living in sandy mud, in 30 to 50 fathoms. The shell is covered with particles of sand, as the specific name implies.

Pandora (*Kennerlya*) *glacialis* Leach :—Living with the above. Externally it closely resembles the *Pandora obtusa* of Forbes and Hanley, which is the *Solen pinna* of Montague. According to Dr. P. P. Carpenter, *P. glacialis* has an internal ossicle, which is wanting in the British shell.

GASTEROPODA.

Cylichna alba Brown :—Living in 40 to 60 fathoms.

Tonicia marmorea O. Fabr.—Common on stones, in 10 to 20 fathoms.

Leptochiton albus Linn.—With the above; frequent.

Tectura testudinalis Müll.—In very shallow water.

Lepeta cæca Müll.—On stones, in 20 to 50 fathoms, living.

Cemoria Noachina Linn.—Living with the above.

Margarita striata Brod. et Sow. (=*M. cinerea* Gould).

Margarita Grœnlandica Chemn. and var. *undulata*

Margarita obscura Couth.

Margarita varicosa Migh. :—These four species were taken living, in from 30 to 50 fathoms mud, the last being by far the most abundant. The *M. varicosa* is the same as the *M. elegantissima* of Searles' Wood's Crag Mollusca.

Lacuna vincta Fabr.—On sea-weeds in shallow water.

Littorina littoralis Linn. fide Jeffreys (= *L. palliata* Say) :—Common on rocks on the shore.

Littorina rudis Mont.—With the above. The varieties *patula* and *tenebrosa* were common, but I did not meet with the type. *L. Grœnlandica* Chemn. appears to be a variety of this species.

Scalaria Grœnlandica Perry :—One living specimen on a stone, in 20 fathoms water.

Mesalia (?) *erosa* Couth.—Abundant, living in 20 to 50 fathoms mud.

Mesalia (?) *reticulata* Migh.—With the above, but less frequent.

Aporrhais occidentalis Beck :—Alive, with the two preceding.

Menestho albula Möll.—Three living; adult specimens were taken on a stone, from about 20 fathoms water.

Velutina (Morvillia) Zonata Gould :—Three examples taken on stones in deep water.

Velutina haliotoidea Müll.—One taken living, with the above.

Natica affinis Gmelin (= *N. clausa* Brod. et Sow.):—Fine, in about 40 fathoms.

Lunatia Grœnlandica Möll.—Very large, living with the above.

Lunatia heros Say :—Frequent in sandy parts of Gaspé Bay, but rare opposite Grande Gréve.

Pleurotoma bicarinata Couth :—Rare, in 30 to 50 fathoms.

Bela nobilis Möll.—A few living, at the same depth as the above.

Bela exarata Möll.—One living, in about 40 fathoms.

Bela scalaris Möll.—In mud, at from 30 to 50 fathoms. I regard these three as good species, distinct from the British *B. turricula*, cf which I have never seen typical specimens in Canada.

Bela decussata Couth.—Frequent, living in from 30 to 50 fathoms mud.

Bela pyramidalis Strom (= *Fusus pleurotomarius* Couth. *F. rufus* Gould and *B. Vahlii* Möll.) :—With the preceding, but rare.

Nassa trivittata Say :—Living, a little above the village of Gaspé Basin, where the water is brackish.

Buccinum undatum Linn.—Several varieties of this species were dredged in deep water. I regard the *Buccinum undulatum* of Möller and the *B. Labradorense* of Reeve, as varieties of this protean mollusc.

Buccinum tenue Gray (= *B. scalariforme* Möll.) :—Alive, in 60 fathoms mud.

Buccinofusus Kroyeri Möll. sp.—One living specimen, with the preceding; it is the *Buccinum cretaceum* of Reeve and the *B. Donovani* of Prof. Bell's list.

Chrysodomus decemcostatus Say :—One dead immature specimen was dredged in deep water.

Chrysodomus pygmæus Gould :—Not rare, living in about 30 fathoms.

Trophon Gunneri Lovén :—Living in about 30 fathoms.

Trophon clathratus Linn.—One taken with *T. Gunneri.*

Trichotropis borealis Brod. et Sow.

Admete viridula O. Fabr.—The two last species were fine, and frequent in 30 to 40 fathoms.

CEPHALOPODA.

?*Loligo illecebrosa* Lesuer :—Abundant; is used by the fishermen largely as a bait for cod.

Among other invertebrates dredged here were *Metridium marginatum* Edw. et Haime, *Alcyonium rubiforme* Ehrenb., *Echinarachnius parma* Linn., *Ophiopholis aculeata* Lutk., *Ophioglypha robusta*, and *O. Sarsii*, with other commoner forms, and some fine sponges.

It is thought desirable to place on record a list of the sea shells known to inhabit the River and Gulf of the St. Lawrence, north of New Brunswick, and south of north-eastern Labrador. The species enumerated in the preceding list are included, and only unrecorded localities are given for rare species. My thanks are due to Principal Dawson, to Drs. Stimpson, and P. P. Carpenter, and to Messrs. S. Hanley and J. G. Jeffreys, for their kind critical assistance in the identification of difficult species. At the same time, having carefully compared the Canadian shells with Möller's types in the British Museum, and in the cabinets of Messrs. Hanley and Jeffreys, this and the preceding list must be regarded as the expression of my own individual judgment on the several species.

LIST OF THE MARINE MOLLUSCA OF EASTERN CANADA.

PALLIOBRANCHIATA.

Rhynchonella psittacea, Gmel.

LAMELLIBRANCHIATA.

Anomia ephippium, Linn.
and var. aculeata.
Limea subauriculata, Mont.
Amusium tenuicostatum, Migh.
Pecten Islandicus, Chemn.
Nucula tenuis Mont.
and var. expansa.
Nucula delphinodonta, Migh.
Leda pernula, Müll.
—— minuta, Müll.

Yoldia myalis, Couthuouy,
(is the Leda limatula of Principal Dawson's list).
Crenella pectinula, Gould;
(Mingan, J. Richardson, Jr).
—— glandula, Totten.
—— decussata, Mont.
Modiolaria discors, Gray,
and var. lœvigata.
—— nigra, Gray.

Modiola modiolus, Linn.
—— plicatula, Lamarck.
Mytilus edulis, Linn.
Cardium Islandicum, Linn.
—— pinnulatum, Conr.
Serripes Grœnlandicus. Chemnitz;
Axinus Gouldii, Phil.
Astarte borealis? Chemn.
(Marsouin, Prof. R. Bell).
—— undata, Gould.
—— semisulcata? Leach.
—— striata, Leach.
—— Banksii, Leach.
—— quadrans, Gould;
(Mingan, J. Richardson, Jr).
Cardita borealis, Conr.
Gemma Tottenii, Stimp.
(= Venus gemma, Totten).
Venus fluctuosa, Gould.
Mactra polynema, Stimp.
(= M. ovalis, Gould—name preoccupied).
Ceronia deaurata, Turton,
(= Mesodesma Jauresii, De Joannis); Little Metis, J. F. W.
Ceronia arctata, Conrad;
(This species I believe to be the young of the preceding).
Macoma Grœnlandica, Beck.
—— sabulosa, Spengl.
Tellina (Angulus) tenera, Say;
(collected in Gaspé Bay by Principal Dawson).
Solen ensis, Linn.
Machæra costata? Say.
Mya arenaria, Linn.
—— truncata, Linn.
Crytodaria siliqua, Spengl.
(Tadoussac, Principal Dawson; Little Metis, J. F. Whitheaves).
Panopœa Norvegica, Spengl.
Saxicava rugosa, and var. arctica.
Anatina papyracea, Say.
Thracia myopsis, Möll.
Lyonsia (Pandorina) arenosa, Möll.
(is the Osteodesma hyalina of Prof. Bell's list, but not of Conrad).
Pandora glacialis, Leach.
Zirphœa crispata, Linn.

GASTEROPODA.

Opisthobranchiata.

Cylichna alba, Brown.

Prosobranchiata.

Tonicia marmorea, O. Fabr.
Leptochiton albus, Linn.
Amicula Emersonii, Couthuouy;
(Gaspé Bay, Principal Dawson).
Lepeta cœca, Möll.
Cemoria noachina, Linn.
Margarita striata, Brod. et Sow.
—— obscura, Couth.
—— varicosa, Migh.
—— Grœnlandica, Chemn.
and var. undulata.
—— helicina, O. Fabr.
Adeorbis (Molleria) costulata, Möll.;
(Mingan, J. Richardson, Jr).
Rissoa minuta, Totten;
(Little Metis, J. F. W.)
—— castanea, Möller;
(Mingan, J. Richardson, Jr).
Lacuna vincta, Fabr.
Littorina littoralis, Linn.
Littorina rudis, Montagu;
vars. patula and tenebrosa.
Scalaria Grœnlandica, Perry.
Mesalia erosa, Conthuouy,
(= Turritella polaris, Möller).
—— reticulata, Mighels,
(= Turritella lactea, Möller).
Aporrhais occidentalis, Beck;
(Mingan, J. Richardson, Jr).
Menestho albula, Möll.
Velutina haliotoidea, Müll.
—— (Morvillia) Zonata, Gould.
Lamellaria perspicua, Linn.
Natica affinis, Gmelin.
Lunatia heros, Say.
—— Grœnlandica, Möll.
—— triseriata, Say.
Bulbus flavus, Gould.
Amauropsis Islandica, Gmelin,
(= Natica helicoides, Johnstone).

Pleurotoma bicarinata, Couth.
Bela nobilis, Möll.
—— scalaris, Möll.
—— exarata, Möll.
—— decussata, Couth.
—— pyramidalis, Strom.
Astyris Holbolli, Beck; smooth var. (= Columbella rosacea, Gould); Mingan, J. Richardson, Jr.
Purpura lapillus, Linn.
Nassa trivittata, Say.
Buccinum undatum, Linn. (varieties = B. undulatum Möll. and B. Labradorense, Reeve).
—— tenue, Gray.
Buccinofusus Kroyeri, Möll.
Chrysodomus tornatus, Gould.
—— decemcostatus, Say, (varieties occur with characters intermediate between this and the preceding species).
—— Islandicus ? Chemn. (?= Fusus Spitzbergensis, Reeve).
—— pygmœus, Gould.
Trophon clathratus, Linn.
—— scalariforme, Gould.
—— Gunneri, Lovén.
—— craticulatus, O. Fabr. (= T. Fabricii, Beck); Mingan, J. Richardson, Jr.
Trichotropis borealis, Brod. et Sow.
Admete viridula, O. Fabr.

CEPHALOPODA.

Loligo illecebrosa ? Lesuer.

The following species have been found in Labrador, but have not yet been taken living in the area in question:—

Terebratella Labradorensis, Sow.
Yoldia sapotilla, Gould.
Leda buccata, Möll.
Mactra solidissima, Chemn.
Thracia Conradi, Couth.
Clione limacina, Phipps.
Limacina helicina, Phipps.
Bulla pertenius, Migh.
—— occulta, Migh.
Philine lineolata, Couth.
Pilidium rubellum, Fabr.
Scissurella crispata, Flem.
Turitella acicula, Stimps.
Bella violacea, Migh.
—— cancellata, Migh.
Buccinum Grœnlandicum, Hancock.
Ommastrephes todarus ?

All of these, with the exception of the first species, are given on the authority of Dr. A. S. Packard, Jr. (this Journal, vol. viii., page 401. Throughout Dr. Packard's article, wherever the depth of water is given as "feet," read "fathoms").

Ostrea Virginiana ? Lam., *Venus mercenaria* Say, *Crepidula fornicata*, *C. plana*, and *Nassa obsoleta* live in the Bay of Chaleur, but barely within the limits we have prescribed.

Machœra squama Blainv., *Fasciolaria ligata* Mighels, and *Fusus ventricosus* Gray, occur both north and south of Lower Canada, but they have not as yet been taken in its waters.

Lastly, a few shells are found in the post pliocene beds of Lower Canada, which, as yet, have not been detected as members of its recent fauna. These are:—

Terebratella Spitzbergensis ? Dav.
Leda truncata, Brown.
Cardium Dawsoni, Stimp.
Astarte Laurentiana, Lyell.

Macoma inflata, Stimp.
Cylichna nucleola, Reeve.
Buccinum glaciale, Linn.
Buccinum Grœnlandicum, Hanc.
—— cyaneum, Brug.
—— Tottenii, Stimp.

The three last named species of Buccinum are quoted on the authority of Dr. Stimpson. The Terebratella has been referred to the *T. Labradorensis* of Sowerby. Having seen recent specimens of this shell from Halifax, N. S., and fossil examples from Rivière-du-Loup, it seems to me to come nearer to Davidson's *Terebratella Spitzbergensis.*

At depths as great as fifty fathoms and upwards in Gaspé Bay, the mud or sand brought up by the dredge, even in July and August, is icy cold. It is not improbable that in this bay one of the branches of the cold northerly arctic current may flow. An experiment made by Dr. Fortin of trying to naturalize oysters in Gaspé Bay seems to have failed. Oysters are very sensitive to cold, and not only does extreme cold exist at the bottom in deep water all the year round, but the surface is frozen over along the shore during the winter.

The marine mollusca of the River and Gulf of the St. Lawrence are remarkable, first, for the extreme antiquity of many of the species, and secondly, for their wide geographical range. The majority of them belong to an arctic or sub-arctic fauna, which is to a large extent circumpolar. In time, some date back to a period as old as that in which the European coralline crag was deposited, and during the formation of the European tertiaries and post-pliocene beds, many species lived in the seas of Great Britain, etc., which are now extinct there but which still live on the western side of the Atlantic. There may be perhaps, in addition to this, a small local assemblage consisting of species apparently of a more recent date of creation and confined to a comparatively limited area. Nearly all of the Greenland shells will probably be yet detected in the River and Gulf of the St. Lawrence. When we possess more definite information as to the geographical distribution of the living marine invertebrates of the Dominion, we shall be better able to understand the conditions under which the Canadian post-pliocene beds were deposited. And further, a careful comparison is still required between the recent invertebrates of the northern seas, and the fossils of the tertiary and post tertiary beds of Europe and North America. Not only would the results of such investigations add to our knowledge of physical geology, and help to form a key towards the solution of the problem of the rationale of the geographical distribution of plants and animals, but it might also throw some light on that vexed question the origin of species. These arctic or sub-arctic molluscs are not only in many cases of high antiquity, but from their wide spread distribution we get an opportunity of studying the modifications of species caused by altered physical conditions.

ON CHEMICAL EXPLOSIVES.

GUNPOWDER—GUN-COTTON—NITRO-GLYCERINE—DYNAMITE.

By J. B. Edwards, Ph.D., F.C.S.

The rapid advance of gun-cotton and its congeners as formidable rivals to gunpowder, is a remarkable example of the industrial intelligence and enterprise of modern Europe. Gunpowder has long occupied a remarkable position as a projectile. The mechanical genius of the most advanced nationality, has been invoked for improvements in armaments and defences; but the chemical condition of this explosive projectile has remained the same during the past century. It would be rash to say that the days of gunpowder are over, as our past experience has shown that new inventions bring new appliances into action, and that in the spread of civilization over the globe, all are required. Hence it is probable that as much gunpowder will be consumed hereafter, as before the invention of gun-cotton, but the latter will, undoubtedly, be in large demand for mining industries, as well as for some forms of ordinance. On the comparative mechanical value of gun-cotton and gunpowder, Mr. Scott Russell has brought some valuable data before the members of the Royal Institution, and thus compares them: "Gun cotton, as prepared by the Austrian process, is uniform in quality and permanent in action; it possesses the greatest cleanliness in use, not fouling the gun as gunpowder does, and hence possesses great advantages for use with breech-loading arms."

Exploding in the open air it acts differently from gunpowder; if the latter is exploded in one pan of a pair of scales, the arm of the balance is violently depressed; an equal weight of gun cotton, on the contrary, can be ignited without moving the pan. In the same manner a bag of gunpowder will blow open the gate of a town, which would not be injured by the explosion of an equal weight of loose or unpacked gun cotton.

Enclosed in a case or gun, the effect of gun cotton is three times greater than that of powder, and for blasting purposes it is twelve times greater. When the cotton is converted into gun cotton in the state of twist or yarn, and afterwards plaited, it may be made into cartridges of almost any proportion of projectile force; and this force is increased per weight of cotton. The recoil is one-third greater in the case of gunpowder, than that caused by gun cotton. Gun cotton is found not to heat the gun to the same extent as as gunpowder; the former can be repeatedly wetted and dried again without injury, which is a great advantage over gunpowder. In confined places, such as mines and casements, the absence of sulphurous smoke, enables workmen and soldiers to continue firing for any length of time without inconvenience.

The relative power and proportions of gunpowder and gun cotton, may be inferred from the following tables, compiled by Mr. Scott Russell:—

GUNPOWDER.	GUN COTTON.
100 lbs. occupy....... 1.8 C. ft.	100 lbs. occupy.... . 4 C. ft.
55 lbs. " .... 1.0 C. ft.	25 lbs. " .... 1 C. ft.

PRODUCTS.

100 lbs. yields 68 lbs solid, 32 lbs. gases.	100 lbs. yields 25 lbs. steam, 75 lbs. gas.

Professor Abel, the able chemist at Woolwich laboratory, points out two distinct actions of nitric acid upon cotton. If the nitric acid be permitted to act at a high temperature, and in an energetic manner, the carbon and hydrogen of the cotton may be completely oxydized. When, however, the temperature is controlled, and the action moderated, the hydrogen is removed in gradations, peroxide of nitrogen being substituted for it, and various compounds formed in definite proportion. Thus, when the atoms of hydrogen are replaced by two of nitric oxide Xyloidine is produced

$$C.\ 24 \left.\begin{matrix} H. & 18 \\ 2\ N.O. & 4 \end{matrix}\right\} O.\ 20$$

When three atoms of hydrogen are replaced, pyroxiline, or collodion cotton is produced

$$C.\ 24 \left.\begin{matrix} H. & 17 \\ 3\ N.O. & 4 \end{matrix}\right\} O.\ 20.$$

By the precautions adopted in the Austrian army, a definite compound has been produced for martial purposes.

$$C.\ 25\ \left.\begin{array}{l}H.\ \ \ \ 15\\ 5\ N.O.\ \ 4\end{array}\right\}O.\ 20$$

The cotton loosely spun with yarn, is boiled in a weak solution of alkali, in order to remove more easily oxidized materials which would consume a portion of the nitric acid. After this washing the yarn is dried in a centrifugal drying machine, and immersed in a solution of 1 part by weight nitric acid, Spgr. 1.5, and 3 parts sulphuric acid, 1.845. To secure uniformity of result, it is allowed to remain in this acid for forty-eight hours; great care being taken that the temperature does not rise during the operation. When loosely arranged the Austrian cotton inflames at a temperature of 300°, it burns without smoke, and leaves no ashes. When twisted into yarn its rapidity of combustion is diminished, and by varying the degree and tightness of the twist, various rates of burning may be obtained, from the rifle cartridge to the mining fuse. Economically, these results all tell in favor of the gun cotton over gunpowder, in every modification of its grain; and in many respects the actual manufacture of gun cotton is the safer of the two.

In competition with these substances are explosive derivatives of the same type from starch and sugar; but these have not at present shown any commercial capabilities. A formidable opponent to gun cotton has, however, appeared in the product of glycerine, the waste product from soap manufacture, which is converted by nitric acid into nitro-glycerine or glonoine. This substance was discovered in 1847 by Sobrero, but its manufacture on a commercial scale is due to the persevering enterprise of M. Nobel, a Swedish chemist, who has established six factories for its manufacture. The Nitro-glycerine Company in Stockholm, sold, in 1865, 32,258 feet, in 1866, 48,785 feet, in 1867, 76,575 feet, and in 1868, 150,009 feet, which shows the rapid increase in the demand for this explosive, this quantity being principally consumed in Sweden for mining purposes.

Nitro-glycerine is an oily fluid, having a specific gravity of 1.6. It is insoluble in water, but soluble both in wine and wood alcohol, and in ether. It freezes at 46° F. and explodes at 350° F. Flame will not always ignite it, and when struck on an anvil only the portion actually struck explodes. It is exploded by agitation, and by friction, which is a source of danger in its handling, and has been the probable cause of some of the serious and unexpected accidents to which its sudden explosion has given rise. Great caution is therefore necessary in its manufacture, as during the action of the nitric acid on the glycerine, the temperature rapidly rises, and has to be controlled by the use of a freezing mixture, otherwise the compound formed would explode; and, on the other hand, if frozen solid, the same danger exists from the friction of its particles.

Although, therefore, a highly dangerous process, it may, by care and precaution, be produced as we have seen in very large quantities. Fearful destruction of life has, however, arisen from ignorance and recklessness in its conveyance from place to place. In 1865, a small rudely formed box was found to be creating a suffocating smell in the baggage room of the Wyoming Hotel in New York, and which not being claimed was thrown into the street when it immediately exploded with great violence filling the air with nitrous fumes, and doing much damage.

One hundred pounds weight exploded at Sydney, and seventy cases exploded at Aspinwall, Panama, in the same year, on board the 'European,' which was nearly destroyed, a large ship near her greatly injured, the freight house blown down and 400 feet of the quay obliterated, upwards of seventy persons were killed and wounded and not a single pane of glass was left in the city. Similar casualties have followed in quick succession. Two boxes of oil were transmitted as ordinary merchandise through the most important and populous localities in Europe and finally landed in San Francisco, where it exploded, causing a fearful loss of life and the destruction of $200,000 worth of property. Such extraordinary and criminal recklessness has given rise to prohibitory legislation and probably induced an unnecessary panic in reference to the real dangers of transhipment and conveyance of the article. In the history of gunpowder and gun-cotton, we have been occasionally startled by fearful accidents with terrific loss of life, which has awakened us to the necessity of constant vigilance and the utmost precaution in handling and storing large quantities of such potential commodities. Nitro-glycerine has been prohibited in Belgium, and in Sweden it has been placed under restrictions of a similar class to those imposed on gunpowder. Some railway companies refuse to carry it, which has induced those requiring it to smuggle it through as ordinary merchandise, a most unjustifiable proceeding. The wisest policy is doubtless to carry it under special precautions, and thus a car load has been recently sent through from New York to the new Pacific railroad without being unladen, in perfect safety.

Much scientific attention has been bestowed on the important subject of rendering these substances non-explosive during their storage and transhipment.

Gunpowder was to be treated with sand and thus rendered non-explosive and when required for use the sand to be sifted out. This simple and ingenious idea was however found in practice less practicable than could be wished. The sand cut the grain of the powder, and caused loss by dust, while to an inconvenient extent it remained with the powder after sifting.

Gun-cotton can be kept wet until required for use and, when manufactured in yarn or cartridges, is much safer than powder. Prof. Abel has suggested some important modifications in the process for manufacturing mining cotton, which render it comparatively safe and in a very compact form.

Nitro-glycerine has received similar assistance from the hands of M. Nobel, which promises to give a new stimulus to its manufacture and which may enable it to outstrip all competitors for blasting purposes.

His first idea was to dissolve it in two or three volumes of Naptha, or methylated spirit. This renders it perfectly safe for transport, but adds of course to the cost the additional freight of extra bulk, and the value of the spirit. When the compound is dropped into water the nitro-glycerine falls to the bottom and may be collected or used in that state. A still more valuable suggestion, however, is to mix it with 25 per cent. of porous silica, and use it in this pasty condition. This is a form said to possess special advantage for blasting purposes over either the solid or liquid agents; it loses none of its power by dilution to this extent and is then called Dynamite.

Experiment have been made at Glasgow and Mertsham which leave no doubt of its safety. A box containing 8 lbs. of Dynamite (equal to 80 lbs. gunpowder) was placed over a fire where it slowly burned away. Another box containing the same quantity was hurled from a height of sixty feet on to the rock below and no explosion took place. At Stockholm, a 200 lbs. weight was dropped from a height of twenty feet on to a box containing Dynamite, which was completely smashed but without any explosion.

It may of course be much more easily packed that nitro-glycerine and is not liable to leakage which is a serious difficulty with all liquids of an oily nature. Its power is fully equal to the same bulk of nitro-glycerine and it has also several advantages. Thus it does not evaporate and give off fumes, which is a complaint made by workmen against nitro-glycerine, because in a close tunnel it gives rise to severe headaches.

The saving of time and labour by its use is said to be very great. The Dynamite is put up in cartridges, so that the workman has simply to put them into his bore-hole and fire. Mr. Nobel states, as the result of his experience, that the use of Dynamite or nitro-glycerine, reduces the general cost of blasting by at least one third. It is being largely used in Sweden, in Wales, at the Phœnix mine on Lake Superior, also in the construction of the Pacific Railway and the demand now considerably exceeds the ability of existing factories to supply it.

ON THE GREAT SNOW FALLS OF 1869.

By C. Smallwood, M.D., LL.D., D.C.L.

The more than usual amount of snow which fell during the winter 1868-9, renders it worthy of record for comparison with past and future observations.

The first snow of the winter (1868-9) fell on the 17th day of October, and though inappreciable in quantity, ushered in a season of very heavy snow falls.

The total amount which fell during the month of

October was	4.92	inches
During the month of November	17.28	"
During the month of December	27.96	"
During the month of January, 1869	28.07	"
During the month of February	73.76	"
Up to the 15th March	11.67	"
Total	163.66	"

The mean average depth of the snow fall for the past twenty years was 79.50 inches per annum.

The greatest depth which fell in one month during the above period fell in January, 1861, and was 31.80 inches.

The total depth which fell in 1861 (a year of great snow fall) was 99.58 inches.

Last year (1868) 105.27 inches of snow fell; this is above the yearly average, but is owing in a great measure to the unusual large amount which fell in November and December.

The first heavy fall commenced at 7 a. m. on the 3rd of February and ceased at 4 p. m. on the 4th day, 25.44 inches having fallen. The barometer fell from 29.751 inches to 28.841 (a range of 0.910 inches). The mean temperature of the 3rd day was 17 degrees, and of the 4th day 21 degrees; wind was from the N. E. by E.; greatest mean velocity 18.42 miles per hour.

The second heavy fall commenced at 3.15 p. m. on the 14th day, and ceased at 2.15 p. m. of the 15th; there fell 14.90 inches. The barometer stood at the commencement at 30.001 inches and fell to 29.175 (a range of 0.826 inches); the wind was from the N. E. by E.; greatest mean velocity 19.11 miles per hour. The mean temperature of the 15th day was 19 degrees.

A third fall, which was remarkable for heavy drifts and somewhat severe cold, commenced at 4 a. m. on the 10th of March and ended at 11 p. m., during which time there fell 8.82. inches. The barometer attained the lowest reading at 10 p. m., and indicated 29.119 inches; wind was from the N. E. by E., and was succeeded by a heavy gale from the West. The mean temperature of the day was 12.1 degrees; the thermometer at 7 a. m. stood at 16°.1 and fell to 8°.0 at 2 p. m., and at 9 p. m. it rose to 12°.2.

The heaviest fall of snow on record to which we have had access, occured on the 17th and 18th of January, 1827, when from 60 to 70 inches of snow fell. Drifts of from 12 to 15 feet high were common in many places.

February has not generally been characterized by very heavy snow falls, being for the most part dry and cold. The heavy fall of November last far exceeds the usual average for that month, which is about 6 inches. December, 1830. 1831 and 1834 showed a fall of 26.50 inches, 27.45 inches, and 27.70 inches respectively; large amounts fell in February, 1831, viz., 23.30 inches; in 1832, 25.85 inches; and in 1835, 21.80 inches, but these are exceptions; and March, 1832, shows an amount of 21.35 for that month. The amount of snow which fell in the month of December corresponds very clo.e'y to the above amounts.

We may state for the purpose of illustrating our climatology, that from the year 1824 up to 1868, a period of 44 years, the ice left the River St. Lawrence in front of this city—varying from the earliest period, 16th March (1825), to the latest, April 28 (1855), showing a variation of 43 days during this period of 44 years, but these early periods are not confined to late dates, but occured in March 1825, 1828, 1834 and 1842; the intervening years vary from 3rd to the 28th of April inclusive.

NATURAL HISTORY SOCIETY.

MONTHLY MEETINGS.

(*From December 1st*, 1868, *to February 28th*, 1869.)

Third monthly meeting, December 28th, 1868; Mr. E. Billings in the chair.

The following donations were announced.

TO THE MUSEUM.

Twenty-eight species of coleoptera from the Mackenzie River; from G. Barnston. A named series of Canadian beetles, consisting of 733 specimens of 475 species; from E. Billings.

Fifty-four species of Canadian beetles; from A. S. Ritchie.

TO THE LIBRARY.

The 20th Annual Report of the Regents of the University of the State of New-York; from Prof. J. Hall.

Céphalopodes Siluriens de la Bohême. Groupement des Orthoceres, par Joachim Barrande; from the Author.

Annuaire de Ville Marie, etc., from L. A. H. Latour.

NEW MEMBERS.

Mr. C. C. Stewart B. A. was elected a member of the Society.

PROCEEDINGS.

Mr. Whiteaves made a communication on a collection of exotic birds recently added to the Collection. Ninety-two specimens have been acquired by purchase during the past summer. Of these sixty-three examples were exhibited, and the points of interest in each species were briefly pointed out. Two of the species belong to the order Raptores, and the rest to the various subdivisions of the large order Insessores.

Fourth monthly meeting, January 25th, 1869, the President in the chair.

DONATIONS TO THE MUSEUM.

A collection of Devonian plants (35 specimens of 22 species) from the Fern ledges, near St. John, New Brunswick: from the Natural History Society of St. John.

TO THE LIBRARY.

Catalogue of N. American Orthoptera described previous to 1867, by Samuel H. Scudder: from the Smithsonian Institute, Washington. Twenty eight volumes of the Zoological catalogues of the British Museum: from the Trustees.

Messrs Walter McOwatt and Walter Cross Cowan were elected ordinary members.

Mr. F. Mackenzie read a paper "on the prevention of cruelty to animals." A discussion ensued in which Principal Dawson, Rev. Dr. De Sola, Dr. Bernard, R. Moat, D. Mackay, Jas. Ferrier Jr. and Mr. Mackenzie took part.

Dr. P. P. Carpenter then made a communication "on some of the features of the Montreal mortality returns for 1868."

Some remarks were made on this subject by Dr. Girdwood, G. Stephens, and Principal Dawson.

Fifth monthly meeting, held February 22nd, 1869, the President in the chair.

DONATION TO THE MUSEUM.

Specimen of the silicious sponge (*Euplectella aspergillum*) popularly known as Venus' flower basket, from the Philippine Islands: presented by Jas. Ferrier, jr Specimen of the Missouri pouched Rat, *Geomys bursarius:* from Mr. W. Hunter. Plaster models of five Indian pipes from the supposed site of the ancient Indian village of Hochelaga; from Principal Dawson.

TO THE LIBRARY.

Acadian Geology. Second edition. From Principal Dawson.

Five volumes and 5 numbers of the London Quarterly Journal of Microscopical Science; from Dr. J. Baker Edwards.

Messrs Bryce Scott, H. R. Gray, and E. Hartley were elected members of the Society.

Dr. John Bell read a paper entitled "Notes on a cruise in the Gulf of St. Lawrence."

Mr. A. T. Drummond read an essay "On the introduced plants of Ontario and Quebec.

SOMERVILLE LECTURES.

Four lectures of this series have at present been delivered, as follows:

1. January 21st, 1869. On Palæozoic land Animals; by the President.

2. January 28th, 1869. On the Chemistry of the Soap manufacture; by Dr. John Baker Edwards F. C. S.

3. February 11th, 1369. On the Zoology of the Bible; by Rev. A. De Sola L. L. D.

4. February 25th, 1869. On Primœval Chemistry; by Dr. T. Sterry Hunt F. R. S.

CONVERSAZIONE.

The 7th Annual Conversazione was held at the Rooms on Thursday evening, February 18th, and was well attended. Music was given by Herr Mayerhofer and pupils, by the Germania glee club, and by Mr. Brandt. Philosophical instruments were contributed by the authorities of McGill College, and microscopes, with objects, by members of the Microscopic club. Mr. C. Baillie illuminated the Museum with the electric light, and Dr. J. Baker Edwards exhibited Plateau's soap bubbles. Mr. Ross illustrated the operation of his new automatic fire alarm signal box, and contributed a small aquarium containing living sea anemones from the Clyde. Dr. Bell exhibited a series of the Plants of Newfoundland, Mr. J. P. Clark photographs and prints, and other gentlemen contributed interesting Zoological specimens. During the evening the following address was delivered by the President, Principal Dawson.

Ladies and Gentlemen:—It is my pleasing duty to bid you welcome to the Seventh Annual Conversazione of this Society—a Society which has not ceased, since its incorporation in 1832, to labour for the promotion in this city of a taste for natural science and allied subjects; and this, with marked success. In addition to its Lectures and meetings, I may mention as a permanent monument of its utility, the issue of nine volumes of its Proceedings, containing more than 4,000 pages of matter of the highest scientific value, and of the utmost importance to the knowledge of nature as it exists in this country, and to the development of our resources. No other institution in Canada can pretend to have made any contribution to the Natural History of this continent approaching this in value and extent. I may also mention its Museum, which has within the last few years made great progress, under the care of Mr. Whiteaves, and by the patient labour of our cabinet-keeper, Mr. Hunter. When I look through this museum today, and observe its admirable arrangement and the great amount of scientific material of real value which it contains, I can scarcely believe that it has grown from the confused and paltry collection which was huddled together in our former rooms in Little St. James street. Nor has its growth ceased. The additions made wlthin the last six months amount to 200 species of vertebrate animals, a large number of invertebrates, and about 200 fossils, besides many other objects. Taking together, the collections of this Society, of the Geological Survey and of the McGill University, Montreal now stands far in advance of any other city of this Dominion in its museums of Natural Science; and thus affords greater facilities than any other to the student of Canadian Natural History and Geology. This is no mean advantage, and is especially appropriate to a commercial and manufacturing metropolis; and it will be far more strongly felt when we shall have in connection with the University, or with any other agency that may be established, Schools of Science for the training of our young men in the practical application of Science to the Arts. In this respect this Society has all along been in advance of the age; because here, as elsewhere, the accumulation of museums must always precede the establishment in any large and effectual way of the higher grade of scientific schools. A knowledge of this fact, has I confess stimulated my own efforts in behalf of this museum and that of the university, since I hoped that here, as in the old world, the collection of objects would afford a safe basis for the erection of scientific education. There are some branches of knowledge and culture, and these very valuable in themselves and the training they afford, which require nothing but teachers and books for their successful prosecution. But training in science, to attain to any useful results, must have large preparatory appliances in collections and apparatus. This along with the apathy which naturally exists as to anything of which the public has had no previous experience, is no doubt, a cause of the lamentable fact that Canada has not yet attained to the establishment of one scientific school, while in the mother country, in the various states of the continent of Europe, and also in the United States of America, such schools largely supported and admirably appointed exist in great numbers, and are productive of immense results in the promotion of the scientific arts and manufactures. In the Christmas vacation I enjoyed the pleasure of visiting some of these institutions in the United States, in which the means of old University foundations are made available, along with modern donations and grants, for the cultivation of practical science. Such institutions are furnished with laboratories, museums, scientific libraries and apparatus; and their courses of study embrance such subjects as Mining, Metallurgy, Agriculture, Botany, Zoology. Geology, Mineralogy, Engineering, Architecture, Drawing, Military Science and Tactics, Practical Mechanics, Astronomy; all eminently practical, and arranged so as to suit the wants of young men entering on a variety of useful trades and professions. Although these institutions are numerous and largely attended, they have not yet reached the limits of the demand for their work, and large grants in their aid have recently been made by Congress, while State Legislature and the munificence of private individuals are daily adding to their number and efficiency. It should be a fact that requires but to be mentioned to excite earnest inquiry and effort, that while all the older universities in the United States have scientific schools, and while multitudes of similiar schools are supported by the several States and the general government, we have in this Dominion four States, certainly equal in resources to any of those in the American Union, without a scientific school. In the mother country the subject is attracting great attention. I have just read a report presented to the House of Commons last year by a select Committee on Scientific Instruction, which after hearing the evidence of a number of leading Professors, Teachers and Educationists, strongly recommends to Parliament to proceed at once to organize the technical education of the country, and to add to the existing means as far as possible; and further, to recognize natural science as an indispensable element in such education. This report will, no doubt, be acted on soon, probably before anything can be done in this country, and we shall have the satisfaction of being another step behind the mother country in this most important matter. It may be asked what connection has all this with this Society, and with the present occasion. One such connection is, that this

Society would derive aid from every graduate of any Scientific school established here; and on the other hand, it can never attain for its collections their full utility, until there should be such schools. Another is, that while as President of this Society I have its immediate interests in view, I have also at heart the advantage of the young men growing up among us, and whom I should wish to see rising to something higher than the position of subordinates to men trained in other countries; and with this feeling, I propose, on every fitting occasion, and I regard this as one, to insist as strongly as I can on the necessity of schools of practical science to the welfare and progress of this country.

VISIT OF HIS EXCELLENCY THE GOVERNOR GENERAL.

At the Court House, on the morning of the second of February, the following address to His Excellency was presented and read by the President, Principal Dawson. The President was accompanied by Sir W. E. Logan, Dr. T. Sterry Hunt, Dr. Smallwood, Dr. J. Baker Edwards and other officers and members of the Society.

To His Excellency the Right Honourable Sir JOHN YOUNG, Bart., G.C.B., G.C.M.G., &c., &c., Governor General of the Dominion of Canada, &c., &c.

May it please your Excellency:

We, the President, Vice Presidents, and Members of the Natural History Society of Montreal, beg leave to approach Your Excellency with our most respectful salutations and most cordial welcome on this your first visit to Montreal, and to tender our hearty congratulations on your assumption of the government of this Dominion.

The Institution which we have the honour of representing is one of the oldest in Montreal, and has ever had for its chief object the advancement of the study of Natural Science in this city and throughout Canada. To this end it has striven amid much difficulty, but with some success, to establish a museum of Natural History and Archæology, and a library of scientific works, to which we respectfully invite the inspection of Your Excellency. It also, by its papers periodically read, its lectures, and its organ the Canadian Naturalist, and such other means as it may command, seeks to promote original investigation and to foster a taste for the study of nature so far as it can make its influence extend.

Believing that the objects of our Society, and especially that which tends to diffuse a knowledge of the products of this country, will command the sympathy of Your Excellency, as they did that of Your Excellency's predecessors, who took a warm interest in its operations and success, we venture now to solicit the honour of being allowed to name Your Excellency as Patron of the Natural History Society of Montreal.

We beg, in conclusion, to express our hope that the residence of Your Excellency in this country may prove as agreeable to yourself and Lady Young, as we are assured it will be beneficial to all its best interests.

We have the honour to be,
Your Excellency's very obedient Servants:

(Signed) J. W. Dawson, LL.D., F.R.S.
A. De Sola, LL.D.
E. Billings, F.G.S.
W. E. Logan, LL.D., F.R.S.
T. Sterry Hunt, L.LD., F.R.S.
C. Smallwood, M.D., LL.D., D.C.L.
J. F. Whiteaves, F.G.S.
J. Baker Edwards, F.C.S.
(And other Members.)

To which His Excellency delivered the following reply.

To the President, Vice Presidents, and Members of the Natural History Society of Montreal.

Mr. President and Members:—In the study of Natural Science, which is the object of your Institution to encourage, I recognize one of the most agreeable exercises for the intellectual faculties, as well as a rich mine for exploration in the interests of the practical arts and of the material comfort and advancement of the community. I hope to have, either now or at some future early occasion, the pleasure and advantage of visiting the Museum which you worthily laboured to establish.

I tender you many thanks for the complimentary terms of your welcome, as well as for the kind wishes you express, that Lady Young's and my residence in Canada may prove useful to the country and agreeable to ourselves.

(Signed,) John Young.

His Excellency also stated verbally that he should be happy to become Patron of the Society.

On the afternoon of February 3rd, His Excellency visited the Society's Museum. He was accompanied by His Worship the Mayor, Col. McNeil, A.D.C., Lieut. Col. Duchesnay, P.A.D.C., Mr. Turville, Lieut. Gov. Howland, Hon. A. Campbell, Hon. John Rose and C. E. Lee, Esq. At the Society's rooms His Excellency was received by the President, Principal Dawson, Rev. Dr. De Sola, Hon. Jas. Ferrier, Dr. Smallwood, Dr. J. B. Edwards, and others. He examined with care the collection of North American and exotic mammalia and birds, the more interesting features of which were explained by Principal Dawson, and Mr. Whiteaves. The visit lasted about an hour, during which the Governor General expressed his gratification at the interest taken in the study of Natural History in Montreal, and the pleasure which his visit had afforded him.

GEOLOGY AND MINERALOGY.

The Wakefield Cave.—Though Sir Duncan Gibb has enumerated no less than thirty Canadian caverns, they are for the most part insignificant and scarcely deserving of the name. The Wakefield Cave, recently described by Dr. Grant, F. G. S., in a paper read before the Natural History Society of Ottawa is more important. It is thus described by Dr. Grant:—

"North from Ottawa, in an almost direct line, *viâ* the Portland Road distant eighteen miles, on the farm of Mr. Pellessier, is the "*Wakefield Cave.*" It is situated on the side of one of the Laurentian Mountains, and faces the North. The mouth of the cave is fully eighteen feet in diameter, of an oval shape, beautifully arched and having overhanging it pine and cedar trees of considerable size. The entire height of the mountain is about 300 feet, and the entrance to the cave is about 100 feet from the summit. At the base of the mountain is a small lake, which discharges into the Gatineau River through a mountain gorge of exquisite beauty. Looking inwards from the mouth of the cave it is funnel shaped, directed obliquely forwards and downwards, a distance of seventy-four feet, at which point it is contracted to a height of five feet and width of fifteen feet. This contraction forms the entrance to the first "*Grand Chamber*," eighty feet in length, twenty-one feet across and nine feet in height thoughout. At the posterior part of this chamber, in an oblique direction to the left, is an opening five feet in height, forming the entrance to the third chamber, which is about eighteen feet in diameter and five feet high. The floor, however, is covered with *calcareous breccia* to a depth of three feet or more. Looking outwards, two openings are to be seen to the left of the first chamber, one anterior, broad and elevated, and one posterior, contracted and shallow, passing obliquely upwards and backwards, a distance of fully twenty-five feet. This chamber is entirely encrusted with carbonate of lime of a cheesy consistence, and in the centre, a perfectly white column reaches from the floor to the ceiling, about six inches in diameter, formed by the union of a stalactite and stalagmite. The antero-lateral chamber passes in an oblique direction upwards, a distance of thirty feet, at which point the ceiling is fully fifty feet high, of a gothic shape, and beautifully ornamented with stalactites and fringe like encrustations of carbonate of lime. About sixty feet from the mouth of the cave to the right, is a narrow passage, rough, uneven, and forming the entrance to a chamber the floor of which ascends obliquely upwards a distance of thirty feet, the height of this point being about fifty feet. On the way up a beautiful arch is to be seen, above and beneath which this chamber communicates with the one entered by the antero-lateral opening from the "*Grand Chamber*," and the light reflected from a lamp through the opening below this arch illuminates the entire ceiling of the adjoining chamber and presents a rich appearance as seen through the opening above the arch. To the right of the oblique floor of the antero-lateral cavity, is an opening horse-shoe shaped, scalloped, about five feet in diameter, and considerably obscured by the over-hanging rock. From the body of the cave, the passage leading from this opening takes a direction at an angle of about 25° to the right. Its entire length is about 270 feet, height between four and five feet, and width the same. The floor is rough and covered with small fragments of rock of various sizes and from the ceiling hang many small stalactites. At the inner terminus of this passage is an opening more or less circular, about twenty feet in diameter, and the rock over it is concave, and fully fifteen feet in height. Stones thrown into this well or cavity give rise to a loud rumbling noise. Its depth is thirty.seven feet, and the bottom measured nine feet by thirty feet, on either side of which are two openings, one five feet by twelve feet, twenty-two feet in depth, the othor two feet by three feet, and forty-five feet in depth. The floors of these lower cavities are covered with fine sand, and on every side are to be seen beautiful stalactites. On the right and left of the main passages of this well are to be observed several smaller passages, which from their narrowness, are entered with difficulty. The entire cavern presents a water-worn appearance, more or less smooth on the surface, of a light gray color, and considerably excavated at intervals. Here and there, in each chamber, particularly from the ceilings, are to be seen rough projecting portions of rock of various shapes and composed chiefly of quartzite, pyroxene, serpentine, iron pyrites, and various mineral ingredients peculiar to the Crystalline Laurentian limestone formations. In many parts of the cave the walls, particularly those to the right of each chamber entered, were covered with moderately uniform sheets of carbonate of lime. The cavern is entered by descending on talus or broken rock; this is succeeded by a floor, partly flat, smooth and presenting also a water-worn appearance. Generally speaking, the floor is uneven and strewed with fragments of rock of various sizes, more or less mixed up with broken stalactites and shelved portions of carbonate of lime. The entire cave, excepting the entrance, is perfectly devoid of light; the atmosphere moist, but exceedingly pure, even to the extent of our explorations, and a uniform temperature of about 45° Fahrenheit. The only organic remains so far discovered were those of the *Vulpes Vulgaris* or common fox, Castor Fiber (Lin) or Beaver, Lutra Vulgaris (Lin) or Otter, and a few drift shells. From the purity of atmosphere in the entire cave, the opinion formed from that fact is, that any accumulating carbonic acid is absorbed by water in some part of the unexplored portion of the cave, and it is not unlikely that parts already visited are only an entrance to vast labyrinths yet to be explored."

It is to be hoped that Dr. Grant will pursue the exploration of this cave; more especially with the view of ascertaining whether any remains of pre-historic man, or of post pliocene animals occur in the accumulation on its floors. J. W. D.

GEOLOGICAL TIME.—Mr. Croll, of the Geological Survey of Scotland, has published a series of suggestive articles in the Philosophical Magazine on the "Date of the Glacial and the Upper Miocene Period." He presents a number of very interesting calculations, not only bearing on these questions, but also on the entire age of the earth, and on the relative duration of geological periods. Of course in such inquiries much is conjectural, and the most precise calculations may be vitiated by uncertainties as to the data. Still anything having even the aspect of arithmetical results is preferable to the vague assumption of indefinite periods, and may at length lead to reliable conclusions. In the meantime we give the following as an illustration of the manner in which Mr. Croll deals with the subject:—

"But is it the case that geology really requires such enormous periods as is generally supposed? At present, geological estimates of time are little else than mere conjectures. Geological science has hitherto afforded no trustworthy means of estimating the positive length of geological epochs. Geological phenomena tell us most emphatically that these periods must be long; but how long, these phenomena have, as yet, failed to inform us. Geological phenomena represent time to the mind under a most striking and imposing form. They present to the eye, as it were, a sensuous representation of time; the mind thus becomes deeply impressed with a sense of immense duration; and when one under these feelings is called upon to put down in figures what he believes will represent that duration, he is very apt to be deceived. If, for example, a million of years as represented by geological phenomena and a million of years as represented by figures were placed before our eyes, we should certainly feel startled. We should probably feel that a unit with six ciphers after it was really something far more formidable than we had hitherto supposed it to be. Could we stand upon the edge of a gorge a mile and a half in depth that has been cut out of the solid rock by a tiny stream, scarcely visible at the bottom of this fearful abyss, and were we informed that this little streamlet was able to wear off annually only $\frac{1}{10}$ of an inch from its rocky bed, what would our conceptions be of the prodigious length of time that this stream must have taken to excavate the gorge? We should certainly feel startled when, on making the necessary calculations, we found that the stream had performed this enormous amount of work in something less than a million of years.

If we could possibly form some adequate conception of a period so prodigious as one hundred millions of years, we should not then feel so dissatisfied at being told that the age of the earth's crust is not greater than that.

Here is one way of conveying to the mind some idea of what a million of years really is. Take a narrow strip of paper an inch broad, or more, and 83 feet 4 inches in length, and stretch it along the wall of a large hall, or round the wall of an apartment somewhat over 20 feet square. Recall to memory the days of your boyhood, so as to get some adequate conception of what a period of a hundred years is. Then mark off from one of the end of a strip $\frac{1}{10}$ of an inch. The $\frac{1}{10}$ of the inch will then represent one hundred years, and the entire length of the strip a million of years. It is well worth making the experiment, just in order to feel the striking impression that it produces on the mind.

The methods which have been adopted in estimating geological time not only fail to give us the positive length of geological periods, but some of them are actually calculated to mislead. The method of calculating the length of a period from the thickness of the stratified rocks belonging to that period can give no reliable estimate; for the thickness of the deposit will depend upon a great many circumstances, such as whether the deposition took place near to land or far away in the deep recesses of the ocean, whether it took plaee at the mouth of a great river or along the sea-shore, whether it took place when the sea-bottom was rising, subsiding, or remaining stationary. Stratified formations 10,000 feet in thickness, for example, may, under some conditions, have been formed in as many years, while under other conditions it may have required as many centuries. Nothing whatever can be safely inferred as to the absolute length of a period from the thickness of the stratified formations belonging to that period. Neither will this method give us a trustworthy estimate of the *relative* lengths of geologieal periods. Suppose we find the average thickness of the Cambrian rocks to be 26,000 feet, the Silurian to be 28,000 feet, the Devonian to be 6000 feet, and the Tertiary to be 10,000 feet, it would not be safe to assume, as is sometimes done, that the relative duration of those periods must have corresponded to these numbers. Were we sure that we had got the correct average thickness of all the rocks belonging to each of those formations, we might probably be able to arrive at the relative lengths of those periods; but we can never be sure of this. Those formations all, at one time, formed sea-bottoms; and we can only measure those deposits that are now raised above the sea level. But is it not probable that the relative positions of the sea and land during the Cambrian, Silurian, Old-Red-Sandstone, Carboniferous, and other early periods of the earth's history differed more from the present relative positions than the relative positions of sea and land during the Tertiary period differed from the relative positions which obtain at present? May not the greater portion of the Tertiary deposits be still under the sea-bottom? And if this be the case, it may yet be found at some day in the distant future, when these deposits are elevated into dry land, that they are much thicker than we now conclude them to be. It is simply asserted that they *may* be thicker for anything that we know to the contrary; and the possibility that they may, destroys our confidence in the accuracy of this method of determining the relative lengths of geological periods.

The palæontological method of estimating geological time, either absolute or relative, from the rate at which species change appears to be even still more unsatisfactory. If we could ascertain by some means or other the time that has elapsed from some given epoch (say, for example, the glacial) till the present day, and were we sure at the same time that species have changed at an uniform rate during all past ages, then, by ascertaining the percentage of change that has taken place since the glacial epoch, we should have a means of making something like a rough estimate of the length of the various periods. But without some such period to start with, the palæontological method is useless. It will not do to take the historic period as a base-line. It is far too short to be used with safety in determing the distance of periods so remote as those which concern the geologist. But even supposing the palæontologist had a period of sufficient length measured off correctly to begin with, his results would still be unsatisfactory; for it is perfectly obvious, that unless the climatic conditions of the globe during the various periods were nearly the same, the rate at which the species change would certainly not be uniform. But we have evidence, geological as well as cosmical, that the climate of our globe has at various periods undergone changes of the most excessive character.

The palæontological method, as we have already seen, will give 60 millions of years or 240 millions of years as the period that has elapsed since the commencement of the Cambrian period, just as we choose to adopt 250,000 years ago or 1,000,000 years ago as the commencement of the glacial epoch.

It is the modern and philosophic doctrine of uniformity that has chiefly led geologists to overestimate the length of geological periods. This philosophic school teaches, and that truly, that the great changes undergone by the earth's crust must have been produced not by great convulsions and cataclysms of nature, but by those ordinary agencies that we see at work every day around us, such as rain, snow, frost, ice, and chemical action, &c. It teaches that the valleys were not produced by violent dislocations, nor the hills by sudden upheavals, but that they were actually carved out of the solid rock by the silent and gentle agency of chemical action, frost, rain, ice, and running water. It teaches, in short, that the rocky face of our globe has been carved into hill and dale, and ultimately worn down to the sea-level, by means of these apparently trifling agents, not only once or twice, but probably dozens of times over during past ages. Now, when we reflect that with such extreme slowness do these agents perform their work, that we might watch their operations from year to year, and from century to century, if we could, without being able to perceive that they make any very sensible advance, we are necessitated to conclude that geological periods must be enormous. And the conclusion at which we thus arrive is undoubtedly correct. It is, in fact, impossible to form an adequate conception of the length of geological time. It is something too vast to be fully grasped by our conceptions. What those to whom we have been alluding err in is not in forming too great a conception of the extent of geological periods, but in the way in which they represent the length of these periods in numbers. When we speak of units, tens, hundreds, thousands, we can form some notion of what these quantities represent; but when we come to millions, tens of millions, hundreds of millions, thousands of millions, the mind is then totally unable to follow, and we can only use these numbers as representations of quantities that turn up in calculation. We know, from the way in which they do turn up in our process of calculation, whether they are correct representations of things in actual nature or not; but we could not, from a mere comparison of these quantities which the thing represented by them, say whether they were actually too small or too great. It is here that some geologists have erred: they have not made the necessary calculations, and found by the known rule of arithmetic that 100,000,000 is to small a number to represent in years the probable age of the earth's crust; but they look first at the phenomena and then at the figures; and as the two produce totally different impressions, they pronounce the figures to be too small to represent the phenomena.

If the geologist could find a method of ascertaining the actual rate at which these denuding agents do perform their work; if it could be ascertained at what rate the face of the country is at present being denuded, how much, for example, per annum the general level of the country is being lowered and the valleys deepened, then we should have a means of ascertaining whether or not the agents to which we refer were really capable of producing the required amount of change in the earth's surface in the allotted time. But mere conjectures in the absence of some positive determinations are worse than useless."

Mr. Croll then proceeds to state that there is an available method afforded by the measurable rate of denudation of our continents by sub-aerial and oceanic agencies, and enters into elaborate calculations as to this rate in different regions, and at different geological times. The results are very curious and interesting, but the completion of the series of papers, containing the final conclusions of the writer, has not yet reached us.

J. W. D.

Deep-Sea Dredging in Its Relations to Geology.—The proceedings of the Royal Society contain a most interesting Report of Dr. Carpenter and Dr. Wyville Thomson, of dredgings conducted by them in 1868, at depths previously reached only by the comparatively inefficient means of the sounding line. In their deepest dredgings, 650 fathoms, they brought up not only Foraminiferœ, but sponges and star-fishes allied to Ophiura, thus showing that a somewhat varied life exists at these great depths. At this great depth, also, they found the calcareous mud of the bottom penetrated and covered with that diffused protoplasmic or sarcodic substance which Prof. Huxley has named *Bathybius*, and which seems to be an organism even less specialised than the ordinary Rhizopods, and to be, perhaps, a representative in the modern seas of the primeval Eozoon of the Laurentian rocks. Another remarkable discovery is that of the existence of a minimum temperature of 32° Fahrenheit at the sea-bottom, in depths of 500 fathoms or more, in the ocean westward of Great Britain. This is a proof by actual thermometric observation of a fact on which the writer of this notice has long insisted on other grounds, viz., that cold and dense currents of water flow over the sea bottom; and must be taken into the account in our reasonings as to erosion and the distribution of life in the glacial period. Those who have hitherto denied this will now have an opportunity to modify some of their views with regard to Post-pliocene Geology. Other applications of these researches to Geology will be seen in the following extract :—

"It can be scarcely necessary to point out in detail those various important applications of the foregoing conclusions to Geological science, which will at once occur to every Geologist who endeavours to interpret the past history of our globe by the light of the changes it is at present undergoing. But this Report would not be completed without some notice of these.—In the first place, it may, I think, be considered as proved that no valid inference can be drawn from either the absence or the scantiness of Organic Remains in any unmetamorphosed sedimentary rock, *as to the depth at which it was deposited.* So far from the deepest waters being *azoic*, it has been shown that they may be peculiarly rich in Animal life. On the other hand, comparatively shallow waters may be almost *azoic*, if their temperature be low or their currents be strong; and thus even littoral formations may show but few traces of the life that might be abundant on a deeper bottom at no great distance.—Again, it has been shown that two deposits may be taking place within a few miles of each other, *at the same depth and on the same geological horizon* (the area of one penetrating, so to speak, the area of the other), of which the Mineral character and the Fauna are alike different,—that difference being due on the one hand to the *direction of the current* which has furnished their materials, and on the other to the *temperature of the water* brought by that current. If our "cold area" were to be raised above the surface, so that the deposit at present in progress upon its bottom should become the subject of examination by some Geologist of the future, he would find this to consist of a barren Sandstone, including fragments of older rocks, the scanty Fauna of which would in great degree bear a Boreal character; whilst if a portion of our "warm area" were elevated at the same time with the "cold area," the Geologist would be perplexed by the *stratigraphical continuity* of a Cretaceous formation, including not only an extraordinary abundance of Sponges, but a great variety of other Animal remains, several of them belonging to the warmer Temperate region, with the barren Sandstone whose scanty Fauna indicates a widely different climatic condition, which he would naturally suppose to have prevailed at a different period. And yet these two conditions have been shown to exist *simultaneously* at *corresponding depths*, over *wide contiguous areas* of the sea-bottom; in virtue solely of the fact that one area is traversed by an *Equatorial* and the other by a *Polar* current *. Further, in the midst of the land formed by the elevation of the "cold area," our Geologist will find a hill of some 1800 feet high, covered with a Sandstone continuous with that of the land from which it rises, but rich in remains of Animals belonging to a more temperate province; and might easily fall into the mistake of supposing that two such different Faunæ, occurring at different levels, must indicate two distinct climates separated in time, instead of indicating, as they have been shown to do, two contemporaneous but dissimilar climates, separated only by a few miles horizontally, and by 300 fathoms vertically.—It seems scarcely possible to exaggerate the importance of these facts, in their Geological and Palæontological relations, especially in regard to those more localized Formations which are especially characteristic of the later Geological epochs. But even in regard to those older Rocks, whose wide range in space and time would seem to indicate a general prevalence of similar conditions, it may be suggested whether a difference of bottom-temperature, depending upon deep oceanic currents, was not the chief determining cause of that remarkable contrast between the Faunæ of different areas in the same Formation, which is indicated by the abundance and variety of the Fossils of one locality, and their scantiness and limitation of type in another; as is seen, for example, when the "Primordial Zone" of Barrande is compared with its equivalent

* It may be said that the asserted existence of these Currents is a mere hypothesis, until an actual movement of water in opposite directions has been substantiated. But, as Prof Buff has pointed out, the existence of such deep currents is a necessary consequence of the difference of surface-temperature between Equatorial and Polar waters; and those who raise the objection are consequently bound to offer some other conceivable hypothesis on which the facts above stated can be accounted far.

in North Wales.—Further, in the case of those Calcareous deposits which owe their very existence to the vast development of Organisms that possessed the power of separating Carbonate of Lime from the ocean-waters, *temperature* may be pretty certainly assumed to be the chief condition, not merely of the character of the Animal remains which those formations may include, but of the very production of their solid material."

CALAMITES AND CALAMODENDRON. — (*Flora of the Carboniferous Strata.*)—Binney, Memoirs of Palæontographical Society, vol. xxi.

A wit who had been bored with the inspection of the stony treasures of a "fossil" botanist, once said that the latter had shown him all his "Calamities and felicities," and Mr. Binney would seem to agree as to the character of the *Calamites*, since he endeavours, though apparently with some scruples, to extinguish the genus altogether. On this point we must take issue with him, and try to maintain the cause of the proscribed Calamite. The case stands thus: In the coal formation, one of the most common kinds of fossil plants is that on which the genera *Calamites* and *Calamodendron* or *Calamitea* have been founded. They have cylindrical stems, with longitudinal narrow ribs and transverse joints. This is the common character of the whole, but when more narrowly examined they resolve themselves into two distinct groups. The first and most common is that including stems with somewhat flat ribs, coated with a very thin coaly bark, and having, when well preserved, at the top of each rib where it reaches one of the transverse joints, a round or oval mark or cicatrice from which a leaf or branchlet has been broken off. Plants of this kind are seen erect in the sandstones, with their outer bark perfectly preserved, and with their roots and leaves attached. The writer has specimens of two species in his collection, showing the leaves in one species and the thin branchlets bearing leaves in another, attached to the surface of the cylindrical jointed ribbed stem, and he has other specimens as unequivocally showing the bases of such stems, giving off roots and also budding out into secondary stems. Farther, such stems were described and figured by him in the Journal of the Geological Society, vol. x., p. 35, in a paper to which Mr. Binney does not refer, though he mentions other papers in which the fact is less explicitly noticed. It may be added that Goeppert and Geinitz have shewn that these plants had a thin internal investment of vascular tissue, having somewhat large vessels with numerous rows of pores, a curious and peculiar form of scalariform tissue which will be found figured in Acadian Geology, page 442, where leaves of Calamites actually found attached to the stems are also figured.*

The plants above described are the true *Calamites*, of which several species occur in the Devonian and Carboniferous; though except when the stems are very well preserved or have the leaves attached, it is difficult to fix the limits of these species; and it is probable that many have been named which are merely varieties, depending on the age of the stems or their state of preservation.

But beside these there occur striated and jointed stems of a very different character. Their internodes are usually, though not always, short, they have no distinct scars at the nodes, their ribs are usually narrower and more angular; and when found well preserved, instead of being entire stems, they prove to be casts of an internal cavity surrounded by a thick woody envelope disposed in radiating wedges, and exhibiting not true scalariform tissue, but wood-cells with bordered pores under that transversely elongated variety in which they occur in the axes of Cycads and the inner layer of the axes of Sigillaria, along with round pores,—also similar to those of Cycads. Stems of this kind have usually been described as Calamites, and many of them have been included under the species *C. approximatus*, but they are evidently very different from the ordinary Calamites, and of much higher organization, approaching in this respect to Sigillariæ. Unfortunately their external surface is not well preserved, but it appears to have been destitute of transverse joints, and to have been irregularly ribbed, at least near the base of the stem. Brongniart places them with the Asterophyllites,† and suggests that some of the leaves referred to that genus may have belonged to Calamodendron; but so far there is no certain evidence of this. Brongniart has on the whole very accurately stated the distinction between the two genera, Calamites and Calamodendron, in the work already cited; as the writer has amply satisfied himself by the study of the beautiful Calamite brakes so well exposed in the cliffs of the South Joggins section, and of several

* See also paper on Structures in Coal. Journal of Geological Society 1860, p. xviii., fig. 11.

† Tableau des genres, 1849.

stems of Calamodendron showing structure. Cotta, who originally described the structure of Calamodendron, named the genus *Calamitea*, and figured what he regarded as four distinct species in his "Dendrolithen." Brongniart regards two of the four species as probably coniferous; and for this reason, as well as the too close resemblance of the names Calamitea and Calamites, proposes for the genus the name *Calamodendron*.

Mr. Binney, in the monograph before us, has figured portions of four specimens having internal striated or ribbed axes, and radiating bundles of wood-cells with transversely elongated pores, of the type already referred to, and which also occur in the remarkable *Protopitys* of Goeppert from the lower carboniferous of Silesia. Mr. Binney refers all his specimens to one species, *Calamodendron commune*, though one of them certainly appears to differ sufficiently from the others to warrant a specific distinction. The question what these specimens really are, with relation to described genera of carboniferous plants, is, however, somewhat difficult to settle, in the absence of the alternating zones of wood-cells and peculiar medullary rays of Calamitea as described by Cotta and Unger, and characterized by Brongniart as an organization "*toute speciale*." This difference should have suggested some doubt as to the identity of these curious specimens with Calamodendron; and we think it not improbable that they will be found on further investigation to be entirely distinct from Calamitea of Cotta or Calamodendron of Brongniart. On the other hand it is perfectly clear that they have no connection whatever with Calamites proper, and cannot even belong to the same family with that genus, with which they have in reality no closer connection than that of accidental similarity of markings. Mr. Binney's specimens are, however, evidently nearer to Calamodendron than to Calamites; and this is all that can be said of them with safety with our present information.

It is singular that Mr. Binney, who described erect Calamites in 1847, and who is well acquainted with erect Sigillariæ, should not perceive that the fact of the former standing erect in sandstone, with their roots attached as Mr. Binney has observed, and even with their leaves attached to the nodes as the writer showed in his paper of 1854, is absolute proof that they are not internal axes, but in reality casts of entire stems.

It is also somewhat strange to find such a statement as that on page 17 that "for many years Asterophyllites has been known as "the leaves of Calamites." This will be new to most Palæobotanists, more especially when they turn to plate xv. and find a plant figured as "*Asterophyllites longifolia*" which appears, if correctly represented, to be an *Annularia*, not far removed from, if not identical with Annularia longifolia, a plant usually regarded as distinct from Asterophyllites. Now it is true that Brongniart has suggested that Asterophyllites may be branches of Calamodendron, and it is possible that this may be the case, as the leaves of Calamodendron are not certainly known, but the leaves of Calamites are well known, and have been figured by Lindley and Hutton, by Geinitz and by the writer, and they may be easily distinguished by very simple characters from those of Asterophyllites and Annularia, which they resemble merely in their verticillate arrangement. The leaves of the species C. Cistii and C. Suckovii and C. Nodosus, all of which the writer has seen, are aculeate, thick and apparently triangular in cross section, and finely striate without any distinct rib. Those of Asterophyllites and Annularia are flat, and with a conspicuous median nerve. Badly preserved specimens of leaves of such species as *Asterophyllites longifolia* might be mistaken for Calamite leaves, but the characters of the genera are sufficiently distinct, and in so far as the writer's experience has extended, there is little evidence even of the association of Calamites and Asterophyllites in the same localities.

We had intended to make some remark on the curious statement at page 15, as to fossilization, in connection with Professor Graham's discovery of Dialysis, which seems to ignore the fact that this whole subject has been again and again illustrated most fully both microscopically and chemically. We may, however, content ourselves with remarking in general, on this and some similar statements, that they are not so much matters of blame to Mr. Binney personally, as evidences of the remarkable neglect in England of the scientific pursuit of fossil botany. Though we cannot admit that Mr. Binney has in his monograph added much that is new to our knowledge of Calamites and Calamondendron, yet he has figured well several curious specimens of stems and some remarkable strobiles, the interpretation of which will come in due time; and for that we have good reason to thank him. More especially have we reason to do so, in view of the almost incredible fact that this is the first time the Palæontographical Society, in the twenty-one years in which it has flourished, has recognized the existence of vegetable fossils; and this at a time when the coal mines of England have probably reached their maximum of production, and when precious specimens, in quantity unsurpassed in any other country, are weathering on the rubbish heaps of the mines, or lying unnoticed in collections public and private. We should add that this omission is not to be remedied by the repetition of isolated and imperfect efforts like that in the present monograph; but by associating the few competent cultivators of fossil botany into a committee of discovery, to ransack the existing collections and to prepare monographs exhaustive of their material with reference to each genus. J. W. D.

PRE-HISTORIC MAN IN FRANCE.

(*Reliquiæ Aquitanicæ*, by EDOUARD LARTET & HENRY CHRISTY.)—Of this valuable work, which is intended to be completed in twenty parts, seven are now published. Though the name includes a large part of the south-east of France, it is more particularly devoted to the interesting pre-historic antiquities which have been collected in that part of Périgord which comprises the Arrondissement of Sarlet in the Department of Dordogne.

The remains are usually found in caves or "rock shelters" overlooking the rivers, and formed by the action of the atmosphere in wearing away the softer beds of rock.

"The two sides of the valley rise in great escarpments of massive rock, more or less interrupted by ancient falls. Their summit is usually crowned with projecting cornices, below which are great horizontal niches, or hollow flutings. These great flutings are strikingly evident at the same level on the two sides of the valley where the escarpments overlook the river, and where they are continued in the rocks bordering the lateral valley, down which small streams run into the Vézere."

The implements found in these caves consist wholly of chipped flint, and reindeer horn; associated with large quantities of bones of reindeer, horse, aurochs, &c. No polished stone implements have been found, nor bones of domesticated animals, which are supposed to have belonged to a much later period. The flint implements are principally of four kinds; nuclei or cores, flakes, worked spear and arrow heads, and scrapers. The nuclei are blocks of flint which have been used to supply flakes from time to time, and have thus been gradually split down to long or conical shapes. Flake is a word used to designate any rough chip of flint of undeterminable form, which may have been used for any household purpose from a knife to an awl. The spear and arrow-heads are of all sizes, and sometimes very neatly worked, and finely chipped along the edges, they are of all forms, from long and tapering to very short and blunt. There seem also to have been different modes of fastening them to the haft, as some are equally pointed at both sides, others simply rounded, and others again notched. The scrapers are generally somewhat blunt at the edges, more or less pointed behind for fastening into a handle, and often rounded for the hand. They were used mostly for preparing and dressing skins.

A considerable number of water-rounded, flattish pebbles, bearing a shallow artificial hollow on one side, have been found. These may have been used for preparing paint for personal decoration, or grinding up small quantities of grain; but some of them seem too small for even such purposes.

The most curious and interesting implements are those of bone, and reindeer and stag antler. On these great labour seems to have been expended, and some of them are not only neatly finished but highly ornamented, mostly with drawings of animals of the period. These very interesting works of art are sometimes executed with great spirit, and though often much out of proportion, are drawn in all essential points with fidelity to nature. The bone and horn implements comprise spear heads, harpoon heads, clubs, and other minor kinds of not very well defined uses. Among these last, is a very curious style of implement, made of deer antler; flat and thin, and usually pierced with a row of holes, sometimes large enough to admit the finger. They seem too thin and weak to have been used for any kind of work; and concerning them, a variety of conjectures have been hazarded, among others that they have been used as sceptres or symbols of authority. Their use, however, is still considered undeterminable.

The bone spear heads are usually very long and pointed, and circular in section. These, however, are rare, in comparison with the harpoon points, which have been found in great number. They are long and narrow, with a succession of barbs extending sometimes almost from end to end. They are generally somewhat blunt at the point, which seems to indicate that they were used for harpooning fish; some of the smaller ones may, however, have been arrow heads. The barbs differ much in size, shape, and arrangement, but nearly all agree in having notches or grooves on their surface; these, it is thought, may have served for holding some poison. The club is simply the beam of an antler, so arranged that the stump of one of the side antlers served as a point with which a very severe blow might, no doubt, be struck. The clubs are often very neatly made, and smoothed, and notched at the small end to afford a firm grasp to the hand. They bear a great analogy to the "Puck-â-maugun" of the Indians of North West America.

The drawings found on these implements of bone and antler, usually represent the horse, reindeer, stag, and auroch; these animals seeming to have been the staple food of the cave-dwellers. There appear also, though more rarely, drawings of fish. On one piece of bone there is a rough representation of a human figure, certainly not very flattering to the man of the period.

A description of the opening of one of these bone caves, (that of Cro-Magnon), is given in great detail. It was discovered by the removal of the accumulated talus from the foot of one of the cliffs overlooking the Vezère, for the construction of a railway embankment. It was a broad, but deep natural cavity, sheltered by a projecting ledge of hard rock. This cave was systematically worked out, and the history of its occupation by pre-historic man read by the deposits of ashes, etc., contained in it.

The first visit paid to this cave by the hunters of the reindeer, is represented by a broad but shallow deposit of ashes and charcoal, containing worked flints and broken and calcined bones, and in its upper portion the stump of an elephant's tusk. After this first visit, it seems to have been unoccupied for a long period of time which is represented by a thick layer of debris, slowly accumulated by the weathering of the roof and walls. Above this is another thin layer of ashes, and then another layer of calcareous debris. Lastly, there is a thick series of beds of ashes, which seem to indicate that the cave was from this time used continuously as a place of residence; or at least so continuously as not to allow of the intercalation of any roof debris. These beds of ashes are full of pieces of charcoal, bones, pebbles of quartz, worked flints, flint cores, and bone implements. The cave, in fact appears to have been used as a place of residence till the accumulated ashes and rubbish of the inhabitants, had rendered it too small and narrow. It was then abandoned, and above the last ash bed there is another thick deposit of roof debris. After this last deposit had increased to a considerable thickness, and the cave was just high enough to crawl into, it was used as a place of sepulture. At the very back of the cave and partly buried in calcareous debris, were found bones referable to five human skeletons. Among these, the most perfect skulls were those of an old man and of a woman. The woman's skull had been pierced by some pointed instrument (in shape answering very well to that of one of the flint lance heads) which had been the cause of her death. Death did not, however, ensue immediately, as the edges of the cut were partly healed up; indeed, it is the opinion of physicians to whom it has been referred that she survived several weeks.

M. Louis Lartet writes, at p. 70, "Amidst the human remains lay a multitude of marine shells (about 300) each pierced with a hole, and nearly all belonging to the species *Littorina littorea*, so common on our Atlantic coasts. Some other species, such as *Purpura lapillus*, *Turritella communis*, &c., occur, but in small numbers. These also are perforated, and, like the others, have been used for necklaces, bracelets, or other ornamental attire. Not far from the skeletons I found a pendant or amulet of ivory, oval, flat, and pierced with two holes. M. Laganne had already a smaller specimen; and M. Ch. Grenier, schoolmaster at Des Eyzies, has kindly given me another, quite similar, which he had received from one of his pupils. There were also found near the skeletons several perforated teeth, a large block of gneiss; also worked antlers of reindeer, and chipped flints of the same types as these found in the hearth layers underneath." The bones found in this cave comprised, besides the commoner kinds as those of the reindeer, horse, &c., those of an enormous bear, of the mammoth, of the great Cave-Lion, &c. Another peculiarity of this cave is the absence of any engraving or carving. "Hence, we may refer this station of Cro-Magnon to the age immediately preceding that artistic period which saw in this country the first attempts of the engraver and the sculptor"

Dr. Pruner Bey gives a very full and elaborate description of the skulls and other anatomical details found in the cave of Cro-Magnon, he considers the inhabitants of this cave, "as decidedly affiliated to the other Mongoloids of the age of the Reindeer," and in their cranial character to approximate most nearly to the Esthonians. He also writes, "Lastly, as to the data of philology, the skulls are mute enough; nevertheless, the conformation of the bony plate leads us to conclude that, at least phonetically, the language of our cave-dwellers was neither Aryan nor Semitic. In fact we find their peculiar palate low and extending forwards, only in those modern races which have a weak phonology, and sweet at times; and such are the Finnish idioms."

All the various implements and remains described in the *Reliquiæ Aquitanicæ* are profusely illustrated with excellent lithographs.

Great attention is now given in the Old World to archœological studies, and large quantities of valuable facts and collections have been accumulated. And though some of the theories founded on these facts are rather wild, still the facts themselves always remain, and nothing can tend more to the elucidation of the habits and customs of the ancient pre-historic man in Europe, and the uses of their implements, than the study of still existing tribes of savages, or those which have but lately died out. Especially as it is always found that the customs and implements of all savage people of little intelligence, wherever found, are so nearly identical.

A great deal more attention might profitably be given to such studies in America, more especially in Canada, where we have so many interesting remains of its former possessors, and their immediate descendants still living among us. G. M. D.

NOTE ON THE BLASTOIDEA.—The remains of the Blastoidea have as yet proved to be extremely rare in the Canadian formations. The whole collection in the Museum of the Survey consists of only five small specimens, two of *Codaster*, and three *Pentremites*. The study of these with a view to their description led me to inquire into the subject of the functions of the summit apertures of the several genera that have been referred to the order. As our material was not sufficient for such an investigation, I applied to S. S. Lyon, Esq., of Jeffersonville, Indiana, one of the Geologists of the Kentucky Survey, and he supplied me with a large collection from which I shall endeavor to prove:—

1. That the tubular apparatus beneath the ambulacra of *Pentremites* is the homologue of the so-called "Pectinated rhombs" of the Cystidea,—that the five orifices heretofore supposed to be ovarian apertures were respiratory in their function—the larger of the five being also the mouth and the vent, and that the central

aperture is not the mouth, but the homologue of the ambulacral orifice of the Cystidea and Palæozoic crinoids.

2. That in the summit of the genus *Nucleocrinus*, there are sixteen apertures—ten respiratory, five ambulacral, and one which is both mouth and vent. There is no aperture in the centre of the summit.

3. That *Codaster* does not belong to the Blastoidea. E. B.

BOTANY AND ZOOLOGY.

English Plant Names.—That most troublesome weed to farmers, the Couch-grass (*Triticum repens*), has a variety of names. In Cumberland and Essex it is Twitch; in Cheshire and Shropshire, Scutch; in North Buckinghamshire, Squitch; in South Buckinghamshire, Couch, or Cooch-grass; all evidently having the same derivation, but an obscure one. In the Norfolk "Quicks," and Warwickshire "Quicken-grass" we have a clue. No plant is so retentive of vitality as this *Triticum repens;* the smallest piece left in the ground will grow. All these names are but forms of the A-S *cwic*, living, a word with which we are familiar as occurring in the Apostles' Creed in the English Prayer-book, where "the quick" are referred to in opposition to "the dead." The words "quicks" and "quickset" are applied to living hawthorn hedges as distinguished from dead-wood fences; *cwic-beam*, the living tree, was, according to Dr. Prior, the A.-S. for the Aspen (*Populus tremula*), on account of its ever-moving leaves; and Quick-in-hand was an old name for the Touch-me-not (*Impatiens Noli-me-tangere*), from the suddennes with which its seeds discharge themselves when handled.

Many north-country names are derived from Swedish and Danish sources. The black heads of the Ribwort Plantain (*Platago lanceolata*) are, in the northern countries, called kemps· We find the origin of this in the Danish *kæmpe*, A.-S. *cempa*, a warrior. Children often play with the flower-stalks, each endeavouring to knock the head off the other's mimic weapon; and this game is still known in Sweden,, where the stalks are called kam par (Prior). The same game is very popular with the Cheshire children, who term it "playing at conquerors;" the heads themselves they call "fighting cocks." Rushes (*Junci*) are called sivs and seaves, from the Da. *siv*, Sw. *saf*, a rush. The name Roan, Ran, Royne, or Rowan-tree, by which *Pyrus aucuparia* is known in Scotland and the northern counties, comes from Da *rönn*, Sw. *runn*, which is traceable to the "O. Norse *runa*, a charm, from its being supposed to have power to avert the evil eye" (Prior). *Vaccinium Myrtillus* is, in Cumberland and Yorkshire, known as Blue-berry, in Scotland Blackberry, from Sw. *bloa-bær*, or Da. *böllebar*, a dark berry; its more ordinary name, Bilberry, is probably from the same source.

From the German and Dutch we obtain several of our commonest plant-names. Buckwheat (*Polygonum Fagopyrum*), for instance, is from Da. *boekweit*, G. *buchwaitzen*, beechwheat, "from the resemblance of its triangular seeds to beachnuts, a name adopted with its culture, from the Dutch" (Prior). The Figworts (*Scrophularia aquatica* and *S. nodosa*) take their name, Brown-wort, from G. *braunwurz*. probably in reference to their dark foliage and brown stems and flowers. Dr. Prior thinks it more probable that it is from the plants "growing so abundantly about the *brunnen*, or public fountains of German towns and village;" but the former derivation seems to me the more likely, especially as neither species is peculiar to these localities. In Devonshire the name Brunnet is applied to one or both species; this is probably a corruption of brownwort, or possibly an abbreviation of brown-nettle; the word Burnet is not very different from this, and that is applied to a brown-stemmed plant (*Poterium Sanguisorba*),

Names of French origin are yet more frequent. The Dandelion (*Leontodon Taraxacum*) gives us a familiar example; it is in French *dent-de-lion*, lion's tooth, although the reason for the name is not satisfactorily known. At Glasgow the Gooseberry (*Ribes Grossularia*) is called groset; in other parts of Scotland, grosert, grose and groser: the Black Currant (*R. nigrum*) is gazles in Sussex; and in Kent the same name is applied to the White Currant. We find the origin of all these words in the Fr. *groseille*. In the Ayscough MSS., as quoted in *Notes and Queries* (Series IV. i. 532), we read that the Raspberry (*Rubus Idæus*) is called framboise by the country people in Dorset; and the St. George's Mushroom (*Agaricus Georgii*) is known as champeron to the people about Abingdon. Mushroom itself, by the way, is but an anglicised form of Fr. *mousseron*, formerly *mouscheron*. "One of the most conspicuous of the genus (*Agaricus*), the *A. muscarius*, is used for the destruction of flies, *mousches;* and this seems to be the real source of the word, which by a singular caprice of language, has been transferred from this poisonous species to mean, in the popular acceptation of it, the wholesome kinds exclusively" (Prior.) Tutsan (*Hypericum Androsœmum*) is from Fr. *toute saine*, a name by which it has been known since the time of Gerarde, who gives this explanation of it. In Buckinghamshire a corrupted form of this is still in use in the words Tipsen-leaves and Touch-and-heal; in Hampshire it is Touchen-leaves. In the second of these we have an example of the tautology so frequently found in English names where foreign words have been translated and then both original and translation have been combined. The "Touch-and" is the same as Touchen, and is evidently a corruption of *toute saine;* the "heal" is a translation of *toute saine.* It has been converted into Touch-*and*-heal to make sense of it; and the word is now, perhaps, supposed to indicate the rapidity with which the healing properties of the plant take effect.

From Latin names, the transition to another class, in a measure connected with them, and introduced by the same agency, is an easy one; I refer to what I may term religious plants, such as have been in some manner associated with, and have taken their titles from, the pious observances of former times. The Church taught by the eye as well as by the ear; and by natural objects sought to recall not only, as we shall presently see, her more solemn seasons, but the saints whose festivals she kept. The coincidence, for example, of the flowering of a plant with the feast of a saint led to a connection between the two, and eventually, in many cases the name of the latter was bestowed upon the flower. A natural feeling of reverence seems to have prevented at any rate in England, the dedication of plants to either person of the Blessed Trinity; and the few exceptions to this rule with which I am acquainted, are associated with our Lord in His human nature exclusively. The Blessed Virgin, however, who held a foremost place among the saints, is commemorated, under the title of 'Our Lady,' by which she was formerly more generally known in England, in the Lady's Bedstraw or Bedestraw (*Galium verum*), Lady's Smock (*Cardamine pratensis*), Lady's Finger (*Anthyllis vulneraria*), Lady's Tresses (*Spiranthes autumnalis*), Lady's Comb (*Scandix pecten*), Lady's Mantle, (*Alchemilla vulgaris*), and very many more. During Puritan times it became the custom to substitute the name of Venus for that of the Blessed

Virgin. Thus Lady's Comb became Venus's Comb, and so on; and this substitution was fostered by the false classical spirit which became fashionable during and after the reign of Charles II. Among plants popularly dedicated to other saints, we may notice St. John's Wort (*Hypericum* especially *H. perforatum*), in many places corrupted into Sinjonswort, which blossoms about St. John the Baptist's day, June 24; St. James' Wort (*Capsella bursa pastoris*), and many more will be found in herbals. In some cases, however, we must admit that names referred by modern writers to a similar dedication have really a very different origin. Herb Bennett, for instance, is said to commemorate St. Bennet or Benedict, although, as I have shown, it has a very different origin; Timothy-grass, (*Phleum pratense*), which really took that name by being brought into cultivation by one Timothy Hanson, is supposed to have been dedicated to St. Timothy; Paul's Betony (*Veronica officinalis*), which, according to Dr. Prior, refers to an old author, Paul Ægineta, who described it as a betony—to St. Paul; and so on. In the floral kalendar, the Church's seasons were duly noticed. The Holly (*Ilex aquifolium*) from its use in church decorations at that season, is in many places still called Christmas; the Snowdrop (*Galanthus nivalis*) in its old name "Fair Maid of February," commemorates the Feast of the Purification (Feb. 2); Lent brings its Lent lillies (*Narcissus pseudo-Narcissus*); Palm Sunday its "palms," as the willow catkins are pretty generally called; Easter, its Paschal, or Pasque, flower (*Anemone Pulsatilla* ; the days preceding the Ascension are referred to in Rogation-flower or procession-flower (*Polygala vulgaris*), which received its name from its use in the garlands which were carried in the religious processions which marked Rogation-week; Herb Trinity (*Viola tricolor*) pointed to Trinity Sunday; the Virgin's Bower (*Clematis*), to the Assumption; and the Michaelmas Daisy (*Aster*) to the feast of SS. Michael and All Angels.

But we must pass on to the consideration of another class. Many plants take their names from a resemblance, real or imaginary, to animals or parts of animals. The tail-like infloresceuse of some has suggested many names; amongst which are Mouse-tail (*Myosurus minimus*), with the carpels arranged on the long slender receptacle; Cat's tail (*Typha latifolia*) with a thick stout spike, a name applied also to *Phleum pratense*; Hare's-tail (*Lagurus ovatus*), remarkable for its soft flowerheads; Squirrel-tail

(*Hordeum maritimum*, in Canada to *H. jubatum*); and Dog's-tail (*Cynosurus cristatus*). The Horse-tails (*Equiseta*), flowerless plants, have their long slender branches growing in whorls up the barren stem; the name is particularly appropriate to *E. maximum*. The gaping corolla of the Snapdragon (*Antirrhinum majus*) has suggested, not only that appellation, but the allied ones, Rabbit's-mouth, Lion's-snap, and Dog's-mouth. The Hound's-tongue Fern (*Scolopendrium vulgare*) took its name from the shape of the fronds; the narrow slender spike of *Ophioglossum vulgatum* accounts for its name, Adder's tongue. The long projecting nectary of many species of *Delphinium* suggested the name Lark's-spur, or Lark's-claw, a name which is applied in Buckinghamshire to the Toadflax (*Linaria vulgaris*), from a similar peculiarity in its blossoms. The soft heads of *Trifolium arvense* render Hare's-foot appropriate; those of the Kidney Vetch (*Anthyllis vulneraria*) are called Lamb-toes; *Dactylis glomerata* is Cock's foot, from the shape of the panicle (Prior).

Any one who will take the trouble to look through a list of English plant-names will not fail to observe that many of them have the name of some animal entering into their composition, used in a different sense from those which we have been considering. Formerly I alluded to the meaning which "horse" has in composition—*i. e.*, large, or course. as in horse-chestnut, horse-blobs, horse-gowans, and many more. "Dog," as an affix, usually conveys worthlessness: thus we have Dog-Violet, a scentless species, Dog's-grass (*Triticum repens*), a useless species of a genus which contains wheat (*T. sativum*); Dog's Camomile (*Matricaria Chamomilla*); etc. This is not always its meaning; the Dog-wood (*Cornus sanguinea*) means dagge-wood, *dagge* being the old English equivalent for a dagger, and the wood having been used for skewers (Prior). Dog Rose (*Rosa canina*) may mean, *par excellence*, Prick-flower, a very appropriate name for it; but cultivated roses are equally prickly, so that is probably implies a worthless rose. "Ox," "bull," or "cow," differ somewhat from "horse," in composition: they imply something large but not of necessity coarse. Bulrush (*Scirpus lacustris*) is thought by Dr. Prior to have been originally *pool*-rush, "from its growth in pools of water, and not, like the other rushes, in mire;" but Mr. Holland considers that the name simply denotes a large rush. 'Toad' means false or spurious: Toadflax, for example, means, as I have before endeavoured to show, a false flax, from its superficial resemblance, when out of flower, to the flax of commerce; Dr. Prior, however, favours a different derivation.—Abridged from *Science Gossip*.

THE WOOLHOPE NATURALISTS' FIELD CLUB introduced a novelty into its proceedings by devoting a day to explore the Fungi of the district where the Club meets, and after a critical examination of the species collected, closing its meeting by a feast, the principal feature of which was the edible species which were the spoil of the days 'foray.' Such excursions will certainly bring into notice many species of a tribe of plants which are not only extremely fugacious, but also very enigmatical in their appearance. They will also overcome popular prejudices against a wholesome and nutritious source of food almost entirely overlooked, and introduce additional valuable species to those who already have found out their virtues, as will appear from the report of the dinner which follows, and for which, as well as that of the excursion, we are indebted to the kindness of Dr. Bull.

The members met at the Mitre Hotel, at 9 o'clock, Friday, October 9, 1868, and after transacting the ordinary business of the Club, they set out for Holme Lacy Park, accompanied by Mr. Edwin Lees, F.L.S., and Mr. W. G. Smith, F.L.S. Leaving their conveyance, and entering the grounds of Sir E. L. S. S. Stanhope, a beautiful group of the maned Agaric (*Coprinus comatus*) attracted attention. It took almost the form of a circle, though not one of those that usually do so. It is very common, and as interesting and handsome in appearance as it is good to eat, if people did but know it. The pretty crested Agaric, (*Agaricus cristatus*,) also edible, and *A. vulgaris*, were next gathered, and on a bank under Scotch fir-trees several specimens of the not very common *Boletus granulatus* were found, and, as a matter of course, some bunches of the common poisonous *Agaricus fascicularis*. A flower-bed in the garden had a fine crop of *A. infundibuliformis* in it, and a cluster of *Boletus subtomentosus* was gathered below the terrace walk. This Boletus was also seen many times during the day.

The Club had a part of their dinner to procure in the park, not in the shape of venison from the deer, but as vegetable beef-steaks from the trees. Several specimens of *Fistulina hepatica*, the 'liver fungus,' or 'vegetable beef-steak,' as it has been called, were met with—one nearly two feet in diameter, and weighing ten or twelve pounds—on nine different trees, and had the search for it been continued many more might doubtless have been found.

Scattered about in proper hunting order the members climbed the hill. They were specially directed to look out for the very rare *Cantharellus cinereus*, which was found here three years since, but which Berkeley marks as "not found since the days of Bolton." It was not found, however. The delicate *Agaricus prunulus*, 'vegetable sweetbread,' as it has been termed, was met with, together with *A. campestris*, *A. arvensis*, and its smaller and more delicate variety *A. cretaceus*, all, of course, edible; also the small puff-ball, *Lycoperdon gemmatum*, the large rough-stemmed *Boletus scaber*, the buff gilled *Russula alutacea*, the less common *R. vesca*, and the Parasol Agaric (*A. procerus*). Some others were collected here not quite so good in character. Some fine pale orange specimens of this last poisonous Agaric were gathered, which at first sight resembled the delicious edible 'orange milk Agaric,' so highly recommended, and figured in the Club's Transactions last year. It had, however, a shaggy woolly margin, without the orange gills and the orange-coloured milk.

As the hour for dinner approached, the party remounted and returned to Hereford. Some time was devoted to an examination of the spoil, and then twenty-one sat down to partake of a dinner which fitly closed the 'Foray among the Funguses.'

With the fish and the soup came the first novelty in the form of Oreades ketchup. It was good with either, and as guest after guest helped himself to an experimental taste, it was curious to hear one after the other ask again for "that bottle." It was a brilliant success. Hie every one with a regard for table luxuries, and that should include all sensible people; hie to your lawns and grassplots and gather while still you may, the pretty little fairy-ring Champignon (*Marasmius oreades*), and make for yourselves a ketchup, that is as superior to the ordinary vile black compound you meet with as champagne is to gooseberry. Don't you know it? Then get a member of the Woolhope Club to point it out to you, or better still, borrow the last volume of the Club's Transactions, and there you will find a pretty coloured picture of it, and receipts, moreover, for cooking it in many ways. Have a care to keep down the spice, however, for if in too great abundance, it destroys the true delicate delicious flavour of the Agaric itself.

A side dish of stewed kidneys narrowly escaped being mistaken for a dish of sliced Agarics, and another of sweetbreads with buttons of the Horse Mushroom (*Agaricus arvensis*) was too good to travel far. Next followed a dish of beef-steak, animal and vegetable, deliciously mingled, to the advantage of both, and at the same time a dish of the *Fistulina hepatica*, the 'liver fungus,' or 'vegetable beefsteak,' by itself was handed round. The slices were cut from the large one gathered in the morning.

The next Agaric to appear was *Hydnum repandum*, 'the spiked Mushroom,' from Haywood forest. It was stewed and broiled, and those members of the Club who had resolved themselves into a committee of critical taste, and to whom, therefore, all dishes were immediately brought fresh and hot, quickly separated the Agarics from their gravy, and found them excellent, and particularly the broiled ones, not at all unlike the oysters to which they have been compared. Then followed the Parasol Agaric, *Agaricus procerus*, but its delicious flavour, perhaps the lightest and best of all of them, not excluding the common Mushroom, was drowned in its over-condimented gravy.

The fairy-ring Champignon (*Marasmius oreades*) appeared then, broiled on toast, after the admirable receipt of Soyer. We give it here in full, for it is the very best receipt for broiling Agarics, or Mushrooms, of every kind.

"Place young fresh Agarics, or Mushrooms, on toast freshly made and properly divided. Salt, pepper, and place upon each one a small piece of butter (or a little scalded or clotted cream). Put one clove on the toast, then cover with a glass and bake for a quarter of an hour, or broil before a quick fire for twenty minutes. Do not move the glass until it is served up, by which time the vapour will have become condensed and gone into the toast, and when the glass is removed a fine aroma of Mushroom will pervade the table." (N.B.—A common kitchen basin will answer the purpose of a glass as a cover for baking, though it is by no means so elegant.)

A dish of *Agaricus prunulus* was served simply stewed. The Agaric had fair play—salt and spice were kept in due abeyance—and "delicious" was the unanimous verdict. This dish never reached a third of the way down the table!

Many other Agarics might have been dressed, but it was thought best not to tax too highly the patience of the cook; and so with the distribution of dried specimens of the fairy-ring Champignon to all who wished it, the feast of Agarics was over for the day. This excellent Agaric will keep well, when threaded on string and dried and kept dry, through the winter, readily imparting its flavour to soups or made dishes as required.—Condensed from the *Journal of Botany.*

MIMICRY IN NATURE.—The few remarks on so-called "Mimicry in Nature," which I introduced in my new work on Central America, particularly relate to the predominance of the Willow form on river-banks. It is almost unnecessary to say that in the work from which the extract is taken it was undesirable to insert more than a few names in support of my observations, but it might not be difficult to show that most plants bearing leaves of a true Willow form do grow by running streams. To say nothing of those species of Salix having Willow leaves (or those Salices not having Willow leaves, and not growing by running streams, as *S. herbacea*, etc.), I would remind you of the different species of Nerium (Oleander), our *Epilobium angustifolium* (*vulgo*, Willow herb), *Lythrum Salicaria*, etc. That some plants are found by rivers which do not have Willow leaves (as pointed out) has, in my opinion, nothing to do with the question, how it comes to pass that the Willow form predominates to so great an extent in such localities. The answer may be very simple, but at present it has not come forth. About the term 'mimicry' there should be a clear understanding. It is, so far, a thoroughly objectionable one, as by employing it either in zoology or botany, the whole question is prejudged; indeed, it is assumed—1, That organisms have the power to mimic other organisms; and 2, That they have come in contact with those organisms which they are supposed to mimic. Employ the terms 'outer resemblance' instead of mimicry, and we are on neutral, undisputed ground. The subject of these external resemblances of species and whole genera to others having an entirely different organic structure, is a wide and complicated one; and I think that the best way to approach it is to go through the whole vegetable kingdom, and take note of every case where the outer features of one species or genus are reflected in any other. Some years ago my late lamented friend, Dr. Schultz-Bipontinus, read a paper on his favourite order, the

Compositæ, in which he pointed out that in this, the largest of all phanerogamous orders, the habit of almost every other order of the vegetable kingdom cropped up again. In Euphorbiaceæ, and other large orders, similar instances are noted. Sometimes this outer resemblance is perfectly startling. I remember finding a Sandwich Island plant, which looked for all the world like *Thomasia solanacea* of New Holland, and well-known Buettneriacea of our gardens, but which on closer examination turned out to be a variety of *Solanum Nelsoni;* the resemblance between these two widely separated plants being quite as striking as that pointed out in Bates's Travels on the Amazon, between a certain moth and a humming-bird. This outer resemblance between plants of different genera and orders has played us botanists many a trick, and is one of the many causes of the existence of some almost incomprehensible synonyms in our systematic works. Wendland in his monograph on Acacia described many good species, and thought he knew an Acacia when he saw one; yet one of his new ones (*A. dolabriformis*) which he referred to the genus from habit alone, turned out to be a Daviesia. Few men had a better knowledge of Ferns than Kunze, yet 'mimicry,' Puck-like, played him a trick when, relying on the nature of the leaf and venation, he referred *Stangeria paradoxa*, a Cycad, to true Ferns; and Sir W. J. Hooker, good botanist as he was, would never have figured a Veronica as a Conifer, if 'mimicry,'—using the term for the last time—had not been at play. At present I have no theory to propose on this subject, but whoever has, ought to both bear in mind that it must apply with equal force to the animal and vegetable kingdoms, and to say that these resemblances are merely accidental, counts for nothing until it shall have been proved that there are such things as "accidents in nature."—Seemann, in *Gardener's Chronicle.*

THE ORDEAL POISON-NUT.—In a recent number of the *Journal of Botany* Dr. Bennett, of Sydney, says that "this elegant tree is now naturalized in New South Wales, and is readily propagated. There is a noble specimen of it in the Sydney Botanical Gardens, which attracts attention from its bright green foliage, delicate and fragrant blossoms and pendulous, egg-shaped fruit. The label, close to the tree, inscribed 'Madagascar Ordeal Poison Tree,' occasions it to be treated with some respect by visitors to the gardens, for while other things suffer from their depredations it has been remarked that this is the best preserved tree in the collection." This specimen is twenty feet high, and the circumference of the branches full fifty feet. It flowers in November and December, and is often at the same time covered with fruit in different stages of maturity. The fruit, which is oviform and about the size of a hen's egg, contains a hard nut with a dark brown shell,* the white kernel of which is in size, appearance and taste like a bitter almond. The *Tanghinia veneniflua* is a specific poison for the heart and muscles, acting powerfully on the heart. Some of the natives of Madagascar say that there are two kinds of these trees, the one poisonous, the other only emetic, and so similar in appearance that none but the administrators know the difference, and that even they sometimes err and kill when they intend only to sicken. Dr. Bennett suggests that there may be two species of Tanghinia found in Madagascar, one of which may be analogous to the *T. Manghas* of India, the milky juice of the fruit of which is used as a purgative.

Canadian Wild Flowers.—Under this title Mrs. Fitzgibbon has published a very pretty volume for the parlor table, consisting of ten lithographic plates of some of our showiest wild flowers, drawn on stones by herself and afterwards coloured by hand. The letter-press, consisting of popular descriptions of each plant, is by Mrs. Traill, and is part of a work by that authoress still in MS. "descriptive of the most remarkable of the wild "flowers, shrubs and forest trees of Canada." Mrs. Traill's English names of flowers are excellent; in lieu of the vulgar Dutchman's Breeches for *Dicentra Cucullaria* she proposes the characteristic Fly-flower. The elegant name Gossamer-fern for *Dicksonia punctilobula* is also hers. The publisher's portion of the work is the least satisfactory. The plates are on poor paper, and the text needs the supervision of a proof-reader. The following is the list of species illustrated by the ten plates:—

Anemone nemorosa *Linn.*	Trientalis Americana *Pursh.*
Hepatica acutiloba *DeC.*	Penstemon pubescens *Soland.*
Aquilegia Canadensis *Linn.*	Veronica Americana *Linn.*
Nymphæa odorata *Aiton.*	Castilleia coccinea *Spreng.*
Nuphar advena *Aiton.*	Arisæma triphyllum *Torr.*
Sarracenia purpurea *Linn.*	Orchis spectabilis *Linn.*

* Some of these nuts are in the Society's museum.

Dicentra Canadensis *DeC.*
Claytonia Virginica *Linn.*
Geranium maculatum *Linn.*
Rubus odoratus *Linn.*
Rosa blanda *Aiton.*
Rudbeckia fulgida *Aiton.*
Campanula rotundifolia *Linn.*
Pyrola elliptica *Nuttall.*
——— uniflora *Linn.*
Cypripedium parviflorum *Salisb.*
————— pubescens *Willd.*
————— spectabile *Swartz.*
Iris versicolor *Linn.*
Trillium grandiflorum *Salisb.*
——— erectum *Linn.*
Uvularia grandiflora *Smith.*
Lilium Philadelphicum *Linn.*
Erythronium Americanum *Smith.*

ZOOLOGICAL NOTES.—We have received an analytical chart of the birds of Canada, by J. J. G. Terrill, of Hamilton, C. W. The classification of Dr. Baird is adopted, and the orders, sub-orders, families, genera, species, &c., are given in a tabular form. It will prove very useful to schools, and to students of Canadian ornithology generally. The list contains 242 species, which have been principally recorded from Western Canada. Some few additional species of marine birds occur in the Gulf of the St. Lawrence, and on the other hand a few birds have been catalogued from Western Canada that have not as yet been found in the Province of Quebec.

Dr. Elliot Coues' monograph on the American Alcidœ, published in the journal of the proceedings of the Academy of Natural Sciences of Philadelphia for January and February, 1868, is of considerable interest to the student of North American ornithology. It is not yet very certainly ascertained whether the Great Auk has ever been taken on the coast of Eastern North America. The species is reported to breed on a low rocky island to the south-west of Newfoundland. Mr. J. Wolley has shewn that this species is not a bird of high latitudes, as was at one time supposed, and an interesting account by this author is quoted of its supposed extinction in Iceland; also his statement that the last specimens of the species known to have been taken were captured in 1844. The Razor Bill and the common Puffin both breed in the River and Gulf of the St. Lawrence, and it is not unlikely that the "large-billed" puffin, *Fratercula glacialis*, may be met with in Eastern Canada. The tufted puffin, it appears, occasionally occurs on the East Coast of North America, it has been thought an almost exclusively western species. Other Canadian examples of the order are the Sea Dove, *Mergulus alle*, and four species of Guillemot, of each of which detailed descriptions are given in Dr. Coues' essay.

In Silliman's Journal for November, 1868, Prof. Marsh shews that the Siredon lichenoides of Baird is the immature form of Amblystoma mavortium of the same author. An interesting account is given of the gradual metamorphosis of the species, showing its various changes of colour, the absorption of the dorsal and caudal membranes, and finally that of the external branchiœ. The author states that there can be little doubt that this creature breeds in its immature or Siredon state. Dumeril's researches on the Mexican Axolotl seem to prove this; also that all Siredons are larval Salamanders, a circumstance which Cuvier appears to have suspected.

Prof. Cope's review of the species of Amblystomidœ, a genus of tailed batrachians, from the 4th number of the Proceedings of the Academy of Sciences of Philadelphia for 1868, is a valuable contribution to our knowledge of North American Amphibia. Two species of this genus, so far as we are aware, occur in Lower Canada. The Amblystoma punctatum is the species formerly known as Salamandra subviolacea, and A. Jeffersonianum is the Canadian form which used to be called by Dekay, Salamandra granulata.

The seventh volume of the British Museum Descriptive Catalogue of Fishes, by Dr. Gunther, published in 1868, contains some matter of special interest to our local zoologists. Descriptions are given of several of the Canadian species of the difficult and intricate family of the Cyprinidœ, a group which includes the suckers, chubs, minnows, dace, &c. The following species are described from the neighbourhood of Montreal, and examples of each of them were forwarded to Dr. Gunther by the writer of this summary.

Catastomus teres, *Mitchill.*
Catastomus carpio, *Cuv. & Val.*
Hyborhynchus notatus, *Agassiz.*
Rhinicthys marmoratus, *Agassiz.*
Leuciscus cornutus, *Mitchill.*
Leucosomus pulchellus, *Storer.*

In addition to these Catastomus hudsonius, Lesuer; Carpiodes cyprinus, Lesuer; and Rhinicthys atronasus, Mitchill; also inhabit the vicinity of Montreal. A little fish common in the St. Lawrence, which used to be referred to the Abramis Smithii of Richardson, is the Hyodon tergisus of Lesuer, and is not a true bream. From various parts of Western Canada the following species are recorded, and full descriptions are given in the volume under consideration.

Catastomus aureolus, *Lesuer.* Lakes Erie and Superior.
Catastomus macrolepidotus, *Lesuer.* Lake Erie.
Ceraticthys plumbeus, *Agassiz.* Lake Superior.
" dissimilis, *Kirtland.* Lake Erie.
Leuciscus Hudsonius, *Clinton.* Lake Superior.
" rubellus, *Agassiz.* " "
Leucosomus corporalis, *Mitchill.* Lake Erie.

The common herring of the Gulf of St. Lawrence, and of the Atlantic Coast of N. America, is looked upon as identical with the European species; and, as Dr. Gunther states positively that whitebait are young herrings, there would seem to be no reason why this delicacy should not be procurable in Eastern Canada.

We notice also that in Dr. Gunther's Catalogue of the Tail-less Batrachians of the British Museum, he considers that the Rana sylvatica of Leconte, a land frog which is frequent on Montreal mountain and elsewhere in Lower Canada, is only a variety of the commonest European frog, the Rana temporaria.

Recent investigations have shewn that the late Prof. E. Forbes' theory that animal life would not be found at great depths in the sea is untenable. Living examples of all the great divisions of the invertebrata have been taken at depths of over one hundred fathoms outside of the Florida reef, and crustaceans, annelids and radiates were dredged in 517 fathoms water in the same locality. Researches off the Coasts of Portugal and Norway give similar results, as also do the investigations of Dr. Carpenter and Prof. Wyville Thompson, off the Faroe Islands, and quite a new zone of animal life has been thus recently revealed to us. J. F. W.

A Butterfly Parasite.—At a meeting of the Montreal Microscopic Club, one of the members exhibited specimens of a vegetable parasite on the tibia and tarsus of the dark swallow-tailed Butterfly, Papilio Asterias. The insect was captured at Brantford, Ont., last summer, along with three other specimens, at the same time and place. The parasite was only found on one of these, growing on the spines of the tibia, tarsus and tips of the ungues. Attention is at present directed to the circumstance, and a full description will be given in the next number of this journal.

Mosquitoes in England.—Most of the readers of *The Naturalist* will remember the outcry last summer in reference to the appearance of the Mosquito in England. Some of the observers maintained that they were simply English gnats, and not the genuine insect. The following is a short paragraph from "Science Gossip," for January, 1869 :—"WOOLWICH MOSQUITOES.—At the Entomological Society's meeting of November 2nd, 1868, the Secretary exhibited a specimen of the so-called Mosquito sent from Woolwich, which proved to be a species of *Chrysopa*." Hence it will be evident that two or three different insects have been confounded together under the designation "Mosquitoes" in that locality, and to none of them does the name strictly apply.

"GUIDE TO THE STUDY OF INSECTS," BY DR. PACKARD.—Part V. of this excellent work is out, and contains a continuation of Lepidoptera. An account is given of the transformation of several species; also, two full-page illustrations of the male and female and female moth, "*Telea Polyphemus*." This work is one of the most valuable of its kind in North America ; the subject is treated of scientifically, yet in a popular manner. The cuts are excellent ; and this number is evidently one of the results of the labors of a practical and experienced Entomologist. The "Guide" is invaluable for the use of schools and of agriculturists. One of the ways to interest our farmers and add to their success may be learnt in the pages of this work. Its perusal might make them acquainted with those insects which are injurious or beneficial to their crops, so that they might know their friends from their enemies. In order to interest this class in advancing scientific agriculture, it would be well to put such works into the hands of their children at school. A. S. R.

"THE CANADIAN ENTOMOLOGIST," TORONTO.—The January number contains notes on Canadian Lepidoptera, by the Rev. C. J. S. Bethune, Secretary of the Entomological Society of Canada; also, a list of Diurnal Lepidoptera collected by Mr. B. Billings, Ottawa. In this list, under the name "Vanessa Milberti," the writer states "that sixty individuals of this species had remained in the pupa state in the breeding cage only four days. What was the temperature of the vivarium which caused so rapid a metamorphosis ? A. S. R.

CHEMISTRY AND PHYSICS.

On Hydraulic Cements.— It is well known that the calcination of argillaceous limestone gives rise to cements which have the power of hardening under water. Various explanations of this property have been proposed. An alkaline silicate, like soluble glass, is known to harden by silicifying calcareous rocks and cements; and Kuhlmann supposed that a silicate of this kind, formed during the calcination of argillaceous and more or less alkaliferous matters, might play an important part in the hardening of hydraulic limes. According to Rivot and Chatonnay, on the other hand, there are formed during the calcination of mixtures of carbonate of lime and clay, three new compounds, a silicate of lime, a double silicate of lime and alumina, and an aluminate of lime. These three compounds they supposed to combine directly with water, so that the solidification of the cement was like that of calcined gypsum, a simple hydratation. According to the recent experiments of Frémy, only one of these compounds, the simple silicate of lime, has the property of thus combining with water. Further, he has shown that although pure clay or kaolin, a hydrous silicate of alumina, does not produce a hydraulic cement when mixed with lime, yet, after exposure to a low red heat it forms, with lime, a perfect cement. The foreign matters often present in clays are without action in this process. The explanation of this curious result seems to be furnished by the observation of Frémy, that a clay which abandoned nothing to hydrochloric acid yielded abundance of alumina to the same acid after calcination. From this it whould appear that a heat, even of low redness, produces a partial decomposition or dissociation of the silicate into alumina and silica.

Both free alumina, and silica in the amorphous condition are shown by the experiments of Vicat to communicate hydraulic properties to lime. This decomposition of the hydrated aluminous silicate by heat is analogous to that many years since observed by Frémy for silicate of potash, whose solution at an elevated temperature is partially decomposed, with separation of pure crystalline silica. In this connection should be noticed the observation of Kengott, that many mineral species acquire a strongly alkaline reaction after having been calcined. The natural pozzuolanas are nothing more than volcanic ash or argillaceous matter calcined by volcanic heat; and it has long been known that similar products artificially prepared by calcination possessed, like the natural pozzuolanas, the power of rendering pure limes hydraulic; but the true mode of their action, which has not hitherto been understood, is now rendered intelligible by this investigation of Frémy.—(*Comptess Rendus de l'Acad. des Sciences, Dec.* 21, 1868.)

In this connection may be mentioned the peculiar power of hardening under water presented by imperfectly calcined dolomites or magnesian limestones. By heating these to a temperature of 400°-500° centigrade the double carbonate is broken up; and the magnesia, losing its carbonic acid, remains mixed with the carbonate of lime, but when moistened with water, is converted in a few hours into a crystalline hydrate, which gives to the mass a great degree of hardness. In like manner a condensed form of magnesia, such as is obtained by calcining at a gentle heat, the native anhydrous carbonate, gradually assumes, by the action of water, a great degree of hardness. T. S. H.

ON THE DECOMPOSITION OP GRANITE BY WATER. (R. HAUSMANN, *Jour. fur Prakt. Chem.*)—The granite employed in these experiments was reduced to a powder so fine that it had a diameter of not more than 0.01 millimeter. This digested for a week, with twenty-five times its weight of pure water, at the ordinary pressure and temperature, yielded an amount of soluble alkali equal for 100 parts to 0.03 or 0.04, and when the mixture was kept in continual agitation, to 0.05 parts. A longer digestion did not sensibly increase the amount of matter dissolved. The solvent power of water, saturated with carbonic acid, was found to be about twice that of pure water. Calculating from the surface exposed in these experiments, the author concludes that the rains of a year would remove about fifteen grammes of alkalies from a surface of 100 square metres of granite. T. S. H.

OXYCHLORID OF COPPER.—Hydrous oxychlorid of copper, to which the name of atacamite is given, is abundant in some regions, especially in Chili, where it is supposed to be formed by the action of sea-water on oxydizing copper pyrites. A late experiment of Prof. Church throws further light on the origin of this compound. He found that two grammes of the native blue hydrous carbonate of copper, azurite, after four years digestion in 200 cubic centimeters of a solution holding ten per cent of pure chlorid of sodium, had lost the whole of their carbonic acid, and become converted into a green oxychlorid, allied in composition to atacamite, carbonate of sodium being formed at the same time. (*Chem. News*, Nov. 27, 1868.) For further observations on the artificial production of oxychlorid of copper, see Dana's Mineral., 794. The power of oxyd of lead to decompose chlorid of sodium with the formation of hydrate of soda and oxychlorid of lead, is familiar to chemists. T. S. H.

Chromic Iron.—Clouet has shown that when an admixture of protosulphate of iron and sesquichlorid of chromium, in the proper proportions, is precipitated by ammonia, and the resulting oxyds are fused with borax, the compound ($Cr_2\ O_3$, $Fe_2\ O_2$) crystallizes in octohedrous, having the aspect, the hardness, density and chemical indifference to acids which belong to the native chromite, some varieties of which have the formula just given.

T. S. H.

Reduction of Nitrates and Sulphates in Certain Fermentations.—The reducing action of fermenting organic matters on these salts is well established; in the case of nitrates, ammonia, and in the case of sulphates, sulphydric acid is formed. According to Bechamp this process is, in all cases, due to the intervention of minute organic germs of a peculiar species, to which he applies the name of *Microzyma*. These, under ordinary conditions, absorb from the air the oxygen which they require; but if this source is excluded they take oxygen from the sulphates or nitrates present. These germs are found in the mud of towns, in which sulphid of iron forms, and also in common chalk. Hence, the addition of chalk to solutions of sugar or starch, with sulphate of lime, gives rise to reduction of the salt. T. S. H.

Effects of Great Cold on Tin.—In a note to the French Academy of Sciences, Nov. 30, 1868, Mr. Fritschze of St. Petersburg, described the effect of intense cold upon ingots of Banca tin weighing from 50 to 60 pounds. The metal had acquired a fibrous structure, and showed fissures like prismatic basalt, besides cavities of considerable dimensions. In this connection Mr. Dumas recalled the brittleness of iron when exposed to great natural cold. T. S. H.

Analysis of Graphite.—A known weight of graphite in powder is dried between 150° and 180° C., intimately mixed in a glass tube with twenty times its weight of pure oxyd of lead, and then heated before the blow-pipe until complete fusion and the disappearance of all froth. The loss in weight corresponds to the carbonic acid formed from the graphite, with the oxygen of the litharge. The pulverized graphite, may also be fused with pure nitrate of potash in a platinum crucible, and the carbonate formed determined in the usual manner.—(*Giutl. Acad. of Vienna.*)

T. S. H.

ON PHOSPHORUS IN IRON.—The importance of manganese as an element in iron ores has long been known, and the experiments of Caron have shown that the addition of manganesian minerals to the charge of the blast furnace has, for effect, to reduce notably the amounts of sulphur and of silicon which pass into the pig metal. At the same time, however, it does not, in any way, diminish the proportion of phosphorus. This element generally exists in the ores as a phosphate of lime, or in combination with alumina or oxyd of iron. These latter are generally decomposed by the addition of lime, which in its turn requires silica to give a liquid slag. The reaction of silica and carbon, at a heat of fusion, on phosphate of lime, sets free the phosphorus, which unites directly with the metallic iron; so that, while the slag is free from phosphorus, the pig metal contains it in quantities often so large as to be very prejudicial.

A solution of the problem of the treatment of phosphuretted ores would seem to require some flux capable of dissolving or rendering fusible the phosphate of lime without liberating its phosphorus. Such a power is possessed by fluor-spar; and the experiments of Caron show that while a mixture of phosphate of iron, lime and silica, fused in a charcoal-lined crucible, gave a button of brittle metal highly charged with phosphorus, a mixture of phosphate of iron, lime and fluor-spar, fused under similar conditions, was somewhat malleable, and contained only one-third as much phosphorus as the first assay. In operating in this way on natural and less phosphated ores, it was found that the substitution of fluor-spar for silica always produced a notable diminution in the amount of phosphorus in the metal; but the improvement became less marked with ores holding small amount of phosphorus. Fluor-spar has also the effect of dissolving alumina in the furnace.

It is questionable how far this process could be applied in the metallurgy of iron, inasmuch as few ores are free from silica.

Moreover, the cost of fluor-spar in many localities would be such as to preclude its use. The experiments of Caron, however, deserve notice as a partially successful attempt to solve a very important problem in metallurgy. T. S. H.

NATURAL INFLAMMABLE GASES.—The recent investigations by numerous chemists of the composition of petroleum from various sources have shown it to consist in great part of homologues of marsh gas, hydride of methyl, $C H_4$ (C=12, H=1), the most hydrogenated series of the hydro-carbons. In addition to these, small portions of benzene and its homologues, and of hydrocarbons of the ethylene or olefiant gas series have been detected in the petroleums of certain regions. Cahours and Pelouze have isolated from the products of the distillation of Pennsylvania petroleum not less than thirteen homologues of marsh gas, having the general formula $C_n\ H_{n2+2}$, in which the value of n increased from 4 to 15, and the boiling point from 0° centigrade to 160°. The lower members of the series in which n equals 2 and 3, and which are gases at the ordinary temperature and pressure, were found by Ronalds in solution in crude Pennsylvania petroleum. The denser and less volatile liquids of petroleum, as well as the various solids included under the name of paraffine, appear to belong to the same series.

Inflammable gases are well known to issue from the palæozoic rocks in many localities in the great Appalachian basin. Steiner (Amer. Jour. Science [2] xxxiv, 46,) examined some years since the gas from a well yielding salt water and petroleum, in the carboniferous rocks of Alleghany county, Pennsylvania, and found it to consist essentially of marsh gas, with a little carbonic acid, and traces of oxygen and nitrogen, but could detect no olefiant gas. My own examinations, many years since, of the inflammable gases from the saline springs of Varennes and Caledonia in Canada, which rise from Lower Silurian limestones, led to the same result.

Some two years since M. Felix Foucou, a French engineer, visiting the oil regions of this country, was furnished with exhausted tubes, in which he was enabled to collect the gases from various localities. These gases were afterwards examined by Mr. Fouqué in the laboratory of the College of France, and the results of the analyses, as well as the observations of Mr. Foucou, are contained in the *Comptes Rendus* of the French Academy of

Sciences for November 23, 1868. The gases examined were from five localities.

1. The so-called Burning spring, just above the falls of Niagara, where an inflammable gas issues in considerable quantity from a spring of slightly sulphuretted water which rises from the strata of the Medina formation, here overlaid by a few feet of clay. This gas consists of marsh gas, with traces of carbonic acid, nitrogen and oxygen, the latter two being in all cases probably accidental impurities arising from imperfections in the apparatus used in collection.

2. Petrolia, Enniskillen, Ontario; the gas was collected from an intermittent oil-well, where petroleum had been reached five days previously, at a depth of 377 feet in the Hamilton formation. Its composition corresponded to a mixture of about equal parts of marsh gas, $C H_4$ and hydrid of ethyl, $C_2 H_6$.

3. Fredonia, New York. This town on the shore of Lake Erie, with a population of 3,000 souls, has been for many years lighted with the gas which issues from a boring about eighty feet deep in the Genesee slates, which occur at the summit of the Hamilton formation. The gas is not accompanied by petroleum, and appears to be like the last, a mixture in nearly equal proportions of the hydrids of methyl and ethyl.

4. Pioneer Run, Venango county, Pennsylvania. This gas, from an oil-well about 600 feet deep in the sandstone of the Chemung formation, was more carburetted than the preceding and had nearly the composition of hydrid of propyl $C_3 H_8$. A fractional analysis by means of alcohol, which dissolves more readily the more highly carburetted compounds of the series, showed however that this gas was a mixture, consisting in part of hydrid of butyl, $C_4 H_{10}$; besides a portion of hydrid of methyl, and the two intermediate bodies of the series.

5. Roger's Gulch, Wirtz county, West Virginia. The gas in this locality was from a flowing oil-well 320 feet deep in the carboniferous conglomerate, and consisted of hydride of methyl with an admixture of 15.86 per cent of carbonic acid gas.

Careful examinations showed the absence from all of these gases of acetylene, $C_2 H_2$, of olefiant gas, $C_2 H_4$, and its homologues, as well as of oxyd of carbon and free hydrogen. T. S. H.

Spontaneous Ignition.—" The spontaneous ignition of pyrotechnical compositions made with chlorate of potash is indeed a very serious subject as regards the safety of both life and property. I know not if any reliable observations have been made in the matter, but the following facts were noted by myself some years ago, and may throw some light upon the probable origin of various terrible fires which have occurred on the premises of firework-makers in London. Mixtures of the three ingredients—nitrate of strontia (or barytes), sulphur, and chlorate of potash—if made up at once from *freshly* and strongly desiccated materials, are certain to take fire spontaneously within a few hours, especially if placed in a rather damp situation. The action, which I twice had the patience to watch for and witness, begins with the evolution of an orange-coloured gas; afterwards a liquefaction is set up at several points in the mass; a hissing noise and a more rapid disengagement of the gaseous matter comes on, and the composition takes fire. It is a curious thing that the addition of a small proportion of sulphuret of antimony at once prevents the occurrence of these phenomena; whether charcoal has the same effect I am not quite sure. Moreover, if such compositions, being damp, are, in order to dry them, placed oo near the source of heat, the same phenomena will take place even when the antimony is used in their composition. Also, compositions to produce a purple flame, if made with black oxide of copper, are almost sure, sooner or later, to take fire of themselves at uncertain periods, whether kept in a damp or dry place. The carbonate should always be used in preference.—R. TREVOR CLARK."—*Chemical News.*

NEW CHEMICAL TOY.—"Pharoh's serpents" and "Vesuvian tea" have paved the way for the reception of a new Chinese wonder in the shape of "ferns growing out of burning paper." This is a neat little experiment free from many of the disadvantages appertaining both to the "Devil's tears" and the lozenge-shaped crystals of bichromate of ammonia, which may chance to prove too inviting to children's tastes. The instructions direct us to crimp or fold the yellow papers backwards and forwards, so that when opened out they may be supported upright in a zigzag form. One of these slips is then placed upright on a plate, and ignited in two or three places along the upper edge, but without being allowed to blaze. It will burn slowly down with a red glow, diffusing an agreeable perfume, whilst the ash of the paper assumes the most fantastic arborescent shapes, together with a green colour, which, to a lively imagination, may be suggestive of the growth of ferns or lichens. We had no difficulty in imitating this effect by saturating thin cartridge paper, in the first instance, with an alcoholic solution of gum benzoin, and, when dry, applying an aqueous solution of the bichromate of ammonia. The decomposition of the latter substance by heat in contact with burning paper affords an explanation of the phenomena observed.—*Chemical News.*

METEOROLOGY.—We had fondly anticipated that one of the results of Confederation would be the establishment of a system by which the corps of observers now scattered (or to be scattered) throughout British North America would receive their instructions from, and transmit their experiences to, some part of the Dominion. By this means a critical examination of them could readily be made, which would at once advance our material interests and conduce to the advance of climatological science. Up to the present moment nothing has been done in this direction. This may be owing, in some measure, to the incipient character of the new regime, and to the uncertainty prevailing with regard to Government aid. Still the Dominion Govermennt has allowed to the various observatories a small annual grant. Every lover of science must feel grateful that amid the din of politics, of commerce, and of railway legislation, our public men have not forgotten the encouragement due to science; and we hope that ere another year has rolled by, our expressed wishes may be fully realized.

In the science of Meteorology unity in action is much needed in its modes, measures and purpose; also in the co-operation of observers, whether individually or collectively,among the various nations. Up to the present time (if we except Admiral Fitzroy's efforts in this department of science) there has been little or no system in Meterology. It is essentially a science of observation, yet observers proceed upon no fixed plan. It is a science coeval with man himself, one which must have furnished the means of observation to the earliest races of mankind, and which has furnished matter for investigation and comparison through all time. Records of a very early date are preserved in our own language. The Bodleian library at Oxford (England) contains registrations of the weather for seven years, from January, 1337, to January, 1344, recorded by Walter Merle. It is believed that this is the earliest available record. The invention of the barometer in 1643, and of the thermometer in 1590, seemed destined to throw new lustre on the progress of the science. Astronomy it is true has given to the world more lasting and fixed results, for the celestial orbs have undergone but little change; while the nature of the ever-changing elements is still unfixed. At the present time every nation has its own measure of temperature, atmospheric pressure, rain, wind, &c.; and above all, a point of the most vital importance, each has its own hour for observation. In this way the results obtained are vitiated, and the great aim of modern science, unity of purpose, is lost. Science is knowledge reduced to order, and the object in Meteorology is to obtain a correct knowledge of the cosmical laws which regulate and influence the universe.

What influence have the sun, moon, and planets on the weather?—is a question which science must answer.

If the sun and moon have so much influence upon the ponderable fluids in our seas, and great lakes, how much more may they not exert over such an elastic and easily moveable body as our atmosphere? Meteorology should embrace the study of such ideas as these, our united efforts should tend towards their solution, from which we may hope to gain practical advantage. At all events, if there are impediments to final results, let such be the means by which they will be detected and exposed.

Observations made either by individuals, colleges, observatories, or nations, must be brought together into a limited space of time. They must each be reduced to one common standard before they can serve the general purposes of science. Self registering instruments are the best and most suitable for this object. By means of them the science itself is at once traced and left indelible on the register. They form at the same time a natural measurement of time, space, and amount; while nothing short of a large area of country will furnish the necessary means and extent of survey. Let our observations, if possible extend beyond the Rocky mountains, and this is a matter of much consequence. This chain separates North America, as it were, into two portions. It influences the climate of British America in no small degree, and seems to produce the ebb and flow of the great atmospheric sea, and to absorb our heat and moisture, At least our instruments at this distant point appear to indicate this.

Another important source of inquiry, especially in reference to storms, is into the history of that "river in the sea" the Gulf stream,—and its reservoir, the Gulf of Mexico. Sailors have been active in the daily notices of occurrences in connection with this subject, but as yet little has been done by individual observers on land in carrying out that unity of purpose so necessary in the pursuit of meteorological science.

Much may still be said in reference to this subject, but immediate action is required. Let us, of the Dominion, no longer procrastinate, a central station should be at once established, to which all observations may be referred; if Montreal, then let a simultaneous system be at once adopted as to time, measure, and amount. Our Telegraph lines have been always ready to aid in the enterprise, the press has also offered its aid. If, for this Dominion, the pressure of the atmosphere, temperature, winds, etc., could be observed at distinct and fixed intervals of time and space, and their connection with other atmospherical phenomena alike be transmitted to this central point for reduction and examination, we should, as a nation newly issued as it were into life, be forming one link in that important chain, which must ere long encircle the whole earth. With the new appliances of science and art in our sub marine telegraph, our storm signals and weather-casts, we should endeavor to unravel the hidden mysteries of those laws which meteorological science has not yet been able to reveal from want of unity of purpose.

If by these united efforts and by these investigations we can predict the ebb and flow of our atmosphere as we can now the ebb and flow of the tide, we should then be in a position to foretell with a great amount of certainty any of those changes that have so direct a bearing on our maritime and agricultural pursuits. We could then at once establish at our principal seaports and head-lands those beacons which might warn the sea-faring man of his impending danger and prevent by timely notice that loss of life and property which every year it is our misfortune to witness and which we feel sure so soon as science is properly and duly applied, may be averted.

The neglect of the study of Meteorology in the Universities of Great Britain is much to be regretted. Its assiduous study in such countries as the United States, Austria, France, Russia, Norway and the Netherlands stand out in striking contrast. In the United States alone we have 800 observers, in Austria 118, and in Switzerland 83. There are now 1,500 rain-gauges in

England employed to ascertain the amount of the rainfall, and we can boast that in British North America the science of Meteorology is taught in our Colleges and Grammar Schools. Observatories have been established through the generosity of our Government at those points of great importance, Halifax and St. Johns, N. B. All that we now require is unity of purpose so as to bring our united efforts to a useful end. We propose to offer suggestions in reference to the organization of some plan of action in a future number. C. S.

METEOROLOGICAL REPORT FOR THE YEAR 1868.—The following summary embraces the principal meteorological phenomena for the past year (1868) condensed from the records of the Montreal Observatory. The geographical co-ordinates being latitude 45° 31′ North, longitude, 4h. 54m. 11 sec. west of Greenwich; the cisterns of the barometers are 182 feet above mean sea level.

The readings have all been corrected from instrumental errors, and the readings of the Barometer have been also corrected for temperature (32 ° F.)

ATMOSPHERIC PRESSURE.—The highest reading of the year occurred at 7 A.M. on the morning of the 30th of October, and indicated 30.400 inches. The lowest reading during the year was at 5 A.M. on the 7th day of December, and indicated 28.687 inches, shewing an annual range of 1.713 inches. The yearly mean was 29.537 inches.

Below is a table for each month, shewing the highest and lowest readings:—

	January.	Feb.	March.	April.	May.	June.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Highest............	30.146	30.248	30.347	30.034	29.999	29.998
Lowest............	29.149	29.033	29.250	28.867	29.247	29.247
	July.	**August.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
	Inches.	Inches.	Inches.	Inches.	Inches,	Inches.
Highest............	29.902	30.061	30.100	30.400	30.249	30.212
Lowest............	29.446	29.271	29.362	29.250	29.161	28.687

TEMPERATURE OF THE AIR F°.—The highest reading of the Thermometer during the year was on the 13th July and was 98·7; the lowest reading was on the 11th of February and was 22·4 degrees (below zero.) The mean temperature for the year was 42·45. This agrees exactly with the observations on the mean annual temperature made by the late Hon. Mr. Justice McCord, also with my own, but it is nearly 2° degrees lower than the mean annual temperature furnished from observations of the late Dr. A. Hall.

The yearly range or climatic difference for the year was 121·1 degrees.

The extreme heat of July was marked by a mean temperature of 76° which exceed by 5° degrees the *Isothermal* for Montreal, deduced from observations continued during a long series of years, and there were during the month *two distinct* hot terms, including the 2nd, 3rd, 4th, and 5th days, when the mean temperature was 82·3, 84·7, 84·4, and 83·1 respectively. The Thermometer never indicated less than 72·7 during the 24 hours.

The *second* hot term includes the 11th, 12th, 13th, 14th, 15th, and 16th days; their respective means being 84·0, 87·6, 87·1, 87·9 and 85·5, and the temperature during this term was never below 71.4 during the 24 hours.

Below is a table shewing the months' highest and lowest readings, also the monthly means, together with the amount of rain and snow in each month:—

MONTHS.	Mean Temperature in F.°	Highest Temperature.	Lowest Temperature.	Rain, depth in inches.	Snow, depth in inches.
January........	10°80	37°2	—13°2	....	12.63
February.......	9°49	33°1	—22°2	....	22.20
March..........	31°90	67°0	—15°6	1 429	5.34
April..........	38°95	68°2	12°9	0.241	14.93
May............	53°89	82°3	36°4	3.462	.....
June...........	66°40	95°7	40°0	0.486	.....
July...........	76°00	98°7	59°1	2.124	.....
August.........	69°94	87°9	52°2	2.362	....
September......	57°94	80°7	37°2	3.494	.....
October........	44°82	69°1	22°1	0 794	4.92
November.......	33°30	53°0	20°7	4.473	17.28
December.......	16°00	32°1	—10°2	....	27.96

The following table shews:—

MEAN TEMPERATURE of the Quarters, with the amount of Rain and Snow, in inches, for the year ending 1868.

Months.		Temperature.		Rain	Snow.
Winter	December.....	10°99	....	0.518	26.16
	January.......	10°80	....	....	12.64
	February.....	9°49	....	....	22.20
	Mean.	10°42	Amounts.	0.518	61.00
Spring	March.........	31°90	....	1.429	5.34
	April..........	38°95	....	0.241	14.93
	May...........	53°89	....	3.462	....
	Mean.	41°58	Amounts.	5.132	20.24
Summer	June..........	66°40	....	0.486	....
	July...........	76°00	....	2.124	....
	August.......	69°94	....	2.462	....
	Mean.	70°78	Amounts.	5.972	......
Autumn	September....	57°94	....	3.494	....
	October	44°83	....	0.794	4.92
	November.....	33°30	....	4.473	17.28
	Mean.	45°45	Amounts.	8.761	22.10

RAIN AND SNOW.—The amount of rain which fell was very much below the average, when compared with previous years. In the month of July there were 16 days on which no rain whatever fell. Rain fell on 31 days during the year, and amounted to 18.865 inches on the surface.

Very few observations of a reliable kind on the rain and snow fall have been recorded for Montreal, but the few to which we have had access would give the mean annual amount of rain somewhat above 36 inches, or about double the quantity which fell during the past year (1868.) This unusual dryness was also felt in Great Britain and on the continent of Europe.

Snow fell on 61 days, amounting to 105.27 inches on the surface. The first snow of Autumn fell on the 17th of October. The first frost of Autumn occurred on the 17th of September, and winter fairly set in on the 7th of December. The first steamer arrived in the port of Montreal on the 17th of April.

WINDS.—The most prevalent winds during the year were the West and W.S.W. The next in frequency were the N.E. and N.E. by E. The least frequent wind was the East.

There were 177 nights clear at 9 P.M., suitable for astronomical observations; this is somewhat above the usual average.

The year was not distinguished by any remarkable displays of the Aurora Borealis, although these phenomena were visible on several nights during each month. Several slight shocks of earthquakes were felt both at Montreal and in its immediate vicinity.

The grand meteoric display was well seen from 11h. 35m. P.M. on the 13th November, to 3h. 45m., A.M., of the 14th, and was most profuse and brilliant.

MISCELLANEOUS.

Illumination of Microscopic Objects.—Notwithstanding the many ingenious methods of microscopists for the illumination of the minute objects they study, none of them seem hitherto to have been based on thoroughly artistic, if, indeed, even on sufficiently correct principles. The new hemispherical condenser, invented by the Rev. J. B. Reade, is certainly, in one point of view, the most correct in principle, and practically the best as far as the proper delineation of objects is concerned. Of its value in bringing out fine lines and markings on the scales of *Podura angulatum* and various other test objects a single inspection would be sufficient for the most obdurate disbeliever in its efficacy. The principle is a modification of semi-circular illumination,—or illumination from one side only, as artists adopt in their pictures. An ordinary achromatic condenser throws the light all round the object, and, consequently, as each half of the circle of illumination throws shadows from any prominences or thicknesses of the object in opposite directions, so there are also illuminations of the shadows from both sides of the circle of light, and the definition of the object, which is only brought out by the *depth* of the shadows, must be weakened. Mr. Reade invented his condenser, as many other things have been invented, by an accident. He placed a lamp directly in front of his object, and another lamp at right angles to it at the side. The shadows were consequently *artistically* thrown upon the object, and he found the definition of it wonderfully increased. From this it occurred to him that by using a hemisphere of glass and covering the top or flat surface with two oversliding diaphragms, pierced with certain orifices, he could throw one ray of light longitudinally and another at right angles horizontally over his object; and that by means of the overcrossing of the intermediate slits of the diaphragms he could throw an intermediate ray at any angle he desired. This in principle, is a semi-circular illumination, but improved by shutting out all but necessary light, and consequently intensifying the shadows; so much so that, with one of the admirable half-inch object-glasses now manufactured by Mr. Andrew Ross, results are conspicuously obtained, which before were but obscurely or were quite unattainable by quarter-inch and even one-eighth-inch glasses. Mr. Mackie has suggested that the principle should be applied to the illumination of opaque objects, the reflected light from the Lieberkuhns being now likewise dispersed over the shadows of the object by the circular radiation from their brightly polished surfaces and no artistic effects are produced, as would be the case if the light were thrown down from one side of the Lieberkuhn only.

THE "NATURALISTE CANADIEN."—We have received the first number of this periodical, and hail with no small pleasure its advent. It is under the direction of the Abbé Provencher, Curé of Portneuf; and is printed in our sister city of Quebec. It contains twenty-four pages of printed matter; and we fully endorse the views of the author's prospectus, "that while furnishing to the amateur the medium of the study of Natural History, it will, at the same time, be the means of disseminating all new discoveries, and form the means by which the public will participate in these investigations."

There is also a page devoted to the Meteorology of Portneuf, which forms a new and important point of observation. We hope that investigations will ere long be extended to other points on the Lower St. Lawrence, and we sincerely wish the author that success which his energy and devotion to the science so richly deserves. C. S.

SOCIAL AND SANITARY SCIENCE.—One of the greatest social problems in all civilized nations is, how to return to the earth what is taken from it; or, how to collect and return to the soil, in a way profitable for cultivation, the refuse of man and animals which now, under favorable circumstances, runs to waste, and, under ordinary circumstances, remains to breed disease.

The simplest of the modes yet adopted is now coming into extensive use in England, viz., "Moule's Earth Closets." It is simply a convenient application of the old principle, that earth is the best absorbent of fœtid matter. The patent consists in an easy mode of dropping dry earth on excreta and carrying it off, charged with plant-food, in pans. It is now being tried, with excellent results, in the Kingston Penitentiary and other public institutions. How far it can be adapted to the ordinary requirements of city or of country life, during our severe winters, remains to be seen. All who have the opportunity will do well to try experiments in it, and communicate their results to the editor of this department, who is also the Honorary Secretary of the Montreal Sanitary Association. The experiment in the English camp during the last unusually hot summer was marvellously satisfactory; all previous experiments, even with good closets and drains, having more or less failed.

The evils of the old system, even with a fair amount of sewering, and a large average of closets, are terribly apparent in the continued, and even increased, mortality of Montreal, in spite of increased vigilance on the part of the sanitary police. The death-rate for 1868 amounts to within a fraction of forty per thousand, or one in every twenty-five. The details will be discussed in the ensuing number.

P. P. C.

PHYSIOLOGICAL.—At a recent meeting of the Royal Society a paper was read by Mr. W. S. Savory, "On the Structure of the Red Blood Corpuscle of Oviparous Vertebrata," which goes far to overturn the conclusions accepted and held by many physiologists. They have maintained that between the red blood corpuscle of mammalia and that of other vertebrate classes a fundamental distinction existed; the distinction being a nucleus in the red corpuscle of the oviparous vertebrata. Mr. Savory shows, according to the *Athenæum*, that this nucleus has no existence, that the appearance which has been mistaken for a nucleus is merely a change which the blood undergoes after death, and by being kept too long before it is put under the microscope for examination. And he describes a method by which the formation of the so-called nuclei can be observed and their fictitious character detected. Assuming that this view is well founded, it follows, to quote Mr. Savory's words, "that the red corpuscle of all vetrebrata is in its natural state structureless."

THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

MODERN IDEAS OF DERIVATION.

Address of Principal DAWSON, as President of the Natural History Society of Montreal. Read at the Annual Meeting, May 18th, 1869.

The sphere of this Society as a modest collector and preserver of local facts in Natural History, does not preclude its glancing at the more difficult and abstruse questions which agitate Naturalists elsewhere; and perhaps no place is more fitting for this than the annual address of the President. I propose, therefore, on the present occasion, to direct your attention to the present state of those exciting questions agitated in our day by Geologists, Zoologists and Botanists, as to the origin of Species and Genera, and the law of their creation.

Time was when Naturalists were content to take nature as they found it, without any over curious inquiries as to the origin of its several parts, or the changes of which they might be susceptible in time. Geology first removed this pleasant state of repose, by showing that all our present species had a beginning, and were preceded by others, and these again by others. Geologists were, however, too much occupied with the facts of their science to speculate on the ultimate causes of the appearance and disappearance of species, and it remained for Zoologists and Botanists, or as some prefer to call themselves, Biologists, to construct hypotheses or theories to account for the ascertained fact that successive dynasties of species have succeeded each other in time. In our day, Darwin has given to such speculations a form and coherency which they did not before possess, by his doctrine of Natural Selection; and theories of derivation and transformation are perhaps more popular than at any previous time, and are impressing themselves legibly on the practical every day work of science. In these circumstances it becomes necessary to watch the phases of opinion on this subject, to examine the various doctrines propounded, and to ascertain what progress they are making, if any, toward the goal of truth.

A very important contribution to this work has recently been made by Professor Owen in the concluding chapter of his great book on Physiology, just completed; and I shall take this as the basis of some remarks on the present state of the question of derivation.

Prof. Owen, availing himself of the privileges of a father in Science, goes back to 1830 in reviewing the history of doctrines of derivation, and shows that in his student days the question of the origin of species was agitated by the great Cuvier and his contemporary, Geoffroy St. Hilaire, and that both of these great masters of Natural Science had doubts as to the permanency of species in geological time, though neither had before him enough of biological evidence to establish this as a fact, or to frame any certain theory as to the relation of modern to extinct species; and Cuvier, at least, saw evidence against derivation in the apparent want of connecting links between fossil and recent species. Owen endeavours to arrange the questions raised in 1830 under several heads, and to state each as then agitated, and to "post it up," so to speak, to the present period—his evident intention being to show that the views of Darwin and other recent advocates of theories of derivation are by no means so original as they are supposed to be.

The first great question agitated by the French naturalists forty years ago is that grand one — Is there unity of plan or final purpose in living creatures? Are the homologies or resemblances of structure in organized beings merely parts of the general plan, or do they point to genetic or other relations of derivation? Are the beautiful adaptations of organs to functions, and of organisms to places in nature, evidences of deliberate purpose working out its ends by means, or have the external necessities given form to the organs? On this question Cuvier, in his assertion of teleology, evidently took the broader and more philosophical view, that which commends itself to the grander and higher style of mind; but neither he nor his opponent were in a position to see fully the bearings of the question. Owen himself, though largely in advance of most other writers of this time, is not free from misconceptions. He clearly sees, with all the more profound thinkers among naturalists, that whichever view we adopt, the problem can be solved only on the hypothesis of a "predetermining intelligent Will." Without this, nature is only a riddle without a solution—man himself a contradiction and impossibility. But, admitting this, are those resemblances which we call homologies, those adaptations which we call analogies, results of direct creative acts or of the operation of secondary causes? If the former, they are ultimate facts, referable directly to will; if the latter, we may study their more immediate causes, and the laws under which these operate. Cuvier and many of his most illustrious disciples have been content to adopt the former alternative. Owen declares that in this he has been led to differ from his great master. The reasons which he gives under this head are, it must be confessed, feeble. He found it necessary to assume an "archetype" or ideal type in explaining the vertebrate skeleton; but this would have been equally suitable under the hypothesis of direct creation or that of secondary causes. He saw in the recurrence of similar segments in a vertebral column and other cases of repetition of similar parts, something analogous to the repetition of similar crystals, as the result of "polarizing force in the growth of an inorganic body." But there is scarcely more philosophy in this than there is in the process by which a savage, ignorant of manufacturing processes, might explain, as the result of some unknown process of crystallization, the recurrence of forms in the pattern of a piece of calico or in the beads of a necklace. Still we are willing to allow due value even to the impressions made upon the minds of naturalists by such facts, and to go on to the next question of the series. Before doing so, however, we must take exception to one expression of the great English naturalist, which, in various forms, recurs in several places. He calls the theory of derivation a principle "more especially antagonistic to the theological idea" of creation. Now, if by the theological idea he means that promulgated in the first chapter of Genesis, he should explain wherein the antagonism consists. The object of the writer in Genesis is obviously to illustrate and enforce the existence and attributes of the Supreme Intelligent Will as opposed to Polytheism, Pantheism and Atheism, and the fact of an orderly and serial origin of things. But if he says that animals were made "according to their kinds," has any modern naturalist a right to hold that the kinds or species of Genesis are equivalent to those of any school of zoologists in our day? Further, all who profess to be acquainted with this part of theology should know that the word "create" is applied in Genesis only to the first animals, and to man considered as an intelligent and moral agent. The other animals and all plants are said to have been "made," "formed," "brought forth," implying that the writer had before his mind the idea of a primary and secondary kind of origin of organized beings. I endeavoured many years ago, in a work well known to members of this Society, and published before Darwin's Origin of Species, to illustrate this old "theological idea." Since naturalists will bring up such subjects, I may be excused for reminding them that if they should come to believe, on zoological and geological grounds, that some of the entities which we call species have been produced by a method which may be properly termed creation, and others by secondary processes, they may possibly find themselves to be in perfect harmony with the oldest and most authoritative theological ideas on the subject.

The second great question as to Derivation is that which relates to the succession of species in Geological time. Was this broken or uninterrupted? Did new species die out and were old ones created in their room, or were the new ones derived by some secondary process from those which preceded them? This question can only be finally settled by inductive investigation, and unfortunately our knowledge of extinct animals and plants is still too imperfect to give us the necessary accumulation of facts. We can only inquire as to a few cases a little better known to us than others. One curious feature of the inquiry is that it seems easier to show relationships between large groups of animals than between particular species. The reasons of this will appear farther on. Prof. Huxley, with his usual dexterity in presenting these problems to the popular comprehension, has recently taken advantage of this in tracing the links of connection between birds and reptiles.* By a series of cleverly arranged transitions, he has succeeded in constructing such a series as no doubt sufficed to

* Royal Institution Lecture on Animals intermediate between Birds and Reptiles.

convince many of his auditors that the gigantic and grotesque Iguanodons of the Mesozoic rocks might have been the progenitors, if not of wrens and titmice, at least of ostriches and cormorants. Yet he could not have placed together any two members of the supposed series without convincing any naturalist that an enormous gap had to be filled between them. Prof. Owen, writing to naturalists, does not attempt this sort of intellectual sleight of hand, but presents, as a case in point, the supposed progenitors of the horse. That useful quadruped was preceded in the tertiary period (Miocene and Pliocene) by a horse-like animal, the Hipparion, which, among other things, differed from its modern representative in having its splint bones represented by two side toes, a conformation supposed to adapt it to locomotion on soft and swampy ground. The Hipparion was preceded in the earlier tertiary (Eocene) by the Palæotherium, in which the side toes were still further developed so as to touch the ground, giving the foot a tridactyle character. These relations induce Owen to believe that these forms may be an actual genetic series, the species of Palæotherium passing through a succession of changes into the modern horse. Perhaps this case, as put by Prof. Owen, affords as fair an example as we can obtain of the bearing of a derivative hypothesis. The three genera in question are closely allied. They succeed each other regularly in Geological time. The horse shows in his splint bones rudiments of organs, which, serving little apparent purpose in him, were more fully developed and of manifest use in his predecessors. Modern horses have occasionally shown a tendency to develop the side toes, as if returning to the primitive type. Taking this as a fair example of derivation, and admitting, for the sake of argument, its probability, let us consider shortly some of the questions that may be raised with regard to it. These are principally two.

1. What limits, if any, must necessarily be set to such an hypothesis, and what relations does it bear to the origin of life at first and to the succession of animals in Geological time ?

2. What causes may be supposed to have led to such derivation ?

Under the first head, we have to enquire as to the limits set to derivation by the structure of organic beings themselves, and by the physical conditions and changes which may affect them. It will be convenient to consider these together.

Supposing that Palæotherium, Hipparion and Equus are links in a chain extending from the Eocene Tertiary to the present time, can we suppose that by tracing the same series further back it might include any Mammal. We must answer decidedly not, for if the whole time from the Eocene to the present has been required to produce the comparatively small change required from Palæotherium to horse, that in other cases would carry us back to the Mesozoic period, long before we have any evidence of the existence of "placental mammals." In other words, the Tertiary and Modern Periods will give us time enough only to effect changes of Mammals within the order Pachydermata, and perhaps in only one section of that order. The other orders must therefore constitute separate series, and these series must have been advancing abreast of each other. Had each series a separate origin, or is there any Mammalian stock in the Mesozoic from which, at the beginning of the Tertiary, these several lines of types may have diverged? Here our information fails. We know only a few small Marsupial Mammals in the Mesozoic. On our hypothesis it is possible that these may have been the progenitors of the more varied and advanced Marsupials of the Tertiary and Modern periods, but scarcely of the placental Mammals of the Eocene. There may have been placental Mammals, unknown to us, in the Mesozoic, which may constitute the required stock. The reptiles of the Mesozoic utterly fail to give us the necessary links. If they were changing into anything it was into birds, not into Mammals.

Again, the time in which the horse and its supposed progenitors have lived is one of continuous, unbroken succession of species. More especially in the later Tertiary there seems the best evidence of gradual extinction and introduction of species, without any very wide-spread and wholesale destruction, and this notwithstanding the intervention of that period of cold and of submergence of land in the Northern hemisphere, which has given rise to all the much-agitated glacial theories of our time. Can we affirm that such piecemeal work has continued throughout Geological time? At this point opens the battle between the Catastrophists and Uniformitarians in Geology, a battle which I am not about to fight over again here. I have elsewhere stated reasons for the belief that neither view can be maintained without the other, and that Geological time has consisted of alternations of long periods of physical repose and slow subsidence in which our more important fossiliferous formations have been deposited, with others of physical disturbance and elevation, with extinction of species. Dana has well shown how completely this view is established by the series of Geological formations as seen on the broad area of the American continent. Now the question arises, how would the law of derivation operate in these two different states of our planet? Let us suppose a state of things in which far more forms were being destroyed than were reproduced—another in which introduction of species was more rapid than extinction. In the latter case we may suppose an exuberance of new species to have been produced. In the former there would be a great clearance of these, and perhaps only a few types left to begin new series. Do we now live in one of the periods of diminution or of increase? Perhaps in the former, since there seems to have been, in the case of the Mammalia of the Post-pliocene, an enormous amount of extinction of the grandest forms of life, apparently without their replacement by new forms. If so, how far can we judge from our own time of those which preceded it? They may have been far more fertile in new forms, or perhaps farther in excess in the work of extinction. The question is further complicated with that which asks if these differences arise from merely physical agencies acting on organic beings from without, or is there in the organic world itself some grand law of cyles independent of external influences? The answers to such questions are being slowly and laboriously worked out by Geologists and Naturalists, and all the more slowly that so many inevitable errors occur as to the specific or varietal value of fossils and the relative importance of Geological facts, while the great gaps in the monumental history are only little by little being filled up.

Nothing can more forcibly illustrate the amount of work remaining to be done toward the settlement of these questions than a glance at the elaborate and most valuable "Thesaurus Siluricus" of Dr. Bigsby, recording, as it does, nearly 9,000 species of animals already found in the Silurian rocks. The rapid increase in the number of known species shows that we know as yet but a fraction of this ancient fauna, while the facts relating to introduction, extinction, geographical distribution and distribution in time, show that we are still a very long way from any definite conclusions as to the general law of succession and its relations to physical changes.

The application of these questions to the animals referred to by Owen, will serve farther to shew their significance as to limitations of derivation. Pictet catalogues eleven species of Eocene Palæotheria. Without inquiry as to the origin of these, let us confine ourselves to their progress. Under the hypothesis of derivation, each of these had capacities for improvement, probably all leading to that line of change ending in the production of the horse. If so, then each of our Palæotheria, passing through intermediate changes, may be the predecessor of some of the equine animals of the Post-pliocene and Modern periods. But if, as seems probable, the time intervening between the Eocene and the Modern was unfavourable to the multiplication of such species, then several may have perished utterly in the process, and all might have perished. Supposing, on the contrary, the time to have been favourable to the increase of such creatures, we might have had hundreds of species of equine animals instead of the small number extant at present. Again, what possibilities of change remain in the horse? Can he be supposed capable of going on still farther in the direction of his progress from Palæotherium, or has he attained a point at which further change is impossible? Will he then, in process of time, wheel round in his orbit and return to the point from which he set out? Or will he continue unchanged until he becomes extinct? Or can he at a certain point diverge into a new series of changes? We do not know any Palæotherium before the Eocene. Is it not possible that they may have originated in some way different from that slow change by which they are supposed to have been transmuted into horses, and that in their first origin they were more plastic than after many changes had happened to them? May it not be that the origin of forms or types is after all something different from derivative changes, and that new forms are at first plastic, afterwards comparatively fixed—at first fertile in derivative species, and afterward comparatively barren. Certainly, unless something of this kind is the case, we fail to find in the Modern world a sufficient number of representatives of the Palæotheria, Anoplotheria, Lophiodons, Elephants and Mastodons of the tertiary. On the other hand, it is scarcely possible to find a sufficient starting point in the

Eocene for the multitude of Ruminants and Carnivores and Quadrumana of the Modern time.

But it may be said, and truly, that these higher forms of life put the doctrine of derivation to the severest test. If we take marine invertebrata, we may trace analogues of these back into the earliest geological periods, and as the species are very numerous, and their structures more simple, it is easier to imagine a continuous derivation with respect to them. Still, even here such facts as the vast multiplication of species of Trilobites, Ammonites, Belemnites, and Ganoid Fishes, at different periods of Geological time, and their disappearance without modified successors, point to limitations of any law of derivation that may be suggested.

To sum up where all is so uncertain is not easy; but we may, I think, affirm that if existing animals are derivative as modified descendants of others—(1) They belong to a vast number of lines of modification which would require to be traced backward separately. (2) That many of these lines end abruptly in comparatively recent periods, perhaps in consequence of our defective information, perhaps because of some other law of creation. (3) That in some periods a series must suddenly bud forth into many ramifications, and in others contract to a few representations or be altogether dropped. (4) That the beginning of such series may take place in a different manner from derivation, and that the law of new series is probably different from that of those of longer derivation. (5) That it is absurd to suppose that any modern animal has originated from any now contemporary with it (e.g., man from the gorilla or bears from seals), since all these existing species must belong to series to be traced backward through species now extinct, and possibly unknown to us. (6) That while it is obvious that such derivation must be related to contemporary physical changes, our views of the nature of that relation must depend on those which we take of the causes of derivation itself.

Before proceeding farther we may remove another of the "theological" misconceptions under which Owen and some other writers on this subject seem to labour. They think that the "Biblical flood" interposes some difficulties in the way of their speculations as to the origin of species. They may readily be relieved from all embarrassment on this subject. The language of the Noachian record in Genesis implies that the Deluge was universal only in so far as man was concerned. The catalogue of animals taken into the Ark, five times repeated, and that of animals destroyed, twice given, show that only a very limited number of species were in the Ark, and that of the rest some certainly survived—others may have perished. Farther, the catastrophe does not require us to suppose either that coral polypes and other marine animals were overwhelmed with fresh water or under an abyssal depth of ocean, for the submergence of the dry land, or of a portion of it, by the "breaking up of the fountains of the great deep," does not imply a deepening of the ocean, but possibly to some small extent a shallowing of it. If the Royal Institution, of London, which has recently done so much in its courses of lectures to ventilate new and sometimes questionable scientific hypotheses, would employ some one to give a few exegetical lectures on the earlier chapters of Genesis, without entering into any disputed questions of criticism, but merely explaining the literal meaning of the terms of the record, it would confer an inestimable benefit on those Naturalists who seem to have derived their notions of the Biblical Creation and Deluge from the picture books and toy Noah's Arks of their childhood, with the comments of their nursery-maids thereon.

It still remains to us to inquire whether the doctrine of derivation can throw any light on the origin of life at first. Nothing in the doctrine of derivation itself necessitates the belief that change has always been in the direction of improvement or of increased complexity; but the Geological history of the earth and the succession of fossils lead to the belief that the general tendency of creation has been from more generalized to more specialized forms, and from simpler to more complex organisms. Still, it is evident that this general doctrine of improvement is to be held with some limitations of detail. For example, the very lowest forms of life have continued down to the present, and some of them—for instance, the sponges and Foraminifera—have apparently attained to their greatest extension in number of species in comparatively late periods. Further, every new form when first introduced appears to be at its maximum in point of development; or, if not so, it rapidly attains to this, and again deteriorates when being supplanted by other and newer forms. Numerous examples of this will occur to every Geologist. Admitting, however, that development has in some cases been indefinitely postponed, and that in others it has advanced by successive waves, each retreating before the advance of the next, still, we may hold that it would be fair to assume a gradual progress from lower to higher forms. Assuming this, and that the lower have preceded the higher, we may limit our inquiry as to the origin of life to the lowest forms, and ask what is involved in the question of their origin. Now, it is easy to affirm that the lowest animals and the lowest plants are but Protoplasm, which is only another name for the chemical compound Albumen, and that if we can conceive this to originate from the inorganic union of its elements, we shall have a low form of life from which we can deduce all the higher forms of vital action. In making such affirmation we must take for granted several things, none of which we can yet prove:—(1) That vital force is merely a modification of some of the forces acting in unorganized matter; (2) That such force can be spontaneously originated from other forces without the previous existence of organization; (3) That being originated, it has the power to form Albumen and other organic compounds. Or, if we prefer another alternative, we may take, instead of the last statement, :—(1) That Albuminous matter can be produced by the union of its chemical elements without life or organization; (2) That being so produced it can develop vital forces and organization, including such phenomena as sensation, volition, reproduction, &c. To believe either of these doctrines in the present state of science is simply an act of faith, not of that kind which is based on testimony or evidence, however slight, but of that unreasoning kind which we usually stigmatize as mere credulity and superstition. It will not help us here to say that vegetable and animal infusions, destitute of germs, will produce a "mucous layer" or "proligerous pellicle" from which organisms may arise, for in the first place such infusion itself contains organic matter, and, as Tyndall has lately shown incidentally in his experiments with the electric light, we have to operate with air and water and vessels, which it is wholly impossible by any chemical or mechanical process to free completely from the smaller kinds of germinal matter.

It is rather discouraging thus to find that, on the philosophy of derivation, as our faith advances the demands upon it increase, until, from belief in the derivation of Horses from Hipparia, we are finally obliged to believe that life with all that it involves is nothing but a peculiar manifestation of dead inorganic forces. In order that, if possible, we may relieve ourselves from this burden, let us now turn to our second inquiry, and consider the causes which are alleged to produce the transmutation of species.

Leaving out of the account many fanciful and untenable hypotheses, both ancient and modern, we may notice :—(1) The Lamarckian theory of Appetency; (2) The Darwinian theory of Natural Selection; (3) The Owenian doctrine of "Innate tendency to deviate from parental type;" (4) The doctrine of arrested or advanced embryonic development;—with the view of ascertaining how far these several hypotheses may be employed to account for observed facts.

(1.) The Lamarckian theory is essentially that of effort in certain directions giving power in those directions, and consequently altering organs. That it has a real basis in nature no one can doubt who has observed the effect of use and effort in determining the development of organs. That it can produce only varietal forms and not species, and that it is practically very limited in its operation, are facts equally patent. It is a mistake, however, to suppose that Lamarck confined himself to the effect of will in producing change. He considered also the effect of external circumstances, and of habits induced by such circumstances, in which respect his theory differed less than is generally supposed from that of Mr. Darwin. The main difference is, that Lamarck supposed animals to be acted on by an attractive influence from before, Darwin by a propelling influence from behind. In this respect Lamarck's hypothesis is the more philosophical, when regarded as means of real progress; but it is less applicable to the lower animals and to plants than to animals of high grade.

(2.) The most popular theory of derivation in the present day is undoubtedly that of Darwin. This view is, essentially, that all organized beings are engaged in a struggle for existence; that in this struggle certain varieties arise, which, being more suited to the conditions, prosper and multiply more than others; that this amounts to a "Natural Selection" similar in kind to the artificial selection of breeders of stock; that members of the same species, isolated from each other and subjected to struggles of different kinds, will in process of time become specifically distinct. The difficulties of Darwinism are many. The following may be stated as fatal to it in its capacity of a sole mode of accounting for derivation : — (1) Conditions which involve a struggle for existence are found by experience to result in deterioration and final extinction rather than improvement, and are directly opposite to those employed by breeders for their purposes. (2) Even if we include, along with the struggle for existence, the action of all conditions, favourable and unfavourable, tending to change, we fail to find any evidence of this other than the formation of varieties and races. True species, no longer capable of interbreeding, have not been observed to be produced. (3) Though it is conceivable that species may have been produced during the lapse of time, yet even this is rendered improbable by the enormously long periods which Mr. Darwin himself admits to be necessary, and which seem to overgo the possibility of the existence of the creatures in question as far back in geological time as the theory demands.

(3.) Owen desires to substitute for the above views "an innate tendency to deviate from the parental type operating through periods of adequate duration." According to this hypothesis "a change takes place first in the structure of the animal, and this when sufficiently advanced may lead to modifications of habits." It is difficult to understand this as anything more than a mere statement of a belief in derivation as a fact. It seems to mean that species change because they tend to change. We may add to this if we please that they change independently of external circumstances, and by virtue of a creative plan embodied in them, or rather in the matter of which they are composed; for Prof. Owen appears to stretch his theory so far as to assert the formation of species spontaneously from inorganic matter, thus giving us the additional thesis that species tend to be before they actually exist. It is also to be observed that the tendency to change, though not caused by external circumstances must act in unison with physical changes, otherwise it would be worse than useless. Taking the case of the Hipparion and horse, Lamarck would inform us that the former endeavoured to accommodate itself to drier and harder ground, and thus changed the character of its feet. Darwin would say that as the ground became harder those individuals which had the most equine feet would succeed best in the struggle for existence. Owen very properly demurs to both views, holding that there were dry and wet places suitable for horses and Hipparia both in the Miocene and Modern periods, and that the increase of dry ground would merely limit the range of Hipparia and not produce horses; but he holds that the Hipparia changed into horses merely because they tended to do so, and that if the change suited the conditions of the case, that was a correlation arising from the plans of the Creator, and with which their poor brains and greater or less safety and comfort had nothing to do. If we were disposed to accept this hypothesis of Owen, we should not in doing so arrive at any true cause, and we should at the same time find ourselves involved in the old difficulties. That a Hipparion should change into a horse it would be necessary that not only his feet but his teeth and other structures should change in harmony with each other. This must take place either at once or gradually. If at once, then a pair of horses must be born from Hipparia in one herd, and must be isolated from the rest so as to produce a herd of horses. This is hard to believe; and if we resort to gradual change, the required isolation of the breed will be still more difficult to secure. The demands upon our faith are obviously greater here than even in the hypothesis of Darwin,—that is if we can be induced to place any reliance on the argument of the latter as to struggle for existence.

(4.) The last of these hypotheses which I shall notice, and, in my view, the most promising of them all, is one which has recently been ably advocated by Mr. Edward D. Cope in a memoir on the "Origin of Genera," published in the Proceedings of the Academy of Natural Sciences,* and which is based on the well-known analogy between embryonic changes, rank in the Zoological scale and Geological succession. It may be illustrated by the remarkable and somewhat startling fact, that while no authenticated case exists of animals changing from one species to another, they are known to change from one genus or family to another, and this without losing their individuality. Prof. Dumeril, of Paris, and Prof. Marsh, of New Haven, have recently directed attention to the fact that species of *Siredon*, reptiles of the Lakes of the Rocky Mountains and of Mexico, and which, like our North American *Menobranchus*, retain their gills during life, when kept in captivity in a warmer temperature than that which is natural to them, lose their gills, and pass into a form hitherto regarded as of a different genus and family,—the genus *Amblysoma*. In this case we may either suppose that the Amblysoma, under unfavourable circumstances, has its maturity and reproduction prematurely induced before it has lost its

* Philadelphia, 1869.

gills, or that the Siredon has, under certain circumstances, the capacity to have its period of reproduction arrested until it has gone on a stage further in growth and has lost its gills. In any case the same species—nay, the same individual—is capable of existing in a state of maturity as a creature half fish and half reptile in regard to its circulation, or in a more perfect reptilian state in which it breathes solely by lungs. Further, we may suppose conditions of the earth's surface in which there would only be Siredons or only Amblysomas, and a change in these conditions inducing the opposite state. Here we have for the first time actual facts on which to base a theory of development. These facts point to the operation of two causes—first, the possible *Retardation* or *Acceleration* of development, and secondly, the action of outward circumstances on the organism capable of this retardation or acceleration. We here substitute for the tendency to vary of Owen's theory, the ascertained fact of reproductive retardation or acceleration, and for the struggle for existence, the action of changed physical conditions, and for the question as to the change of one species into another, the change of the same species from one genus into another. Further, instead of vague speculations as to possible changes of allied animals, we are led to careful consideration of the embryonic changes of the individual animal, and as to the differences that would obtain were its development accelerated or retarded. We can thus range animals in genetic series within which anatomical characters would show change to be possible. I cannot follow these series out into the elaborate lists tabulated by Mr. Cope, but may proceed to notice the limitations which his views put to the doctrine of derivation. It is obvious that, if this be the real nature of derivation as a possible hypothesis, then derivation must follow the same law with metamorphism and embryonic development. Those animals which undergo a metamorphosis must be those most liable to such changes; for example, a Batrachian would be more likely to be so than a true reptile,—consequently those lower forms of animals in which metamorphosis is most decided would be those in which derivation would be most active, and when they had attained to a condition in which metamorphosis is of less amount, the tendency to change would be diminished. When we compare this with the actual succession of animals in geological time, we can see, as many Palæontologists have remarked, that order of succession in time and order of embryonic development correspond with one another to a remarkable degree. We see also, however, that in the higher animals changes of species have taken place more rapidly than in those of lower grade, though in the latter metamorphosis is usually more marked—a fact not apparently in accordance with our hypothesis.

According to this view, also, a species once created may have in itself a capacity for passing through several generic forms, constituting a cycle which ever tends to return into itself, or to advance and recede by steps more or less abrupt under the law of retardation and acceleration, combined with the influence of external circumstances. Yet the dimensions of the orbit of each species must be limited, its duration in time must also be limited, and its capacity to pass into a really new species must still be a point subject to doubt, but open to anatomical investigation and inference. As already hinted, it is a most important point of this theory, that when we have ascertained the series of embryonic changes of any animal, we have thereby ascertained its possibilities in regard to accelerated development. Its possibilities in regard to retarded development may be inferred by similar studies of animals higher in the scale. Now, if we knew the embryonic history of every animal recent and fossil, in its anatomical details, we should be able to construct out of this a table of possible affiliation of animals, and should be able to trace our existing species through the same genera, families, orders and classes in which they might have existed in geological time, and to predict what they might become in time still to come. This hypothetical scheme of creation would approach to the actual one in as far as we were able to correlate it with the physical changes which have occurred or will occur on our planet. Let us take as a crucial test the case of man himself. The actual anatomical and physiological differences which obtain between those races in which maturity is latest, and those in which it is earliest, and a comparison of these with embryonic characters, would give us the modern data. The comparison of these with the most ancient human remains might enable us to infer whether retardation or acceleration has been the tendency in historic or geological time. From this we might infer what might be the condition of man under a still more accelerated development than any now known, or under that antediluvian condition in which immaturity is said to have been protracted over half a century, or that still future time predicted in Holy Writ when the days of a man shall be as those of a tree. Having worked out these problems, we would be in a position to inquire as to the possible transition of Homo from or towards any other generic form. I would by no means put forward this theory of embryonic development as including the whole law of introduction of species or genera* any more than the others reviewed, but I must say that to my mind it appears to hold forth the most promising line of investigation, with the hope of arriving ultimately at some true expression of the law of creation with reference to organized beings.

What that law will ultimately prove to be, and to what extent it may include processes of derivation, it is impossible now to say. At present we must recognize in the prevailing theories on the subject merely the natural tendency of the human mind to grasp the whole mass of the unknown under some grand general hypothesis, which, though perhaps little else than a figure of speech, satisfies for the moment. We are dealing with the origin of species precisely as the Alchemists did with Chemistry, and as the Diluvialists and Neptunists did with Geology; but the hypotheses of to-day may be the parents of investigations which will become real science to-morrow. In the meantime it is safe to affirm that whatever amount of truth there may be in the several hypotheses which have engaged our attention, there is a creative force above and beyond them, and to the threshold of which we shall inevitably be brought after all their capabilities have been exhausted by rigid investigation of facts. It is also consolatory to know that species, in so far as the Modern period, or any one past Geological period may be concerned, are so fixed that for all practical purposes they may be regarded as unchanging. They are to us what the planets in their orbits are to the Astronomer, and speculations as to origin of species are merely our nebular hypotheses as to the possible origin of worlds and systems.

One word in conclusion with reference to our own work here as a Society, and as individual collectors of facts. We may not be in a position to take any leading place in the agitation of the

* It is but fair to say that Mr. Cope himself admits the action of natural selection as one cause of change.

questions to which I have referred; but we are well situated for the useful task of accumulating the necessary data for their settlement. The broad area of the American continent, the wide space occupied by its geological formations, the completeness of the series of its palæozoic rocks, the unbroken connection of its post-pliocene and modern fauna and flora, the meeting on this continent within recent times of multitudes of indigenous and exotic species of plants and animals, the existence up to our own time of feral and aboriginal conditions which are pre-historic in the Eastern continent,—these are all points of vantage on which we can seize in dealing with these questions; and if we properly inform ourselves as to what is being done elsewhere, and diligently improve our own opportunities, I see nothing to prevent us from taking the lead of those who in the Old World are pursuing such inquiries in a comparatively narrow field, and under conditions in many respects less favourable. I must insist, however, that this is not to be done by vieing with them in crude speculations and hypotheses, or in building up specious fabrics of conjecture to dazzle the popular eye, but in patient, honest, and careful accumulation of facts.

We should also bear in mind that in the greater centres of literary and scientific life, there is a strong temptation, especially on the part of ambitious men who have their own fortunes to build up, to deal in that sensation science with which the popular literature of the day is deluged. In our own comparatively obscure field there is little inducement to this or opportunity for its display, and this is so far in favor of a healthy scientific tone, which we should endeavour to preserve and cultivate. Our danger arises from being too ready to follow the extreme views put forth elsewhere, and from impatience with the slow returns for honest and careful work.

ON THE OCCURRENCE OF ARCTIC AND WESTERN PLANTS IN CONTINENTAL ACADIA.

By G. F. Matthew.

(Read before the Natural History Society of New Brunswick, 13th April, 1869.)

To the botanist as well as to the geologist this portion of the North American continent presents an inviting field for research; and the more so as till within a few years its flora has received but little attention. Although one cannot expect to find new species in a region, a large part of which, when viewed from a geological stand-point, has but recently emerged from the ocean, and has, therefore, received its flora from countries older and better known; yet the many peculiarities which may be observed in the distribution of plants in Acadia, form of themselves a subject in the study of which leisure hours may be profitably spent. To bring some of these peculiarities into notice by the public, and to indicate, though very imperfectly, the causes which have produced them, are the objects of the following remarks.

From the correspondence of natural features in Maine and New Brunswick, and from their situation, being alike exposed to the same variations of temperature, we would naturally expect to find no very marked differences between the floras of the two countries. This, indeed, is in a great measure the case, if we look upon Maine as a whole; but if we separate from it that portion of the State northward of the mountains which cross its centre, and eastward of the Penobscot River, a palpable difference in the vegetation of the section north and south of this divisional line is apparent.

The northern section, including the province of New Brunswick, may be designated Continental Acadia. Apparently merging into New England on the south—for there is no conspicuous natural barrier between the two countries—it is, nevertheless, as regards the indigenous plants which grow within its borders, closely allied to the neighboring province of Quebec, although a mountain range intervenes. This portion of Acadia contains four principal districts, viz.: an upper plain or plateau varying from about 200 to 500 feet above the sea, watered by the Upper St. John and its tributaries, the northern affluents of the Penobscot, and the River Restigouche. A triangular plain expands from a point within a few miles of the Maine boundary to a width of 150 miles or more, where it passes beneath the waters of the Gulf of St. Lawrence. This *Lower Plain* rarely rises more than 300 feet above the sea. Between the upper and lower plain lies a broken country rising into a knot of high hills in Northern New Brunswick. Lastly, there is a series of parallel ridges in the south, forming a hill-country of less altitude than the last, lying along the north shore of the Bay of Fundy. About two-thirds of this region is drained by the River St. John, which breaks from the level of of the upper plain at the Grand Falls; and, descending through several rapids and quick-waters, reaches tide-level at the western border of the lower plain, whence its course to the sea (distant 90 miles) is comparatively sluggish.

The rest of the Maritime Provinces of Canada, consisting of Nova Scotia and the twin islands of Prince Edward and Cape Breton, may be comprised under the term Insular Acadia.

Before describing in detail the peculiar groupings of species in this region, it may not be amiss to mention a few of the agencies which have given rise to the diversified forms of vegetation now existing on the earth; and then to add some remarks upon their peculiar manifestation in that part of America to which these observations more particularly relate, and to show their influence upon the range of plants within it.

Of these agents perhaps the most important is *Variation of Temperature.* It is well known that there are two directions in which this variation occurs, one on going north or south from the Equator, and the other in ascending from the level of the ocean to the tops of mountains. In both of these the temperature becomes lower in proportion to the elevation in the one case, or to the distance from the equatorial circle in the other. This decrease in temperature exerts so great an influence over plants that few species are found to be common to places widely differing either in latitude or altitude.

Soil is another influential agent in the limitation of species and the modification of individuals; some plants being peculiarly adapted to certain kinds of soil, and rarely found growing in any other, while others, although they may exist, present a puny and sickly appearance when found growing in soils not adapted in texture and composition to their nature.

Moisture also is of the utmost importance to the well-being of all cellular bodies, as well vegetable as animal; and is in fact so much a necessity that when deprived of it they cease to live. These three agencies are those which have played the most important part in diversifying the vegetation of the globe; but two of them, viz.: temperature and moisture, present themselves under a somewhat peculiar aspect in Acadia.

The renovation of the ocean by the interchange of waters throughout its vast expanse, is affected through the medium of ocean currents, flowing alternately to and from the poles. Such of these "ocean rivers" in the northern hemisphere as flow northward are continually thrown further and further east as they approach the arctic circle, by the retarded rotation of the earth from west to east; while such as run southward are thrown to the west. Hence, while Europe is bathed in the warm waters of the Gulf stream, running in a long arc northward across the Atlantic, the polar current, having a westerly momentum, clings to the American coast, and Acadia not only shares the cool climate prevalent along this seaboard, but owing to its semi-insular position, has its temperature still further lowered. This is strikingly evident when the climate of St. John is compared with that of cities in Europe —such as Bordeaux, Turin and Venice,—under the same parallel of latitude. The principal cause of this difference of temperature is the fact that here we have the north-east a refrigerator in the Gulf of St. Lawrence, traversed as it is by a branch of the polar current, which entering at the Straits of Belleisle, sweeps around the shores of the Lower Provinces and finds an outlet in the Gut of Canso and further east. We have also a cool vapor bath in the sea fogs, which in summer bathe our south-eastern shores, and whose influence on vegetation will be noticed in the sequel. Thus we see that within the limits of these maritime provinces there are variations of temperature, which mere extent of surface or elevation of land will not account for, but which are mainly dependent on ocean currents and their concomitants.

In comparing the relative heat and cold prevalent in various parts of Acadia, and other portions of the British possessions, it has not been thought necessary to notice the temperature of the colder months of the year, during which nature, in these latitudes, sinks into partial inaction, but only of those when she is in full activity.

The following table, condensed from the Canadian Year Book for 1868, will enable the reader to follow these changes during the five warm months, and to effect a comparison of the mean summer temperature in various parts of the Dominion. It also serves to show that the summer temperature of St. John is comparatively low. It is probably this, and the want of any observations by which an estimate of the climate of the interior could be formed, which has led the author of that portion of the Year Book from which this table is drawn, to include the whole of New Brunswick in the same climatic division with Prince Edward's Island, and that portion of the south shore of the St. Lawrence between Gaspé and Quebec. As regards the northern part of New Brunswick, this would appear to be a natural division; but when the climate of central New Brunswick is better known, I am inclined to think it will fall within the division comprising the eastern townships and that part of Upper Canada between Lake Ontario and the Ottawa River. Instead of falling within the region where wheat can scarcely be grown with profit, this portion of New Brunswick is likely to be recognized hereafter as a country much more favorable to farming operations than might be inferred from the classification given in the work above cited. It is distinguished from other parts of the Province by the presence of a group of plants, which indicate a climate in which Indian corn can be brought to perfection. The analysis of the Acadian flora given on succeeding pages will, it is believed, fully bear out this opinion.

TABLE No 1.

	May.	June.	July.	Augt.	Sept.	Oct.	Sum Mean
Labrador	35.0	42.0	48.0	51.0	42.0	31.0	47.0
St. John's, Newfoundland	39.3	48.0	56.2	57.9	53.0	44.5	54.0
St. John, N. B. . . .	47.3	54.5	59.7	60.0	55.0	45.7	58.1
Thunder Bay, L. Superior .	48.9	58.7	62.2	58.8	48.2	41.9	59.9
Halifax, N. S. . . .	48.0	56.3	62.3	63.7	57.0	47.0	60.8
Toronto	51.5	61.0	66.3	65.7	57.4	45.0	64.3
Wolfville	51.6	61.9	67.5	65.5	58.3	49.2	65.0
Quebec	51.6	63.1	67.5	65.9	57.6	44.6	6.55

Not only the coldness, however, but the humidity of the atmosphere, in many parts of Acadia, exercises a powerful influence upon its flora.

It is a well-known fact that the land and sea breezes which alternately fan districts bordering the sea in inter-tropical regions, result from the periodical heating and cooling to which such lands are subject every 24 hours. Analogous to this is the prevalence of certain sets of wind on the coast of large areas of land in temperate latitudes, during the summer, and of others during the winter months.

It is on these lands in going north from the coast that we meet with a new group of species, which range thence up the St. John River and its tributaries into Northern Maine. The influence of natural drainage of soils upon the distribution of species in the neighboring Province of Canada, has been observed by Mr. Macoun, of Belleville, in some remarks drawing attention to the occurrence of certain western species on the dry gravel ridges in that neighborhood; and the presence of continental forms in certain parts of the interior of Acadia, such as the valleys of Kings County, in the southern hills, the dry terraced lands of the St. John River and its tributaries, and the rich calcareous districts in the south-west part of the upper plain, are but manifestations of the same law of distribution, lands thoroughly drained being in a condition to absorb and retain more heat than those which are wet. Were it not for the depressed position of a portion of the lower plain, along the base of the southern hills, which is little above sea-level, and the imperfect drainage which results from the flatness of this region, there would be a more decided exhibition of western species in the southern countries than we now find.

It is to be regretted that so small a part of Continental Acadia has yet received the attention of botanists, and that the material for working out the subject of this paper is so imperfect. It is, therefore, quite possible that a part of its contents may not be confirmed by more minute and extended investigation. The scantiness of the material may be inferred when it is stated that out of the fourteen counties into which the Province of New Brunswick is divided, a detailed examination has been made in *parts of four* only. The *three* catalogues upon which these remarks are based, comprise species collected in Kent County, by Rev. James Fowler, and Rev. J. P. Sheraton; in Central York, by Prof. L. W. Bailey; and in a part of St. John and Kings, by

---

* See article on flora of Canada, by Drummond, Can. Nat., Vol. 1, new series, page 405.

the writer. Reference is also made to notes taken by Prof. Bailey, during a rapid journey through the northern highlands, and by the Rev. James Fowler, when at Dalhousie, as well as to the report of G. L. Goodale, of the Maine Scientific Survey.

In Continental Acadia, as previously defined, there are four principal types of vegetation, exclusive of maritime species, viz.:

I. Arctic and Sub-Arctic.
II. Boreal.
III. Continental.
IV. New England type.

The latter includes all indigenous species which have an extensive range in Acadia, especially in its southern parts.

I. *Arctic and Sub-Arctic* (*or Alpine and Sub-Alpine.*)—This type, as being the most ancient flora of the country, and also being found on the low lands at the parallel of 45° N., half way between the equator and the pole, deserves our first attention.

The species so far as known are the following:

No. 1.—LIST OF ARCTIC AND SUB-ARCTIC SPECIES.

Species.	Southern Hills.	Lower Plain.	Northern Highlands.
Alsine Grænlandica (Greenland Sandwort) - - - - - -	*S′	....	....
*Rubus Chamæmorus (Cloud-berry)	*S′	*E′	....
Solidago virga-aurea (Golden Rod)	*	....	....
Senecio pseudo-arnica - -	*S′	....	....
Vaccinium uliginosum (Swamp Huckle-berry) - - - - -	....	....	*
Calluna vulgaris (Heather) - -	....	....	....
*Empetrum nigrum (Crow-berry) -	*S′	*E′	....
Carex capillaris - - - - -	....	*E′	....
Asplenium viride - - - - -	*S′	....	....
*Solidago thyrsoidea (Thyrsoid Golden Rod) - - - - - - -	*S′	....	....
*Vaccinium Vitis-Idea (Hill Cranberry) - - - - - - -	*	*E′	....
*Euphrasia officinalis (Eyebright)	*S′	....	*E′

[Species in this list marked S′, occur only near the sea-shore on the Bay of Fundy and coast of Maine. Those marked E′ have been gathered along or near the shores of the Gulf of St. Lawrence.]

Of these species *Senecio pseudo-arnica* is introduced on the authority of Prof. Asa Grey, as occurring at Grand Manan, and the Mountain Sandwort (*Alsine*, or Stellaria, *Grænlandica*,) is added on the same authority, it having been found at the sea level, on the coast of Eastern Maine. The common Scotch

Heather, (*Calluna vulgaris,*) has been found near Halifax, by Prof. Lawson, and is more abundant at Cape Breton and Newfoundland. It is accredited to New Brunswick, by Loudon. Prof. Bailey noticed the Bog Bilberry (*Vaccinium uliginosum,*) and the Cow Berry (*Vaccinium Vitis Idea,*) growing on Bald Mountain, the culminating point of the Northern Highlands, but does not seem to have met with any other representatives of this type at the north. We may, perhaps, except the mountain Cinquefoil (*Potentilla tridentata,*) gathered on the Tobique River, but which, although commonly considered Sub-Alpine, has such a range in Acadia, as to show that it may perhaps, with more propriety, be looked upon as a Boreal form. These, and the remaining species of the list, not noticed above, find a congenial climate at St. John. One very obvious cause of their presence here, as already observed, with regard to other species, is the abundance of cool sea fogs in summer time, and consequent low temperature and moist atmosphere. The more thoroughly Arctic species, such as the Cloud Berry (*Rubus Chamæmorus*) and the Crow Berry, (*Empetrum nigrum,*) show a partiality for the peat bogs, so common in our "Barrens," where they grow in company with the Bastard Toad Flax, (*Comandra livida,*) and other high northern forms.

The Sub-Arctic species of our list, have been mostly gathered on the cliffs and terrace banks, bordering the Bay of Fundy. On these, the Eyebright, (*Euphrasia officinalis,*) and the Thyrsoid Goldenrod (*Solidago thyrsoidea*) abound. The first of these has also been met with at Dalhousie, on the Bay of Chaleur. The mountain Cinquefoil has an extensive range throughout Acadia, having been seen near Mount Katahdin, on the Lower Tobique, at several points around the Bay of Fundy, and on the coast of Maine. It even flourishes at Windsor, Nova Scotia, where the mean summer temperature cannot be far from 65° Fahr. The Green Spleenwort, (*Asplenium viride,*) a native of Newfoundland, Gaspé, Labrador and the Rocky Mountains, grows on the sea cliffs near this city, in company with *Carex canescens* var. *vitilis, Cinna arundinacea* var. *pendula, &c.* I may add that the Cowberry, (*Vaccinium Vitis Idea,*) which goes by the name of Hill Cranberry with us, is not only quite common near the coast of the Bay of Fundy, but has also been met with by Mr. Fowler, at Richibucto.

The comparison of the position of this little group of Arctic forms, with that of a similar assemblage of Alpine plants on the White Mountains of New Hampshire, is one of very great interest, when it is considered that the Acadian Sub-Arctic flora grows at the sea level. Let us then look at the vertical range of some of the plants above named on those eminences, the highest peaks of North Eastern America.

Dr. Dawson gives 4,000 feet above the sea as the upper limit of evergreens. Here firs cease to grow, and the mountain side is covered with small shrubs and herbs. On the Plateau between Mounts Washington and Munroe, at a height of 5,000 feet, the Arctic flora is in full possession, and extends thence to the summit. If we note the range of such of our own Arctic and Sub-Arctic species as grow there, we find that they come no lower down the mountain side than to points varying from 4,500 to 3,500 feet above the sea. It is supposed that the principal masses of rain clouds hang at a height of from half a mile to one mile above the earth, in regions near the sea level, encircling the mountain tops with their vapory masses; and the clouds clustering at such a height around Mount Washington, would wrap those little Alpine plants which grow towards the top of the mountain, in those thick mists in which they delight. Need we wonder then that such lowly forms should find a congenial home on the cool mist-covered hills of Maritime Acadia.

By its cool summer temperature, its humid climate, and consequently its vegetation, St. John, when compared with these New England mountains, may be looked upon from a botanical point of view, as standing upon an eminence nearly 4,000 feet high; for it is at this height, on the White Mountains, that evergreens cease and Alpine plants take their place. Fancying ourselves standing upon this elevation, and looking around us through the medium of Mr. Murdock's observations, and those of Acadian botanists, we see across "the Bay" and beyond the fertile valley of Annapolis, the hills of Nova Scotia, rising ridge upon ridge to a mountain range, equal in height to our own, and our sister city of Halifax on its crest; for she has more fog and rain than we have. Around her grow the Scotch heather, the mountain Cinquefoil, and other Alpine forms mentioned in the preceding list.*

---

* I infer this from the table, (at foot of opposite page,) prepared by Mr. Murdock, from his own notes and data, published by the late Colonel Myers, of Halifax.

Mr. G. Murdock, in a paper on the Meteorology of St. John, read before this Society in 1863, pointed to this phenomenon as exhibited in the vicinity of this city, in the following words: "In the wind "columns it is observed that the increase and duration of "southerly weather follows very nearly that of the temperature. "July is the month of *maximum* southerly weather, and December "of minimum. From July to December, there is a constant "diminution, and from this latter month to July again a steady "increase." Of these southerly winds, the south-west is by far the most frequent, and, if continuous, sooner or later brings upon the southern coast of Acadia those fogs for which St. John is unfortunately so notorious. That such is the case may be inferred from the following table, compiled by the same accurate and pains-taking observer, showing a mean of the number of foggy days per month for the years 1861-1867:—

TABLE No. 2.

	May.	June.	July.	Augt.	Sept.	Oct.	Sum. Mean.
Avrge. number of foggy days	3.3	4.2	6.2	6.7	3.4	2.3	5.7
Rainy days	10.0	6.8	9.9	7.6	8.1	7.6	8.1
Mean estimate cloudy days	6.4	6.4	6.3	6.2	5.5	6.1	6.3

From this table we gather that, during each of the two hottest months of the year, St. John is enveloped for nearly a week in constant fog; and this misty curtain, by its presence, not only excludes the direct rays of the sun, but by its coolness lowers perceptibly our summer temperature.

During the months of July and August, there is also a large rainfall, and if we add to the rainy and foggy days those which are cloudy, but nineteen days out of the two mid-summer months remain during which the sun shines upon us in unclouded splendor.

If we give due weight to these sources of humidity and cold, and consider, also, that our position on the sea-side is an additional cause of a diminished temperature, we need feel no surprise at the sub-arctic summers which prevail at St. John,

TABLE No. 3.—MEAN OF 1864 AND 1865.

	May.	July.	Aug.	Sept.	Oct.	Sum Mean.	June.
Halifax foggy days..................	12.5	6.	6.5	1.5	3.5	6.7	7.4
St. John, N. B., do. do..............	4.	4.3	6.5	1.7	1.	5.3	4.
Halifax rainy days..................	16.	12.5	11.	7.	16.5	15.75	8.
St. John, N. B., do. do..............	12.5	7.5	8.5	6.5	7.5	7.8	5.5

nor at the sub-arctic type of vegetation which flourishes around us. It is well known that humidity, in its influence over the distribution of Arctic plants, in a limited degree represents cold. But when a climate is both cool and moist, as ours is, it presents a double attraction to these little northern adventurers.

Having seen what a chilling effect these south-west winds, with their accompanying fog and rain, have at the coast, let us now follow the same breezes into the interior.

As soon as the fogs pass the coast, they are rapidly absorbed by the atmosphere (expanded by warmth radiated from the heated earth), and may be traced in their progress inland, in the long banks of cumuli-clouds which hang over the southern hills; and are finally dissipated entirely in the onward progress of the southerly winds, which now possess nearly the original warmth and most of the moisture that they had when first they began their journey from the Gulf Stream. Now pre-eminently invigorating and refreshing, these winds course onward toward the shore of the Gulf of St. Lawrence, stimulating the growth of many species of plants, which cannot abide their chilling influences at the coast. As may be inferred, they bear a very different reputation along the Gulf from that which attaches to them with us. In spring and early summer, they blow down the valleys of the Miramichi, and other streams debouching on that coast, as warm breezes, prevalent during the night and morning, giving a great stimulus to vegetation; but in the evening they are pushed back, or forced upward by a strong, cold wind from the Gulf, but lately relieved from its wide fields of floe-ice. The latter (N. E. winds) often blow with much violence about 4 or 5 o'clock in the afternoon, and such is their chilling influence, that flowers which have been in bloom in Fredericton for a fortnight are (about 1st June) only opening their petals on the Miramichi. There is nearly the same difference between St. John and Fredericton at this period, although the first flowers of spring, such as the Mayflower, *Epigœa repens,* usually opens with us a little in advance of their time of flowering at the capital. The advent of spring is undoubtedly first felt at St. John, but the increase of fog and chilly winds in the month of May checks the growth of plants with us, while the very same winds give an increased impetus to their growth and expansion in the interior, where, at the 1st of June, vegetation, in its summer development, is a fortnight in advance of the coast, and subsequently much more.

In table 1 it will be seen that the valley of Cornwallis, in Nova Scotia, has a summer mean of 65 deg.; and it is probable that a large area in the interior of Continental Acadia will be found to have, at that period, a temperature equally high. At Fredericton "90 deg. in the shade" is not rare, and at Woodstock the mercury is said to rise to 100 deg. Fah't.

In default of any meteorological tables shewing the climatic changes of the interior of Acadia, I have been somewhat prolix in thus enlarging on the S. W. winds, in order to give some idea of the varying influence which this important agent exercises over the growth of plants.

Of *soils*, Continental Acadia possesses a great variety, which have a proportionate influence with the causes already noted upon the range of plants within its borders.

The Highlands, both North and South, being mainly made up of metamorphic rocks, which are comparatively impervious to water, the drainage of the soil upon them is thereby much impeded. Hence, it happens that, notwithstanding the hilliness of these districts, there are, especially in the southern hills, numerous peat-bogs, interspersed with bare rocky tracts known as "barrens." These barrens extend for many miles along the coast of the Bay of Fundy, where granite and hard metamorphic rocks prevail, and where the natural drainage is imperfect, and the soil scanty and unproductive. The drier portions are covered with a profusion of ericaceous shrubs, &c., such as blue-berries (*Vaccinium Pennsylvanicum*), Labrador Tea (*Ledum latifolium*), Leather Leaf (*Cassandra calyculata*), Sheep Laurel (*Kalmia angustifolia*), *Rhodora Canadensis, &c.* In the swamps, and on mossy slopes, knee-deep with sphagnum, grow the Sweet Gale (*Myrica Gale*), Marsh Rosemary (*Andromeda polifolia*), Cranberries (*Vaccinium oxycoccus*), &c. The larger depressions are occupied by peat bogs, or lakes and ponds, with which such tracts are often studded. There is a striking resemblance in the aspect of these barrens, dotted as they are with numerous little sheets of water, and interspersed with belts and clumps of evergreen trees, to the open tracts in Newfoundland, so graphically described in your late Vice-President's paper on that island, and to the Laurentian region of Canada.

The arable lands along this coast are chiefly clay flats, usually covered with terraced beds of sand. The soil on the ridges is mostly gravelly, and here the forest growth is of Black and Yellow

Birch (*Betula lenta et excelsa*). Beech, Maple, and other forest trees of the interior are seldom or never seen. Beneath the shade of the evergreen growth on the clay flats we find the Tway blade (*Listera Cordata*), the Mitrewort (*Mitella Nuda*), the Rattlesnake plantain (*Goodyera repens*), the Dwarf orchis (*Platanthera obtusata*), the one-flowered Pyrola (*Moneses uniflora*), and other shade-loving plants.

We have seen that the prevalence of a moist climate and impervious soil, coupled with a low temperature, give rise to thick evergreen forests, peat-bogs and swamps saturated with moisture; and while producing, even during clear weather, great radiation of heat and moisture, these causes have contributed to encourage the growth of such northern plants as those above mentioned on the maritime slopes of our southern hills.

On the declension of this hill-country toward the plains of the interior, however, another set of agencies comes into play. It has been already intimated that the summer skies of the central districts are clearer than those of the coast, and the precipitation of moisture less profuse. In the valleys, among the more northerly ranges of the southern hills, much of the soil is loamy, and naturally well drained, as well as fertile. These rich loams are co-extensive with the lower coal formation in New Brunswick. They border the Lower Plain throughout, fill the valleys of the Kennebackasis and Petticodiac Rivers, form islands on it along its N. W. side, and re-appear in the valley of the Tobique among the northern hills. The fertility of other loams, such as those of the internal lands on the St. John River, and the upland tracts around Houlton and Woodstock on the Upper Plain, is evidenced by the growth of such species of plants as the Dwarf Ginseng or Ground Nut (*Aralia trifolia*), Closed Gentian (*Gentiani Andrewsii*), Showy Orchis (*Orchis Spectabilis*), Bass Wood (*Tilia Americana*), *Desmodium Canadense*, the two Osmorrhizas, Wild Ginger (*Asarum Canadense*), and Butternut (*Juglans cinerea*.)

Immediately north of us, but, as regards its flora, about 1,000 feet below, is the elevated plain of the Kennebackasis Bay, beyond which we may look down another 1000 feet, into the sunny valleys of Kings County. Over the Nerepis hills the great plain which occupies the central part of Acadia is visible, and far beyond it the plateau of Northern Acadia stretches away to its junction with the Notre Dame mountains; while to the

South-West our imaginary mountain top connects, by scattered peaks rising through the fogs of the Bay of Fundy, with a similar elevation in eastern Maine, whence it declines, and finally sinks beneath the waters of the Atlantic.

A BOREAL or High Northern type of vegetation may be seen mingling with these Arctic forms, but also extending over many parts of Acadia, where they have not been found.

Of this character are the following :—

No. 2.—LIST OF BOREAL SPECIES.

SPECIES.	North-eastern Coast of America.	Valley of St. Lawrence.	North-west Territory.	Southern Hills.	Lower Plain.	Northern Highlands.	Upper Plain.
Anemone parviflora	*	*	*	...	W*	...	N*
—— multifida	*	*	*	...	...	E*	...
Stellaria uliginosa (Swamp Chick-weed	...	...	*	S′*	...	...	...
Parnassia palustris	*	*	*	...	W*	...	...
Astragalus alpinus (Phaca astragalina)	*	...	*	...	...	...	N*
——— Robbinsii.	...	*	...	...	...	...	N*
Oxytropis campestris	...	...	*	...	W*	...	N*
Hedysarum boreale	...	*	*		...	...	N*
Geum macrophyllum (boreal)	*	*	...	S′*	...	...	...
Potentella tridentata (Mountain cinquefoil)	*	*	*	...	W*	*	N*
Ribes rubrum (Red Currant)	...	*	*	...	E′*	*	...
Sedum Rhodiola (Stone crop)	...	*	*	*	...	...	...
Saxifraga Aizoon (Saxifrage)	...	...	*	*	...	...	...
Nardosmia palmata (Sweet Coltsfoot)	...	*	*	*	E′*	*	...
Artemisia borealis (Wormwood)	...	*	*	*	...	...	N*
Aster graminifolius	...	*	*	*	...	...	E*
Tanacetum Huronense (Huronian Tansey)	...	*	*	...	W*	...	...
Vaccinium Canadense	...	*	*	*	E′*	...	...
Castilleia septentrionalis	...	...	*	...	E*	...	...
Primula farinosa	*	*	*	*	...	...	N*
Utricularia minor (Bladderwort)	...	*	*		E*	...	...
Rhinanthus Crista-galli (Yellow Rattle)	*	*	*	S′*	E*	...	...
Halenia deflexa (Spurred Gentian)	*	*	*	*	...	*	N*
Collomia linearis	...	...	*	...	...	*	...
Echinospermum Lappula	...	*	*	...	...	*	...
Shepherdia Canadensis	*	*	*	...	...	E*	N*
Rumex salicifolius (Dock)	*	...	*	S′*	...	..	...
Comandra livida (Bastard Toad-Flat)	*	*	*	*	...	...	...
Betula pumila	*	*	*	...	E*	...	...
Alnus viridis	*	*	*	*	E*	*	...
Populus balsamifera	*	*	*	...	E*	...	...
Pinus Banksiana	*	*	*	*	E*	...	S*
Platanthera hyperborea	*	*	*	*	...	...	...
Spiranthes latifolia (Ladies' tresses)	...	*	*	...	...	*	...
Calypso borealis	*	*	*	...	W*	...	...
Allium schænoprasum	*	*	*	*	...	*	S*
Tofieldia glutinosa (False Ashpodele	*	*	*	...	E*	...	N*
Juncus filiformis (Thread Rush)	...	*	*	...	E*	...	...
——— Stygius	...	*	*	*	E*	...	...
Scirpus sylvaticus	...	*	...	*	E*	...	...
Eriophorum russeolum	*	*	*	*	E*	...	...
Carex lenticularis	...	*	*	*	E*	...	...
——— flexilis	*	*	*	*	E*	...	...
——— rostrata	*	*	*	*	E*	...	...
——— canescens, var. vitilis	...	*	...	S′*	...	...	...

List of Boreal Species—Continued.

Species,	North-eastern Coast of America.	Valley of St. Lawrence.	North-west Territory.	Southern Hills.	Lower Plain.	Northern Highlands.	Upper Plain.
Vilfa cuspidata	...	..	*	...	E*	...	N*
Festuca ovina, var. duriuscula	...	...	*	..	E*	...	...
Cinna arundinacea, var. pendula	...	*	*	*	...	...	...
Avena striata	...	*	*	S′*	E*	...	...
Elymus mollis	*	*	*	...	...	...	...
Woodsia hyperborea R. Br.	...	...	...	...	...	...	...
(Woodsia Ilvensis, var. alpina Watt)	...	*	*	*	...	*	...
Aspidium fragrans	*		*	...	...	*	..
Polygala pauciflora	..	*	*	...	W*	...	...
Artemisia Canadensis	...	*	*	...	...	...	N*
Nabalus racemosus	*	*	*	*	...	...	N*
Lobelia Kalmii	*	*	*	*	...	...	N*
Platanthera rotundifolia	*	...	*	*	...	...	...
Triticum caninum	...	*	*	S′*	E*	...	...
Pellæa gracilis	*	...	...	...	...	*	...

N.B.—The last seven species of this list have a range intermediate between this type and the succeeding one.

[Species marked S′ have been found at the seaside only in the southern hills. Those in second column marked W., occur on the St. John River, near the centre of New Brunswick. The remainder have been gathered near and on the Gulf Shore. S′ and N′ on the fourth column, designate respectively the southern and northern parts of the Upper Plain, including the Aroostock and St. John districts of Goodale. Species marked E′ in the third column grow in that part of the southern hills bordering the Bay of Chaleur.]

Mr. G. L. Goodale has the merit of first calling attention to the occurrence of this type of vegetation in Acadia. He says :—(2nd Report, p. 125.) "The country lying along the St. John, " from Boundary Branch to Grand Falls, is marked by the very " frequent occurrence of certain North-Western plants. And " the district comprised by the curved northern limit of Maine, " and a line drawn from Grand Falls to a point between Baker " Lake and Boundary Branch, will be found to be nearly the " range of these plants in our State. This district is so entirely " distinct botanically from any other portion of Maine, that its " limits can be said with confidence to be clearly defined. The " following list of plants may be considered as comprising the " most characteristic species of the St. Johns district :—

" Anemone parviflora.

" Astragalus alpinus.

" Astragalus sp. ign.
" Oxytropis " "
" Artemisia borealis.
" ——— Canadensis.
" Tanacetum Huronense.
" Vilfa Cuspidata."

He also instances *Astragalus Robbinsii*, *Hedysarum boreale*, *Nabalus racemosus*, *Primula Mistassinica*, *Solidago Virgaurea* var. *Alpina*, and *Tofieldia glutinosa*, as plants of the same district.

" The whole region through which these plants are distributed is covered by a thick growth of coniferous trees."

So little is known of the flora of the northern counties of New Brunswick, with the single exception of Kent, that we know of the occurrence of but a limited number of these species on the streams flowing to the Gulf, but nevertheless feel satisfied that the majority of them will yet be gathered there. The late Dr. Robb met with Anemone Multifida on the Restigouche, and Shepherdia Canadensis at Grand Falls, on the St. John River. The last named species has also been gathered near Dalhousie. Mr. Fowler has collected in the Gulf Counties *Vaccinium Canadense* and *Nardosmia palmata* (common), the rare *Juncus Stygius*, *Carex lenticularis*, *Cinna arundinacea* var. *pendula*, *Triticum caninum*, and *Elymus Mollis*. Prof. Bailey observed Allium Schænoprasum during his descent of the Nepissiquit.

Some of these, as well as the remaining species of the list (except about half a dozen species still known only on the Upper St. John,) have been gathered in the southern highlands.

Near the outlet of the St. John River is a sheet of water, known as the Kennebackasis Bay, which is as deep as Behrings Straits, and deeper than those which divide France from England. Here the yachtsman may sail for 20 miles without starting sheet, and the lover of the picturesque will see several cliffs and bold hills 400—600 feet high rising from the water's edge. Here also he will find the presence of man indicated by sawmills, factories, shipyards, broad cultivated fields, and scattered villages, whither the citizens of St. John resort in summer, not to avoid the heat, but to escape the fog.

In this basin the spring floods of the St. John River, unable to find free egress to the ocean, are pent up until the middle of

June, exerting their chilling influence on the surrounding air. Even in midsummer, should a bather more venturesome than his fellows swim out of the shallow coves which line the shore, he will soon find his limbs stiffened by the refrigerating power of these profound waters.

As there are here the conditions favorable to the growth of northern forms of vegetation, it will not excite surprise that the boreal type of Northern Acadia should re-appear around this Bay. Its shores have as yet received only an occasional summer glance from the botanist, and therefore the discovery of many more northern forms will probably reward the search of a diligent explorer. Among the species thus far recognized I may instance a stone-crop or live-for-ever (*Sedum Rhodiola*), a Saxifrage (*Saxifraga Aizoon*), and the fern *Woodsia hyperborea R. Br.*, which Mr. D. A. P. Watt regards as a northern variety of *Woodsia Ilvensis*,* as common on the perpendicular cliffs near Rothsay. The first-named species was gathered many years ago on Cape Blomiden, N.S., by Dr. Robb, and, strange to say, has recently been found on the cliffs of Delaware River, Pennsylvania. On the rocky ledges and gravelly beaches around Kennebackasis Bay flourish the American primroses (*Primula farinosa* and *Primula Mistassinica*). the first named in great abundance; also the Wild Chive (*Allium Schœnoprasum*), a small *Aster graminifolius*, and Hooker's *Nabalus racemosus*. The Northern Green Orchis (*Habenaria Hyperborea*) is also sparingly met with. But the most conspicuous plant is the Northern Scrub Pine (*Pinus Banksiana*), which here attains gigantic dimensions, one individual noticed rising to the height of more than 45 feet, with a girth of 6½ feet. This tree, in its elm-like habit of growth, is in striking contrast with all the other evergreens around. At the end of May the numerous pyramidal erect spikes of flowers give it the aspect of a chandelier studded with yellow wax-lights. In Acadia it has an extensive range, for it is not only abundant throughout the Gulf districts, whence it spreads over to Grand Lake and the Petticodiac River, but Goodale also met with it in Northern Maine, where, however, it is scarce.

Around the shores on the upper part of Kennebeckasis Bay, where the waters are shallow, species of a more southern type grow, such as the Nodding Wake Robin (*Trillium cernuum*),

---

* Woodsia Ilvensis var. Alpina, Watt.

the Yellow Violet (*Viola pubescens*,) and the two Anemones (*A. nemorosa* and *A. Pennsylvanica*.) The shrubby cinquefoil (*Potentilla fruticosa*) also is very abundant.

There are two other positions in which the species of this type are found in Southern New Brunswick. One, beneath the cool shade of evergreen trees which cover the abrupt hills between this Bay and the sea coast. On the mossy slopes under these trees the sweet Coltsfoot (*Nardosmia palmata*) opens its flowers in early spring; and the Round-leaved Orchis (*Habenaria rotundifolia*) may be found in bloom at a later period. Kalm's Lobelia (*L. Kalmii*) and the spurred gentian (*Halenia deflexa*) intermingled with other Sub-Arctic forms, abound in the open pastures. Other species, such as the swamp chickweed (*Stellaria uliginosa*), for which, like *Sedum Rhodiola*, a station in Pennsylvania is known; the large-leaved Geum (*G. macrophyllum*), and the willow-leaved dock, (*Rumex salicifolius*) have been found at the sea-side, on the borders of salt marshes, near St. John.

Looking at the known range of this type throughout Acadia, we may fairly suppose that the whole of its northern continental portion will be characterized by the presence of the foregoing and other boreal forms; and that these may also be looked for around the whole southern height of the Gulf of St. Lawrence. In Insular Acadia it probably usurps Prince Edward's Island, mantles over the hills of northern Nova Scotia, and in Cape Breton blends with the Sub-Arctic flora of the Atlantic coast.

In the interior of Continental Acadia there is a large area overspread by a group of plants of a more southern type than those we have been considering. West of the Alleghanies they range as far south as New York, Ohio, and the south-west part of the Province of Ontario. Many of them, however, cross the Appalachian range, and are found more or less abundantly in West New England. The valley of the Connecticut River generally limits their range eastward.

This is essentially the type which G. L. Goodale looks upon as characteristic of the Aroostook country. He says:—

"This second region, which we can distinguish as the 'Aroos-
"took district,' is characterized by the occurrence of a different
"flora. Instead of conifers, we find a prevalence of hard-
"wood trees. Maples, Beeches, Oaks and Amentaceæ form the
"forests. Under such trees we see flourishing Dicentras,

"Claytonias, Adlumia, *Aralia Quinquefolia*, *Solidago odora*; "on the shores of the rivers and their tributaries *Lobelia* "*Kalmii*, *Anemone Pennsylvanica*, and two species of Vitis, "*Vitis labrusca* and *V. cordifoli t.*"

In the following list of Western or Continental species will be found some of those above mentioned; but the range of others is such as to exclude them from this eastern fragment of a flora, which finds its home west of the Green Mountains of New England:—

NO. 3.—LIST OF CONTINENTAL SPECIES.

SPECIES.	Upper Plain.	Lower Plain.	Valleys of the Southern Hills.
Dicentra Canadensis - - -	S*	....	....
Adlumia cirrhosa - - -	S*	....	....
Nasturtium palustre var. hispidum	....	....	*
Lathyrus palustrus var. myrtifolius	....	....	*
Œnothera chrysantha - - -	....	E*	....
Hippuris vulgaris - - -	....	....	*
Artemisia biennis - - - - -	....	E*	....
Blitum capitatum - - -	....	W*	. .
Listera convallarioides - - -	....	E*	*
Carex Richardsonii - - -	....	E*	*
——— cylindrica - - - - -	....	E*	....
Anemone Pennsylvanica - -	S*	W*	*
Claytonia Caroliniana - - -	....	W*	*
Conioselinum Canadense - -	S*	....	....
Aralia quinquefolia - - - -	S*	W*	*
Pogonia verticillata - - -	S*	....	....

Goodale's remarks on the vegetation of the Arostook country apply signally well to the valley of the main St. John River from Eel River to the southern hills; and represent with almost equal fidelity the aspect of the western and central part of the Acadian Plain, where the soil is deep and drainage good. In approaching the Gulf this type of vegetation gives place to a collection of species having a more northerly range. In the valleys of the southern highlands, in King's County, it mingles with the New England flora prevalent to the S.W., of which several species appear to be rare or wanting along that part of the Acadian Plain facing the Gulf of St. Lawrence.

V. *Maritime Type*.—The extensive and varied sea coast pertaining to the Lower Provinces affords ample scope for the growth of maritime plants. On the North Shore, Mr. Fowler has met with more than 30 species, as may be seen by the following list, and most of them, with a few additional forms, occur also on the shore of the Bay of Fundy.

No examination, so far as I am aware, has yet been made of the salt springs in this and the neighboring province of Nova Scotia, for maritime plants. Perhaps a few of the species which once grew around these springs, when they were at the margin of the sea, may yet linger there. *Ranunculus Cymbalaria* was collected at Fredericton by the late Dr. Robb, as appears from a specimen in the Herbarium of the University of that city, which is now distant 80 miles from the salt water.

No. 4.—LIST OF MARITIME SPECIES.

Species.	Gulf of St. Lawrence.	Bay of Fundy.
Ranunculus Cymbalaria	*	*
Hudsonia tomentosa	*	....
Lechea thymifolia	*	....
Honkenya peploides	....	*
Spergularia rubra var. marina	*	*
Lathyrus maritimus	*	*
Ligusticum Scoticum	*	....
Aster Radula	*	*
Solidago sempervirens	*	*
Plantago maritima	*	*
Statice Limonium var. Carolinianum	*	*
Glaux maritima	*	*
Mertensia maritima	*	*
Atriplex hastata	*	*
Salicornia herbacea	*	*
——— mucronata	....	*
Obione arenaria	*	....
Chenopodina maritima	*	*
Salsola Kali	*	*
Polygonum aviculare var. littorale	*	*
Myrica cerifera	*	....
Triglochin Palustre	*	*
——— maritimum	*	*
Ruppia maritima	*	....
Juncus bulbosus	*	*
——— Balticus	*	....
——— Greenii	*	
Eleocharis pygmæa	*	*
Scirpus maritimus	*	*
Carex maritimus	*	*
——— salina	*	*
Calamagrostis arenaria	*	*
Spartina juncea	*	*
——— stricta var. glabra	*	....
Glyceria maritima	*	*
Hordeum jubatum	*	*
Asplenium marinum*	.....	.....

* This species is accredited to New Brunswick in Hooker's Flor. Bor. Am.

Ranunculus Cymbalaria, as above stated, has been gathered at Fredericton. But I am not aware of the existence of any others of the list inland, except the sub-maritime *Aster Radula* and *Atriplex hastata.*

In concluding this division of the subject, it may be added, that our present knowledge of Acadian botany would lead us to suppose that the *Continental* type, besides occupying the southern half of the Plateau of Continental Acadia, also spreads throughout the valley of the St. John, and its tributaries, to the heart of the Southern Hills, and reappears in the valley of the S. W. Miramichi. That the *Boreal* type lies around it to the north-east, and to the south-east, as far as the outlet of the St. John River. Here it mingles with the few sub-Arctic species which still hold their ground along this coast, and in like manner flourishes in company with these same species, on the low points of land jutting into the Gulf of St. Lawrence. The *sub-Arctic* species form, as it were, a fringe to the general vegetation of the country skirting the shores of the Gulf of St. Lawrence and the Bay of Fundy. The occurrence of an Alpine group in the northern highlands seems as yet scarcely established, since, on the highest of those hills, Prof. Bailey met with but one species which could be referred to this type, viz., *Vaccinium uliginosum.* The *New England* type is widely spread throughout Acadia, but appears to be more especially prevalent in the south-western counties. Several species, such as the Blue-bell (*Campanula rotundifolia*), and Hemlock (*Abies Canadensis*), are reported by Mr. Fowler as scarce or wanting on the "North Shore;" and the Cedar (*Thuja Occidentalis*) appears to be a rare tree in Nova Scotia, and even entirely wanting in most parts of that Province.

Special Causes which have Operated upon the Distribution of Plants in Acadia.

Beside two agents, Winds and Migratory Birds, which have had a world-wide influence in spreading vegetation from one region to another, there is a third which, from the important part it has played in modifying the flora of Acadia, deserves special attention. This is the floating ice, and drift-wood of the Polar Current, and of the St. John River.

To form any conception of the vegetation which covered Acadia in early times, we must fall back upon the researches of Geology. As regards its modern botanical aspect, the history of Acadia begins with the Champlain epoch. The clay beds of this period, which cover wide areas in Southern New Brunswick, have yielded no determinable remains of plants, except sea-weeds, which appear to belong chiefly to the Rhodosperms and Chlorosperms, and are of common occurrence in connection with fine clays near the coast. Thus we are left to infer the character of the vegetation from the climatic conditions indicated by the presence of Arctic and sub-Arctic animals in the Acadian seas at the Champlain epoch, and to the known flora of this period in Canada. At Green's Creek, on the Ottawa River, the deposits of this age contain concretions which have gathered around organic remains, such as sea-shells. fishes and bones of the seal. Many of them also contain the remains of land-plants. Dr. Dawson, to whom these relics were submitted for examination, detected the following species of plants: the Norway Cinquefoil (*Potentilla Norvegica*), the Mountain Cinquefoil (*P. tridentata*), the Balm of Gilead (*Populus balsamifera*), the Bear Berry (*Arctostaphylos Uva ursi*), the White Clover (*Trifolium repens*), the Round-Leaved Sundew (*Drosera rotundifolia*), and two kinds of Pondweed (*Potamogeton natans*), and (*P. perfoliatum.*) Such a group of plants would find a congenial home in that part of Acadia now occupied by the sub-Alpine type of vegetation. Indeed, with the exception of the Bear Berry, they are all known denizens of that part of Acadia laved by the Arctic current. It may be perceived, then, that to reproduce the climatic conditions of the Champlain epoch, it is only necessary to submerge the St. Lawrence valley, and the plains east of the Appalachian range, and admit the Arctic current to sweep freely over these submerged lands. That such was the state of the southern half of Continental Acadia during a great part of the age in question there can be no doubt, the Southern Hills alone standing above the icy current, which swept by on either side. With such physical conditions universally prevalent in this region, the Arctic and sub-Arctic must have been the predominant type of vegetation. As the plains began to emerge during the succeeding Terrace Period, which was one of upheaval, no doubt many Boreal forms were added to those already present in the country.

These additions were largely influenced by the constant play of the Arctic current upon our shores. It acted as a circumpolar distributor of species, and to it the wide range of many Arctic and Boreal plants is evidently due. Entering the Polar Sea between Norway and Spitzbergen, it sweeps round the ice-bound shores of the Old World by Russia and Siberia. An insignificant branch escapes into the Pacific by Behring's Straits, but the main body of the current continues its course through the Georgian Archipelago, and passes into the Atlantic again between Greenland and Labrador. The retarded rotation of the earth throws this current, when entering the Polar Sea, upon the coast of the Old World; the accelerated rotation felt by the same moving mass of water on its southward course causes it to cling to the shores of America from Labrador to Florida, and envelope the eastern part of the British Possessions, which are fully exposed to its chilling influence. The principal body of the current passes southward around Newfoundland, but a branch goes westward between this island and Labrador, through the Straits of Belleisle, and courses around the Gulf of St. Lawrence, as has been already stated.

It is the transporting power of this current as a whole, and of this branch, in particular, which has more directly influenced the vegetation of our country.

Three of the largest rivers in the Old World, and an equal number of those in the New, help to freshen the waters of this great oceanic stream. The Spring floods of the great Siberian water-courses sweep down into it vast quantities of drift-wood and debris filled with the seeds of plants. Many of these are carried onward in the floe-ice toward the American coast, where they receive accessions from the McKenzie River, and in the course of years work their way through the group of islands between North America and Greenland. The Saskatchewan River also contributes its quota of organic relics to the burden borne on the bosom of the Polar current from the Arctic regions of the three continents. The peculiarity of all these great water courses is, that their sources are in temperate latitudes, while their embouchures are in Arctic or Sub-Arctic regions, and thus the waste of vegetation which they bear downward toward the sea, when they are swollen by melting snows, is cast upon the ice about their mouths. The seeds of plants flourishing in the regions from which these rivers flow might thus very readily be transported in the course of time, upon floe ice and drift-wood, to the north-eastern parts of America.

Accordingly we find little difficulty in tracing back the course of the Boreal and Arctic types north-westward across the Continent of America, toward Asia. Attached to the table of Boreal forms are three columns shewing the range of the species to the N.W., compiled from the late Sir W. J. Hooker's Flora Boreali Americana, Dr. Gray's Flora of the Northern United States (1859), and a list of the plants collected at Anticosti by Prof. A. E Verrill. Labrador and Newfoundland are bleak, inhospitable countries, whose flora is but imperfectly known; yet of the three score species of this list, more than one-half have been gathered there. In the St. Lawrence Valley, chiefly in that part of it below the great Lakes and around Lakes Huron and Superior, more than two-thirds of the list of Boreal species occur;—many of these being only known in the far western parts of the Valley about Lakes Superior and Huron, or on the mountain tops of New England and New York. The presence of these species in Acadia is easily accounted for when it is considered that there is a continuous water communication from the great lakes of the interior to the northern confines of Acadia. But it is more remarkable, if we fail to give due weight to the transporting powers of the Polar Current, that all the high Northern forms, with half a dozen exceptions, should be already known as indigenous to the North West Territory, between Red River, the Arctic Sea, and the Rocky Mountains. Moreover, there are three species which, if one may judge from the authorities above quoted, are not known to occur in the interspace between this region and Acadia, or to the N.E. of the latter. These are *Collomia linearis*, discovered by Mr. Fowler on the Gulf coast; *Vilfa cuspidata*, found by Mr. Goodale on the Upper St. John, and *Oxytropis campestris*, gathered by Prof. Baily on the Main St. John. This list of adventurous emigrants from the N.W. would be largely increased were we to include species which occur in the intervening country only on the mountain tops of New England and New York.

The River St. John appears also to have played an important part in distributing plants throughout Acadia, and a few remarks on its peculiarites may, therefore, not be out of place. This is one of the most considerable of the numerous rivers which take their rise in the Appalachian range, and about one-half of

Continental Acadia is included within the limits of its basin. A connection with the sea, as singular as that of the St. John, is to be found in few rivers (if any) of equal size, on the globe.

The outlet of this river at the "Falls" (or, more correctly speaking, Rapids), is a narrow and tortuous channel, bordered by cliffs and obstructed by rocky ledges. Over this barrier, as is well known, there is a flux and reflux of the tide twice a day; but as the tidal wave must rise fifteen feet or more before it can overcome this impediment, its influence on the river above is comparatively trifling, the water within the barrier not rising more than 2½ feet, while at high tide the level of the water in the harbour is about 13 feet above that of the river at its summer level.

It is not so generally known, however, that during the spring floods the quantity of water poured into the St. John's River, through its various tributaries, is such as to exclude any influx from the sea. At this season of the year the contracted entrance to the river, which at other seasons excludes the rushing tides of the Bay of Fundy (preventing the formation of mud flats, a striking feature in the estuaries of rivers further up the Bay), also impedes the discharge of the spring floods.

These pent up waters are then compelled to spread themselves over the lowlands of the valley of the river, and such affluents as the Kennebeckasis, Nerepis, Washademoack, Belleisle, Grand Lake and the Oromocto. Two extensive, though very irregularly shaped, lakes are thus formed,—the lower one extending, in the form of an oxbow, down the valley of the Kennebeckasis, around Grand Bay, and up the "Long Reach" and Belleisle Bay; the upper one embracing a large area, beginning at the lower end of Long Island, and extending upwards over the low lands lying around the Washadmeoack River, Grand Maquapit, and French Lakes, and all the interval lands between Gagetown and the Oromocto—submerging also the lands on each side of this river for many miles up. The area of the lake-like expansions of the St. John River, which lie partly among the southern hills, and partly to the northward of them, cannot fall far short of 600 square miles.

During the summer and autumn these extensive sheets of water, which ramify through the southern part of the Province at the opening of navigation on the river, have shrunken to very limited proportions, being represented chiefly by the waters of

Grand Lake, on the one hand, and those of Grand and Kennebeckasis Bay, on the other.

As the excess of water in the southern tributaries, viz., the Kennebeckasis, Nerepis and Belleisle Rivers, has, to a great extent, been discharged before the "freshet" of the main river rises, the great rush of water down from it causes a reflux into the above mentioned rivers, which second overflow is known on the Kennebeckasis as the "back freshet." This large body of cold water, which does not subside before the first week in June, undoubtedly retards very much the development of vegetation on the lower part of the St. John River. About two weeks after the ice in this part of the river has been discharged into the Bay, that from the upper part (above the Grand Falls) makes its appearance in the harbor, and is distinguished not only by the great quantity of drift-wood and freshet debris which accompany it, but also by its clearness and solidity (hence called the "block ice.") It frequently happens that this second run of ice does not pass the falls, but southerly winds hold it in the still waters above until it becomes liquified by the increasing heat of spring. When this happens the debris and vegetable matter, brought down from the head waters of the St. John, are thus scattered over the shores of Kennebeckasis Bay and the "Long Reach," and the seeds of species once peculiar to the upper part, have by this means been distributed along the lower part of the river.

These annual freshets and their concomitants have undoubtedly effected much in the distribution of species over areas in Central and Southern New Brunswick, which they could only have reached otherwise by slow degrees. It is in this way that I would account for the abundance of many species below the freshet mark on Kennebeckasis Bay, which have not been met with on the surrounding hills, but are common in the interior of the Province. Moreover, there are several species, which are noted by Mr. Goodale, as being very abundant on the Upper St. John (above Grand Falls), which are also met with on the shores of the Kennebeckasis, such as *Nabalus racemosus*, a plant decidedly north-western in its range, the two Primroses, *Primula farinosa*, and *P. mistassinica*, which grow in several places along the shore; the latter with its beds of beautiful pale rose-colored flowers tinting the gravelly beaches of Drury's Cove. To these we may perhaps add the Northern Green Orchis (*Platanthera hyperborea*), and the wild Chive (*Allium schœno-*

prasum), the latter being frequently met with on rocky and gravelly shores; also *Aster graminifolius*, *Anemone Pennsylvanica*, a very showy plant, with large white flowers, *Nasturtium palustre*, var. hispidum, *Parnassia palustris*, the White Silver Maple (*Acer dasycarpum*), the Dwarf Cherry (*Prunus pumila*), the Black Alder (*Ilex verticillata*), one of the Loosestrifes (*Lysimachia ciliata*), the Bracted Bindweed (*Calystegia sepium*), more commonly called Convolvulus, whose delicate white flowers, tinged with pink, present a beautiful contrast to the labyrinth of foliage with which they are entwined; also the Water Persicaria (*Polygonum amphibium*), the Canadian Wood Nettle (*Laportea Canadensis*), *Sparganium racemosum*, and the Canadian Lily (*Lilium Canadense*). Another plant, the "Sweet Coltsfoot," (*Nardosmia Palmata*), if not introduced by birds, probably immigrated at a much earlier period (the Post-Pliocene), as it grows far above the present level of the river.

While many North-Western and Western species have, by the spring floods of the river, or other means, been thrust into the group of species which characterize the coastal zone, others have been held at bay on the St. John River by the cool temperature and damp atmosphere, which prevail near its mouth during the summer months.

From the observations presented in the foregoing pages, the following conclusions may be drawn:—1st, One of the most peculiar features in the flora of the region to which these remarks relate, is the arrangement of several of the types mentioned, in zones around a central tract, due to the refrigerating influence of cold waters on the adjacent seas. 2d, That although there are highlands of considerable elevation in Acadia, they do not appear to exercise a very marked influence on the vegetation, except in so far as they act as a barrier to the oceanic winds. 3rd, That on account of its semi-insular position, and its full exposure to the chilling effect of the Arctic current, the maritime parts of this country have become the home of northern species not found within the limits of New England, and of many others which grow only on mountain tops, or cold, sheltered places, in that part of the United States. 4th, That although the sea-coast of Acadia is thus inhospitable, the interior has a summer climate so warm as to encourage the growth of a group of plants, which the damps and chill winds of the same season exclude from New England; such species being either entirely absent from that region, or found only sparingly in its warmer western and southern parts.

Judging from what is known of the flora of our country, as compared with that of the Upper Provinces, we may look upon the narrow girdle of sub-Arctic vegetation, which borders our shores, as paralleled by that which extends up the St. Lawrence River as far as the Island of Orleans, and reappears on the north shore of Lake Superior. The Boreal type, which is supposed to cover much of the northern part of Acadia, reappears on the St. Lawrence at and above Quebec, and is also met with around the shores of Lake Huron, and in the northern peninsula of Michigan. The group of plants which has been referred to as a Continental type, characterizes the country around Lake Ontario. Hence, we may look upon the central parts of Acadia as represented in climate and productions by that part of Ontario which lies around the eastern and northern shore of the lake of that name, and extends thence to Lake Huron.

There is an assemblage of plants in the S. W. part of Ontario, which Mr. Drummond designates as the Erie type, and which is said to characterize the region around that most southerly of the great Lakes. Of this type we have, so far as known, no representatives in Acadia. We may assume, therefore, that there is no portion of Continental Acadia, possessing a summer as warm and dry as prevails in the more southerly part of Canada, around Lake Erie. But while a comparison of the climate of Acadia with that of the Upper Provinces may thus be instituted, through the indigenous plants which grow in different parts of the Dominion, it is to be borne in mind that such a comparison relates only to the temperature and other climatic conditions of the summer. In the winter the climate of the maritime Provinces is very much milder; so that, while the valley of the St. Lawrence may be filled with snows to the depth of six feet or more, the southern shores of Nova Scotia may be but sparsely covered, or entirely bare.

Finally, from the known climatic conditions of Insular Acadia, the character of the vegetation, in its different parts, may be roughly predicated. Thus, the fog-wrapt shores along the Atlantic coast are known to support a vegetation similar to that of the southern shores of New Brunswick and Eastern Maine. Further, the Boreal type probably extends along the northern shore of Nova Scotia into the Island of Cape Breton, and may be expected to mingle to some extent with the sub-Arctic type along the Atlantic coast. The Boreal type may be looked for in force on Prince Edward's Island, fringed, as in New Brunswick, by sub-Arctic forms near the shores. In the central and north-western part of Nova Scotia, a partial recurrence of the Continental type may be looked for; but owing to the moister summers, and nearer proximity to the sea, it is probably more largely mingled with New England forms than it is in the valley of the St. John.

ON THE PROBABLE SEAT OF VOLCANIC ACTION.

By T. Sterry Hunt, LL.D., F.R.S.

The igneous theory of the earth's crust, which supposes it to have been at one time a fused mass, and to still retain in its interior a great degree of heat, is now generally admitted. In order to explain the origin of eruptive rocks, the phenomena of volcanos, and the movements of the earth's crust, all of which are conceived by geologists to depend upon the internal heat of the earth, three principal hypotheses have been put forward. Of these the first supposes that in the cooling of the globe a solid crust of no great thickness was formed, which rests upon the still uncongealed nucleus. The second hypothesis, maintained by Hopkins and by Poulett Scrope, supposes solidification to have commenced at the centre of the liquid globe, and to have advanced towards the circumference. Before the last portions became solidified, there was produced, it is conceived, a condition of imperfect liquidity, preventing the sinking of the cooled and heavier particles, and giving rise to a superficial crust, from which solidification would proceed downwards. There would thus be enclosed, between the inner and outer solid parts, a portion of uncongealed matter, which, according to Hopkins, may be supposed still to retain its liquid condition, and to be the seat of volcanic action, whether existing in isolated reservoirs or subterranean lakes; or whether, as suggested by Scrope, forming a continuous sheet surrounding the solid nucleus, whose existence is thus conciliated with the evident facts of a flexible crust, and of liquid ignited matters beneath.

Hopkins, in the discussion of this question, insisted upon the fact, established by his experiments, that pressure favors the solidification of matters which, like rocks, pass in melting to a less dense condition, and hence concludes that the pressure existing at great depths must have induced solidification of the molten mass at a temperature at which, under a less pressure, it would have remained liquid. Mr. Scrope has followed this up by the ingenious suggestion that the great pressure upon parts of the solid igneous mass may become relaxed from the effect of local movements of the earth's crust, causing portions of the solidified matter to pass immediately into the liquid state, thus giving rise to eruptive rocks in regions where all before was solid.*

Similar views have been put forward in a note by Rev. O. Fisher, and in an essay on the formation of mountain chains, by Mr. N. S. Shaler, in the proceedings of the Boston Society of Natural History, both of which appear in the *Geological Magazine* for November last. As summed up by Mr. Shaler, the second hypothesis supposes that the earth "consists of an immense solid nucleus, a hardened outer crust, and an intermediate region of comparatively slight depth, in an imperfect state of igneous fusion." In this connection it is curious to remark that, as pointed out by Mr. J. Clifton Ward, in the same Magazine for December (page 581), Halley was led, from the study of terrestrial magnetism, to a similar hypothesis. He supposed the existence of two magnetic poles situated in the earth's outer crust, and two others in an interior mass, separated from the solid envelope by a fluid medium, and revolving, by a very small degree, slower than the outer crust.† The same conclusion was subsequently adopted by Hansteen.

The formation of a solid layer at the surface of the viscid and nearly congealed mass of the cooling globe, as supposed by the advocates of the second hypothesis, is readily admissible. That this process should commence when the remaining envelope of

* See Scrope on Volcanos, and his communication to the *Geological Magazine* for Dec., 1868.

† The elevated temperature of the interior of the globe would probably offer no obstacle to the development of magnetism. In a recent experiment of M. Trève, communicated by M. Faye to the French Academy of Sciences, it was found that molten cast iron when poured into a mould, surrounded by a helix which was traversed by an electric current, became a strong magnet when liquid at a temperature of 1300° C., and retained its magnetism while cooling (Comptes Rendus de l'Acad. des Sciences, Feb., 1869.)

liquid was yet so deep that the refrigeration from that time to the present has not been sufficient for its entire solidification, is, however, not so probable. Such a crust on the cooling superficial layer would, from the contraction consequent on the further refrigeration of the liquid stratum beneath, become more or less depressed and corrugated, so that there would probably result, as I have elsewhere said, " an irregular diversified surface from the contraction of the congealing mass, which at last formed a liquid bath of no great depth, surrounding the solid nucleus." Geological phenomena do not, however, in my opinion, afford any evidence of the existence of yet unsolidified portions of the originally liquid material, but are more simply explained by the third hypothesis. This, like the last, supposes the existence of a solid nucleus, and of an outer crust, with an interposed layer of partially fluid matter, which is not, however, a still unsolidified portion of the once liquid globe, but consists of the outer part of the congealed primitive mass, disintegrated and modified by chemical and mechanical agencies, impregnated with water, and in a state of igneo-aqueous fusion.

The history of this view forms an interesting chapter in geology. As remarked by Humboldt, a notion that volcanic phenomena have their seat in the sedimentary formations, and are dependent on the combustion of organic substances, belongs to the infancy of geology. To this period belong the theories of Lémery and Breislak (*Cosmos*, v. 443 ; Otte's translation). Keferstein in his *Naturgeschichte des Erdkörpers*, published in 1834, maintained that all crystalline non-stratified 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. Volcanic phenomena, according to him, have their origin not in an igneous fluid centre, nor in an oxydizing metallic nucleus (Davy, Daubeny), but in known sedimentary formations, where they are the result of a peculiar kind of fermentation, which crystallizes and arranges in new forms the elements of the sedimentary strata, with an evolution of heat as a result of the chemical process (*Naturgeschichte*, vol. i. p. 109; also *Bull. Soc. Geol. de France* [1], vol. vii. p. 197). In commenting upon these views (*Am. Jour. Science*, July, 1860), I have remarked that, by ignoring the incandescent nucleus as a source of heat, Keferstein has excluded the true exciting cause of the chemical changes which take place in the buried sediments. The notion of a subterranean combustion or fermentation, as a source of heat, is to be rejected as irrational.

A view identical with that of Keferstein, as to the seat of volcanic phenomena, was soon after put forth by Sir John Herschel, in a letter to Sir Charles Lyell, in 1836 (*Proc. Geol. Soc. London*, ii. 548.) Starting from the suggestion of Scrope and Babbage, that the isothermal horizons in the earth's crust must rise as a consequence of the accumulation of sediments, he insisted that deeply buried strata will thus become crystallized by heat, and may eventually, with their included water, be raised to the melting point, by which process gases would be generated, and earthquakes and volcanic eruptions follow. At the same time the mechanical disturbance of the equilibrium of pressure, consequent upon a transfer of sediments, while the yielding surface reposes on matters partly liquified, will explain the movements of elevation and subsidence of the earth's crust. Herschel was probably ignorant of the extent to which his views had been anticipated by Keferstein; and the suggestions of the one and the other seemed to have passed unnoticed by geologists until, in March, 1858, I reproduced them in a paper read before the Canadian Institute (Toronto,) being at that time acquainted with Herschel's letter, but not having met with the writings of Keferstein. I there considered the reaction which would take place under the influence of a high temperature in sediments permeated with water, and containing, besides silicious and aluminous matter, carbonates, sulphates, chlorids, and carbonaceous substances. From these, it was shown, might be produced all the gaseous emanations of volcanic districts, while from aqueo-igneous fusion of the various admixtures might result the great variety of eruptive rocks. To quote the words of my paper just referred to: "We conceive that the earth's solid crust of anhydrous and primitive igneous rock is everywhere deeply concealed beneath its own ruins, which form a great mass of sedimentary strata, permeated by water. As heat from beneath invades these sediments, it produces in them that change which constitutes normal metamorphism. These rocks, at a sufficient depth, are necessarily in a state of igneo-aqueous fusion; and in the event of fracture in the overlying strata, may rise among them, taking the form of to eruptive rocks. When the nature of the sediments is such as generate great amounts of elastic fluids by their fusion, earthquakes and volcanic eruptions may result, and these—other things being equal—will be most likely to occur under the more recent formations." (*Canadian Journal*, May, 1858, vol. iii. p. 207.)

The same views are insisted upon in a paper "On some Points in Chemical Geology" (Quart. Jour. Geol. Soc., London, Nov. 1859, vol. xv. page 594,) and have since been repeatedly put forward by me, with farther explanations as to what I have designated above, *the ruins of the crust of anhydrous and primitive igneous rock.* This, it is conceived, must, by contraction in cooling, have become porous and permeable, for a considerable depth, to the waters afterwards precipitated upon its surface. In this way it was prepared alike for mechanical disintegration, and for the chemical action of the acids, which, as shown in the two papers just referred to, must have been present in the air and the waters of the time. It is, moreover, not improbable that a yet unsolidified sheet of molten matter may then have existed beneath the earth's crust, and may have intervened in the volcanic phenomena of that early period, contributing, by its extravasation, to swell the vast amount of mineral matter then brought within aqueous and atmospheric influences. The earth, air, and water thus made to react upon each other, constitute the first matter from which, by mechanical and chemical transformations, the whole mineral world known to us has been produced.

It is the lower portions of this great disintegrated and water-impregnated mass which form, according to the present hypothesis, the semi-liquid layer supposed to intervene between the outer solid crust and the inner solid and anhydrous nucleus. In order to obtain a correct notion of the condition of this mass, both in earlier and later times, two points must be especially considered, the relation of temperature to depth, and that of solubility to pressure. It being conceded that the increase of temperature in descending in the earth's crust is due to the transmission and escape of heat from the interior, Mr. Hopkins showed mathematically that there exists a constant proportion between the effect of internal heat at the surface and the rate at which the temperature increases in descending. Thus, at the present time, while the mean temperature at the earth's surface is augmented only about one-twentieth of a degree Fahrenheit, by the escape of heat from below, the increase is to be found to be equal to about one degree for each sixty feet in depth. If, however, we go back to a period in the history of our globe when the heat passing upwards through its crust was sufficient to raise the superficial temperature twenty times as much as at present, that is to say, one degree of Fahrenheit, the augmentation of heat in descending would be twenty times as great as now, or one degree for each three feet in depth (Geol. Journal, viii. 59.) The conclusion is inevitable that a condition of things must have existed during long periods in the history of the cooling globe when the accumulation of comparatively thin layers of sediment would have been sufficient to give rise to all the phenomena of metamorphism, vulcanicity, and movements of the crust, whose origin Herschel has so well explained.

Coming, in the next place, to consider the influence of pressure upon the buried materials derived from the mechanical and chemical disintegration of the primitive crust, we find that by the presence of heated water throughout them, they are placed under conditions very unlike those of the original cooling mass. While pressure raises the fusing point of such bodies as expand in passing into the liquid state it depresses that point for those which, like ice, contract in becoming liquid. The same principle extends to that liquefaction which constitutes solution; where, as is with few exceptions the case, the process is attended with condensation or diminution of volume, pressure will, as shewn by the experiments of Sorby, augment the solvent power of the liquid.* Under the influence of the elevated temperature, and the great pressure which prevail at considerable depths, sediments should, therefore, by the effect of the water which they contain, acquire a certain degree of liquidity, rendering not improbable the suggestion of Scheerer, that the presence of five or ten per cent. of water may suffice, at temperatures approaching redness, to give to a granitic mass a liquidity partaking at once of the character of an igneous and an aqueous fusion. The studies by Mr. Sorby of the cavities in crystals have led him to conclude that the constituents of granitic and trachytic rocks have crystallized in the presence of liquid water, under great pressure, at temperatures not above redness, and consequently very far below that required for simple igneous fusion. The intervention of water in giving liquidity to lavas, has,

* Sorby, Bakerian Lecture, Royal Society, 1863.

in fact, long been taught by Scrope, and notwithstanding the opposition of Plutonists, like Durocher, Fournet, and Rivière, is now very generally admitted. In this connection, the reader is referred to the *Geological Magazine* for February, 1868, page 57, where the history of this question is discussed.

It may here be remarked that if we regard the liquefaction of heated rocks under great pressure, and in presence of water, as a process of solution rather than of fusion, it would follow that diminution of pressure, as supposed by Mr. Scrope, would cause not liquefaction, but the reverse. The mechanical pressure of great accumulations of sediment is to be regarded as co-operating with heat to augment the solvent action of the water, and as being thus one of the efficient causes of the liquefaction of deeply buried sedimentary rocks.

That water intervenes not only in the phenomena of volcanic eruptions, but in the crystallization of the minerals of eruptive rocks, which have been formed at temperatures far below that of igneous fusion, is a fact not easily reconciled with either the first or the second hypothesis of volcanic action, but is in perfect accordance with the one here maintained, which is also strongly supported by the study of the chemical composition of igneous rocks. These are generally referred to two great divisions, corresponding to what have been designated the trachytic and pyroxenic types, and to account for their origin, a separation of a liquid igneous mass beneath the earth's crust into two layers of acid and basic silicates, was imagined by Phillips, Durocher, and Bunsen. The latter, as is well known, has calculated the normal composition of these supposed trachytic and pyroxenic magmas, and conceives that from them, either separately, or by admixture, the various eruptive rocks are derived; so that the amounts of alumina, lime, magnesia, and alkalies, sustain a constant relation to the silica in the rock. If, however, we examine the analyses of the eruptive rocks in Hungary and Armenia, made by Streng, and put forward in support of this view, there will be found such discrepancies between the actual and the calculated results as to throw grave doubts on Bunsen's hypothesis.

Two things become apparent from a study of the chemical nature of eruptive rocks; first, that their composition presents such variations as are irreconcilable with the simple origin generally assigned to them, and second, that it is similar to that of sedimentary rocks whose history and origin it is, in most cases, not difficult to trace. I have elsewhere pointed out how the natural operation of mechanical and chemical agencies tends to produce among sediments, a separation into two classes, corresponding to the two great divisions above noticed. From the mode of their accumulation, however, great variations must exist in the composition of the sediments, corresponding to many of the varieties presented by eruptive rocks. The careful study of stratified rocks of aqueous origin discloses, in addition to these, the existence of deposits of basic silicates of peculiar types. Some of these are in great part magnesian, others consist of compounds like anorthite and labradorite, highly aluminous basic silicates, in which lime and soda enter to the almost complete exclusion of magnesia and other bases; while in the masses of pinite or agalmatolite rock we have a similar aluminous silicate, in which lime and magnesia are wanting, and potash is the predominant alkali. In such sediments as these just enumerated we find the representatives of eruptive rocks like peridotite, phonolite, leucitophyre, and similar rocks, which are so many exceptions in the basic group of Bunsen. As, however, they are represented in the sediments of the earth's crust, their appearance as exotic rocks, consequent upon a softening and extravasation of the more easily liquefiable strata of deeply buried formations, is readily and simply explained.*

The object of the present communication has been to call the attention of geologists to the neglected views of Keferstein and Herschel, which I have endeavoured to extend and to adapt to the present state of our knowledge. It is proposed in another paper to consider the question of the agencies which have regulated the geographical distribution of volcanic phenomena both in ancient and in modern times.

Montreal, Canada, March, 1869.

---

* See in this connection the *Canadian Journal* for 1858, p. 203; Quart. Geo. Society for 1859, p. 494; Amer. Jour. Science [2] xxxvii., 255, xxxviii. 182; also Geology of Canada, 1863, pp. 643, 669, and Rep. Geol. Canada, 1866, p. 230.

THE TOAD AS AN ENTOMOLOGIST.

By A. S. Ritchie.

The principal object of the following notes on the toad as a collector of beetles, is to show how useful some of the lower animals are to man in his search after knowledge.

Before entering on the subject, a few remarks on the habits of the toad may not be uninteresting.

From the earliest accounts relating to this creature it has always been looked upon by the people as ugly, hideous, and venomous, while even supernatural powers have been attributed to it. Thus an old author says: "If the toad burrowed near the root of a tree, every one who ate a leaf of that tree would die, and if he only handled it, would be struck with sudden cramps." Some of the antidotes recommended for toad venom are the following: Black hellebore, powdered crabs, the blood of the sea tortoise mixed with wine, the stalks of dogs' tongues, the powder of the right horn of a hart, cummin, the vermet of a hare, the quintessence of treacle and the oil of a scorpion, mixed and taken *ad libitum.*

Even in those days when these elaborate prescriptions were invented some good was acknowledged to exist in the toad. The "toad-stone" is alluded to by Shakespere in the passage:

> "Sweet are the uses of adversity,
> Which like a toad, ugly and venomous,
> Wears yet a precious jewel in its head."

During the middle ages the stone found in the head of this reptile was popularly believed to be possessed of the power of giving warning of the presence of poisons. Fenton, writing in the year 1569, says: "There is to be found in the heads of old and great toads a stone they call borax or stelon. This worn in a ring gives a forewarning against venom." Another recommendation the toad had in those days was "its power as a styptic." Supposing any one to fall down and knock his nose against a stone, he could instantly stop the bleeding if he only had in his pocket a toad that had been pierced through with a piece of wood and dried in the shade or smoke. All he had to do was to hold the dried toad in his hand and the bleeding would immediately cease. The reason for this effect is, "that horror and fear constrained the blood to run into its proper place, for fear of a beast so contrary to nature."

In our day, however, the properties of this animal are better understood, although to a great extent it is still held to be venomous by the people, and generally killed wherever it is found.

Recent investigations go to prove that an acrid secretion covers the body of the toad, which is the cause of sore mouths in dogs attacking it. One of the great uses of the toad is its propensity for destroying insects injurious to vegetation. Our gardeners ought to introduce them into their gardens and cultivate the acquaintance of these creatures; their little trouble in so doing would be amply compensated.

The toad is of a retiring disposition, loving dark corners and shady places. It has a slow, crawling motion, and is of a very timid disposition. Numerous instances might be cited of pet toads, and of their becoming quite tame.

The toad differs in some respects from the nearly related frog. The structure of the mouth is, however, nearly the same; the tongue is attached by the root, as it were, to the base and front of the mouth, the tip being reversed and pointing down the throat when the animal is at rest.

The moment it sees an insect its eyes brighten and sparkle, the toes twitch, and quicker than the eye can follow, the tongue is thrown out, the insect transfixed, and withdrawn into the mouth.

Unlike the frog, the toad does not spring after its prey, but remains seated. Having kept frogs in the Aquarium, I have noticed that they will spring two or three times their own length from the moss to catch a fly on the glass, using their tongue, as it were, on the jump. They seldom miss their mark. As far as my experience goes, neither of these animals will eat anything without life or motion. I have, however, often deceived a frog by moving a dead fly in the sight of the creature, which it always took readily. Many stories have been told of toads in rocks, and reasons have been given by authors as to the way in which they became so embedded. My subject has, however, nothing to do with these "old great toads," but to one of our own day and generation. After this digression, I shall now introduce my friend, the toad, in his capacity as a collector of beetles.

The true naturalist, in the pursuit of his study, is a very teachable individual; he never refuses assistance from any one, whatever his station in life is, or however meagre his knowledge of the science may be. The many ways he uses the animal creation to advance his knowledge, in the particular branch of study, may be illustrated as follows:—

The Conchologist wearies for the pleasant days of summer, to take a trip to the sea-side, with his dredges and lines, his bottles and store boxes, where he adds to his collection many interesting and perhaps new forms of molluscan life.

A trip to the sea-side is not always easily obtained; but the naturalist may be seen in the markets buying the several species of flat fish, such as flounders and other species which live and feed at the bottom of the sea. Knowing them to be good collectors, he takes advantage of this fact to procure many and sometimes rare species, and thus adds to his cabinet, without the trouble of dredging for them.

The Entomologist, likewise, has recourse to different methods to obtain the objects of his interesting study. The following is one of many:

Starting at six o'clock one morning, in the summer of 1864, for a walk to our beautiful mountain, to collect insects, provided with the requisite apparatus, a wide-mouthed bottle, with spirits, for beetles, and a small flat box, lined with cork, for butterflies, &c., my success was particularly good. The first captures were eleven specimens of carrion beetles, comprising three species, viz., *Silpha peltata*, *Silpha marginalis*, and *Silpha inæqualis*. These were obtained from the body of a dead hawk owl (*Surnia ulula*). Having secured them in the bottle, and walking leisurely along, I noticed a toad (*Bufo Americanus*) sitting contentedly at the root of a basswood tree (*Tilia Americana*). Having never made use of my dingy friend as an insect collector, although aware of his propensity that way, my mind was made up to press him into the service—but how? He must be dead first. As he sat looking at me with his beautiful eyes (for although his appearance is not very prepossessing, still those beautiful, bright, yet languid eyes go a great way to improve his appearance), I had certain qualms of conscience about taking his life; still it was in the cause of entomology, and for the furtherance of science his life was sacrificed. Now he was dead; how was I to proceed? I had cut up and dissected many insects as well as birds; but to cut up a toad, and before breakfast—"there's the rub"—that grey, warty toad, no beautiful eyes now. One slash of the knife through the skin, another through the walls of the stomach, and the poor creature's breakfast was exposed.

I was a little disappointed at first, as one or two common forms of beetles presented themselves, that might have been obtained without sacrificing the poor animal; still, I reasoned as he had been up nearly, or perhaps all night, collecting, and I had not, he must have taken some species not in my collection. Having scraped the contents of his stomach into my bottle of spirits, I started home, resolved to see what the insects were before breakfast.

I spread them out on a sheet of blotting-paper and counted them, the result being as follows, naming them for the benefit of my entomological friends, who have not made use of the toad as a collector of insects:—

There were thirteen perfect specimens, viz.,—

	No. of Specimens.
Cymindis pilosa, rare, ...	one.
Platynus cupripennis, common, . . .	two.
Bembidium quadrimaculatum, uncommon, .	one.
Cercyon, undetermined, ...	three.
Tachyporus jocosus, common, . . .	one.
Pæderus littorarius, rare, ...	one.
Ips faciatus, common, ...	three.
Ips sanguinolentus, common, . . .	one.

Besides these, there were one elytron each of Hippodamia and of Brachycantha; also vestiges of legs and wings of other insects.

I have killed several toads since, with similar results; one, I may mention, had the stomach filled with a species of *Chrysomelidæ, Doryphora trimaculata*, amounting to eleven specimens. He had evidently come across a colony of that insect, and made a hearty breakfast. I may state that this insect was in great abundance, during 1864, on the Island of Montreal. The same may be said of last summer, 1868; taking them by the score on the Mountain, also along the river at Hochelaga.

The earlier you go out in the morning the better; before sunrise, if possible, ere the process of digestion has gone too far.

Birds are also very useful as collectors of insects, as may be seen by the following from one of the daily papers, being only one of many thousand examples:—

Birds the Farmer's Friends.—An intelligent farmer boy in Illinois observed a small flock of quails, commencing at one side of a cornfield, taking about five rows regularly through the field, scratching and picking around every hill, then returning and taking another five rows, until thinking they were pulling up the corn, he shot one and then examined the field. On the ground they had been over, he found but one stalk of corn disturbed, but in the quail's crop he found one cut worm, twenty-one striped vine bugs, over a hundred chintz bugs that he could distinctly count, and a mass apparently consisting of hundreds of chintz bugs, but not one kernel of corn. During the past five years the quails in that vicinity have been decreasing, and the chintz bug increasing.

It will thus be seen, from what has been said regarding the habits of those humble animals, toads and birds, what great services they render to man in the economy of nature, and will, it is hoped, tend to show that it is the duty of all, especially of agriculturists, to preserve such valuable animals.

ON TRICHINA SPIRALIS.

By J. Baker Edwards, Ph. D., F. C. S.,

(Late Lecturer on Chemistry and Medical Jurisprudence at the Royal Infirmary School of Medicine, Liverpool, England.

The occurrence of two fatal cases of Trichiniasis at Hamilton, Ont., and the successful treatment of several cases in Montreal, have drawn fresh attention to the parasite causing this disease; and as the researches into its natural history are somewhat scattered, it is thought a short *resumé* may not be uninteresting to our readers.

The cysts containing this parasite, and forming its sarcophagus in the flesh, were observed and examined microscopically by Tiedman in 1822. These were found in human muscle after death, and occasioned much speculation as to their real nature. In 1835 they were minutely examined by Mr. James Paget, and described and named by Professor Owen;* but as there then existed no clue to their natural history, they for some years possessed no interest beyond the fact of their existence in human muscle, and their classification as a genus of Entozoa; belonging to the order, Cœlelmintha; family, Nematoidea. Herbst found, in 1841, that dogs, when fed upon parts of a badger containing these worms, became infested with them in their muscles. But it remained for Zenker, in 1860, to show that the human body becomes infected with these parasites in

---

* Trans. Linnean Socy., LXXX., LXXXIV.

consequence of eating pork already containing them. Since this time, thousands of deaths have been traced to this cause, which would previously have been attributed to typhoid, gastric, or rheumatic fever, paralysis, poisoning, or atrophy. Further researches by Virchow of Berlin and Leuckart of Giessen, added greatly to our knowledge of the natural history of the species, and Prof. Dalton has elaborately studied cases of the disease in New York.

Trichiniasis is now fully established as one of the "ills which flesh is heir to." In several hospital examinations of human bodies after death from various causes, from 2 to 3 per cent. of adults are found to contain old encrusted capsules containing these worms, thus bearing evidence of the existence of this disease at some former period. In the Chicago market a medical commission found in the pork offered for sale 2 per cent. of flesh thus infected.

From these facts it may be inferred that the disease occurs much more frequently than has heretofore been supposed, but that it is only under peculiar circumstances that the worm breeds with such excessive rapidity as to cause fatal or even serious results.

The cases of the disease which have recently occurred on this Continent have caused still further investigations to be made as to its character, the probability of its detection, and the means of cure. Of these cases, those which occurred in the west were fatal, but those in Montreal, being of a slight nature and speedily diagnosed, were treated successfully. The whole literature of the question has been searched for an explanation of the facts which presented themselves in the Montreal cases, and whilst they are found to be in general accordance with cases on record, in some respects they may be considered unique. The history of the Montreal cases may be concisely stated thus:

On Wednesday, the 24th of March, a family in a boarding-house partook of some hastily-fried ham. Within an hour afterwards two of the adults felt nauseated and had some pain in the stomach. One took a large dose of brandy, and vomited his dinner; the other felt only abdominal pain, spasms, and faintness. He returned from his work and went to bed. During the night his wife and wife's mother felt ill, and suffered from pains in the bowels, together with great feverishness and thirst. During the following day, five other persons, who had partaken of the same meal, suffered more or less from similar symptoms, and in the evening of Thursday called in a physician, who, after careful enquiry, diagnosed Trichiniasis, and called in a second opinion on the case. On Good Friday a slice of ham was submitted to me for microscopic examination, in which I discovered, after some hours' investigation, several characteristic specimens of Trichina spiralis. By Monday morning, with the assistance of my friend Mr Ritchie, I had found several groups of Trichina, both in the free state and partially, as well as fully, encysted. These were during the same day shown to a considerable number of medical friends.

Mr. C. Baillie kindly placed his micro-photographic apparatus at my disposal, and during the week produced some excellent negatives of the worms "*in situ*" in the pork muscle.

No. 1.—This photograph (reproduced by Mr. Inglis) shows a group of Trichinæ in very close proximity, travelling up a line of muscular tissue, or rather between the muscular bundles.

No. 4 shows an individual worm surrounded by a gelatinous cyst, protruding his head therefrom, apparently in search of food, for his head and mouth can be distinguished under the microscope in the dark mass of muscle to the right of the field. Above, around and below are the worms not encysted, but curled up in the band of muscle, so that thirteen may be counted on a field of view not exceeding the tenth of an inch in diameter.

No. 5 shows what appears to be a lateral section of the worm fully encysted, but the worm is really whole, and the section only optical, the cyst being so transparent as to allow focusing through it. The cyst, although perfect, is not calcareous, and in no case did any calcareous cysts present themselves. The above were found in the slice of ham in question, and, indeed, in one particular muscle of that ham, of which the horizontal section did not exceed one-quarter inch in thickness. It is evident, therefore, that the disease was recent in the young pig from which the ham was taken, and that, being in the free and semi-encysted condition, the worms were in a condition to be aroused into action and activity in a much shorter time than had they been fully and calcareously encysted. According to Virchow*

---

* Virchow's archives, 1850, vol. xxxiii, page 535.

and Zenker the period of incubation of the cyst in the stomach is from six to eight days. This has been erroneously interpreted to mean that such a period must elapse before any marked symptoms can be recognized. Such a period of time however, is meant to be inclusive of the reproducing power of each individual, from whose body successive broods of young, numbering from 100 to 200, are discharged. Dr. T. S. Cobbold* has found a period of sixty-nine hours amply sufficient for the development of the young muscle flesh worms of the human subject into the sexually mature adult Trichina of the dog. If all the worms were calcareously encysted a delay of from three to six days might be expected before intestinal irritation was a marked symptom. But in cases where the worms are young and free in the muscle, development may take place in a few hours, and rapid multiplication take place before other encysted worms were released from their capsules.

Thus a succession of fresh irritations to the muscular and nervous system may be expected from the first few hours to a period of eight or ten weeks. In the fatal cases examined in Chicago and Hamilton no single case of encysted Trichina was found in the flesh, but in the Montreal cases one or two distinct and complete cysts were extracted from the man's leg. This was eight weeks after eating the pork, and when the symptoms had somewhat abated, but considerable pain still felt in the muscles. The great shock to the system, which frequently terminates fatally, appears to result from excessive generation of the worms at any one period;—thus young and healthy persons are frequently killed sooner than older and more feeble individuals, the reason being that in the former case probably more food is eaten, digestion is more rapid, nausea more readily overcome by active exertion, and the breeding of the worms becomes excessive and continuous. In the Hamilton cases the young woman died in three weeks, whilst her mother survived six weeks, after eating the fatal repast. Nos. 2 and 3 in the photograph show examples of the worms in the latter case. In No. 2 the worm is carefully picked out from the muscle. No. 3 shows the muscle containing the worms in various postures on a line of muscle, it also

* Journal Linnean Society, vol. ix, page 209.

shows two generations on or near the same line of muscle. The faint curve near the edge of the margin being a larger and older worm than the other three, it is but partially in focus, and only about one half is, therefore, seen.

These worms have been generally figured in works on Physiology in two conditions, viz., encysted in the muscle, and sexually developed in the intestinal canal. The appearance of the young sexless worm *in transitu* in the flesh has not been carefully described. Some observers have, therefore, mistaken it for another species, whilst others have overlooked it altogether. The photographs Nos. 1, 3, 4 and 5 show fairly the varied forms in which the worm may be expected to be found in flesh during periods of from one to six weeks after ingestion. After a period of from six to twelve months the cysts become covered with a phosphatic opaque deposit, and the worm can only be seen by dissection or by solution of the coating in weak acid. These old cysts are sometimes found empty.

The best medium which I have found for mounting recent muscle for the examination and extraction of specimens, under the microscope, is a mixture of one part glycerine and one part aqueous carbolic acid. The muscle may be conveniently examined by a two-third object glass, and a B. or C. eye piece with the smallest aperture in the diaphragm. The extracted worm is best seen under a $\frac{1}{4}$-inch objective, with a small pencil of light, or by polarised light. No. 1 is magnified 100 diameters; Nos. 2 and 3, 150 diameters; Nos. 4 and 5, 50 diameters.

In 1866 some valuable experiments were conducted, in reference to the propagation of these worms, by Dr. T. Spencer Cobbold,* whose researches on Cestoid Entozoa place him at the head of English authorities on such subjects.

After feeding animals with trichinous food, seven experiments on birds all proved negative. Three sheep, two dogs, one pig and one mouse gave also negative results.

Nine cases were successful, viz., four dogs, two cats, one pig, one Guinea pig and one hedgehog.

While we may, therefore, conclude that birds and herbivorous mammals are very unlikely subjects for infection by this

* Journal of the Linnean Society, Zoology, vol. 9, p. 205.

means; it is also found that other animals, as the dog and pig, for instance, may partake of the food and yet escape infection. This helps to explain the recorded facts that large parties have eaten of trichinous food in company, and some have been killed, others suffered slightly, and again some escaped altogether.

Moreover, in the human subjects examined *post-mortem*, where the disease has not proved fatal, in some cases, the cysts were by no means numerous, whilst in others they have been estimated at from forty to one hundred millions. The excessive alarm which is apt to seize the public mind by the discovery of a case here and there is not, therefore, justified by the facts when properly understood. At the same time, whatever means can be adopted by the public authorities to prevent its becoming a familiar disease in our new Dominion should be forthwith adopted.

REMARKABLE LUNAR PHENOMENON.

By C. SMALLWOOD, M.D., LL.D., D.C.L.

A somewhat rare and singularly beautiful phenomenon occurred between the hours of 9 and 10.20 p.m. of the 25th January, 1869, at this place (Montreal.)

It has been said that *haloes* and *coronæ* are very seldom or ever seen around either the Sun or Moon at the same time, and that their existence is very rare, and has been seen but by very few observers; but such was the case in the present instance, and deserves to be placed on record.

> "The moon of the winter's night had hid the stars,
> A bow of beauty, rich in shades of light,
> Had circled in a crown of golden rays;
> The snow lay stretched in beds of silvery white."

The sky at 8 p.m. was quite free from visible clouds; the moon shone with a brightness peculiar to our Canadian climate; but few of the stars were visible. The Moon's age at noon was 12.9 days. The Barometer at 9 p.m. stood at 29.710 inches, Thermometer at 0° (zero) with light breezes from the West. At 8.30 p.m. very light and indistinct *cirrus* clouds began to form in the Zenith, very minute, and at a very high altitude. They somewhat rapidly increased in size and density, mingling with a slight *cumulus* which had formed in the West, and were carried by the wind eastward. These together formed round the moon a corona of golden light 5° in diameter, encircled by a concentric ring or halo of bright prismatic rays of about 1° in breadth. The red ray was nearest the moon, then the orange,—and next respectively the yellow, green, blue, indigo and violet shades. A second but much larger circle or halo was also visible during part of the time, about 15° in diameter, and tinted with faint prismatic colours. *Cirrus* and *cumulus* clouds were seen floating from the west eastward, and were very visible and well defined within the concentric rings.

These appearances lasted for nearly an hour. The formation of *cumulus* clouds became more dense, and at a less altitude began to obscure the distinct outlines, and seemed to co-mingle and to obliterate these appearances from view.

At 9h. 40m. p.m. heavy *cumulus* clouds spread rapidly and covered the whole horizon. A very high wind prevailed during the whole of the night.

At 7 a.m. the next day (the 26th) the barometer had fallen to 29.646 inches, with a slight rise in temperature. The thermometer at the same hour stood at 1°. A small amount of snow fell at 8h. 20m. a.m.

It might be stated that a partial eclipse of the moon occurred on the evening of the 27th. Its appearance was unsatisfactory, owing to the presence of clouds and to the hazy state of the atmosphere.

ON THE DISTRIBUTION OF RAIN.

By C. Smallwood, M.D., L.L.D., D.C.L.

The geographical distribution of rain over the surface of the globe may be said to be proportioned to temperature, its humidity to the tides or fluctuation in the atmosphere, as indicated by the barometric variations, to changes of temperature, and to the configuration of the earth's surface.

The conditions necessary to the formation of rain are the presence of clouds, (although some observers have recorded rain falling from a cloudless sky,) to that of the cirrus (or snow cloud) at a high elevation, and at a low temperature (some 40° degrees below zero), together with the cumulus (or vapour cloud). These co-mingling by moist air-currents being forced into the higher region of the atmosphere by colder, less humid and consequently heavier currents from beneath, form together the nimbus (or rain cloud). These induce a change in temperature and electrical action, conditions necessary to produce rain. This is carried by clouds and currents of wind and distributed over the lands of our continents, thus watering the earth, supplying vegetation, and the various wants of mankind and returning again by the rivers to the sea. From the surface of the ocean pure aqueous vapours are constantly ascending to supply the unceasing requirements of the organic and inorganic world.

Rain-clouds are attracted to certain localities more than to others, for it was shewn that at Ulleswater (England) the great heat of 1866 caused a great increase in the amount of rain, owing to its condensation by the mountains in that district. But beyond the formation of the surface of our globe, there are other conditions which supply natural conductors, such as the pointed extremities of the leaves of trees and of plants. May not our primæval forests have given rise to a different meteorological condition of a former world ? The great coal formations may be taken as an example in illustration of this.

Many countries have been made sterile by cutting down indiscriminately the whole of the trees. Such, indeed, is actually the case in the recent deserts of Syria, Chaldea and Barbary. The "*Oases*" of the desert are nothing more than a few trees purposely left as a shade for the weary traveller.

The value of several estates in the West Indies has been greatly diminished by the cutting down of the trees upon them, and the rain fall over large regions of our own continent is much diminishing, owing, no doubt, to the large and extensive clearances of our forest; while on the other hand, the rain fall in the Upper Province of Egypt has been increased tenfold by the planting of twenty millions of trees by Mehemet Ali.

Until two years ago rain in that Province was unknown; but in twelve months ending April last there were actually 14 days on which rain fell, and later there fell a heavy shower—a phenomenon which the oldest Arab had never witnessed. Here we see rain returning to the desert on restoring the trees.

In Spanish America, lakes have had their area diminished and their shores dried from the general removal of the trees by the Spaniards; but now that cultivation has been resumed by the enterprising Americans, these lakes are being again filled up with water, and the shores are once more plentifully supplied with rain.

Extensive drainage, although beneficial to the rapid growth of plants and to the profit of the agriculturist, may also tend to diminish the rain fall by robbing the springs of their supply and by conducting the surface water more rapidly to the rivers and to the ocean.

Those lands near the sea over which the wind transports the aqueous vapour there acquired are, as a general rule, the most plentifully watered, while those distant from this source receive less in amount; these facts are fully borne out by actual observations. And may not the diminished rain fall in England be attributed in a great measure to the extensive surface draining by drain-tiles and other methods which are resorted to to promote the rapid growth and excessive yield of grain and some of the other agricultural products?

It will be seen that rain increases with the temperature, from the fact that hot air holds more water suspended than cold. The humidity of the atmosphere attains its maximum at the sea shore, and there tends to produce the greatest amount of precipitation. These causes are always present, but in a modified degree, and frequent, though small, showers are the necessary consequence; heavy and violent rain storms are of rare occurrence there.

In proportion as the mercurial column in the barometer falls, there is more chance of rain being formed, inversely in countries with a high Barometric pressure, such as on the 30th degree of latitude, where there is very little rain. Such regions have a tendency to become deserts.

Variations of temperature and irregularities of climate increase the showers of rain; and the formation of the soil plays also an important part in the production of rain, for ascending concave surfaces of soil receive a maximum, more especially when exposed to rainy winds, and more rain falls in *wooded* than in *bare* districts.

It rarely or never rains on the coast of Peru, in the great Valley of the River Columbia, in that of the Colorado in North America, the Sahara in Africa, and the Desert of Gobi in Asia, while in Patagonia and Chiloe it rains almost every day.

Days of rain are more numerous in high than in low latitudes.

In the region of Calmus it rains during a part of every day, the fall amounting to 225 inches in the year.

The heaviest fall of rain on our globe takes place on the Khasia Hills to the north-west of Calcutta, and amounts to 600 inches annually.

The greatest amount which has fallen in the vicinity of Montreal in one hour was 1.110 inches.

These observations extend over a period of upwards of 20 years.

Below is a table shewing the annual mean amount of Rain fall at some of the principal stations on our globe. The amount is in inches and tenths :—

	Inches.		*Inches.*
Madras	55.10	Dublin	24.00
Bombay	75.00	Glasgow	21.33
Canton	78.00	Aberdeen	28.87
Sierra Leone	87.00	Manchester	36.00
Rio Janeiro	89.00	Liverpool	34.00
Barbadoes	72.00	New York	28.63
Vera Cruz	183.00	Cambridge	44.48
Bergen	89.90	Albany	40.67
Stockholm	19.67	Baltimore	40.98
Copenhagen	18 55	New Orleans	52.31
Brussels	29.96	Cincinnati	48.63
Naples	29.94	San Francisco	22.00
Rome	30.86	Washington	41.20
Paris	22.64	Halifax	43.44
St. Petersburgh	17.65	St. John, N.B	42.10
London	22.00	Toronto	31.50
Oxford	27.10	Montreal	36.00
Cork	40.00	Quebec	39.10

ON SOME OF THE CAUSES OF THE EXCESSIVE MORTALITY OF YOUNG CHILDREN IN THE CITY OF MONTREAL.

By Philip P. Carpenter, B.A., Ph. D.,

Hon. Secretary of the Montreal Sanitary Association.

The object of the present paper is (1) to continue and enlarge upon the data given in the *Canadian Naturalist*, New Series, Vol. 3, pp. 134–156, under the head of "Vital Statistics of Montreal;" and (2) to enquire into some of the causes of the most unusual disproportion between the deaths of young children and adults.

The lettering and numbering is so given as to correspond with the previous article, to which the reader would do well to refer back. The figures for 1866 are repeated, along with the general average of 12 years, in order to make a suitable comparison with the succeeding years. It should be remembered that in each of the years beginning with 1866 the official directors and executors of public hygiene have stated that the city was never before in so cleanly a condition.

A.—The Census Returns.

In advance of the approaching Census, it is most important to remember how inaccurate the last was proved to be; the double entry of "uncooked" figures for Quebec deaths presenting a discrepancy of 296 (see p. 134), and the Montreal deaths presenting a known deficiency of 1,143 (see Table 8, p. 147). It behoves all members of the governments therefore, both federal, provincial and municipal, and all who can bring influence to bear upon these governments, to see to it that the appointments are not given to incompetent political favourites, but to the best men that can be found for so important a public work. The citizens of the largest (and the most unhealthy) city in the Dominion should especially see to this.

B.—The Protonotary's Returns.

These continue to be the only accessible data for the Births in Montreal, as well as for both Births and Deaths in the surrounding counties. Yet they only record religious ceremonies. The births among Baptists (a very small sect, however, in this city and province) are not publicly registered. An imperative Registration of Births and Deaths (with the *proximate* and *remote* causes of the latter under medical certificate) is among the first duties of our government. It should not be left to the peculiar views of the leaders in either Province, but should be *uniform for the whole Dominion*, and enforced by sufficient penalties.

In the following tables, Vaudreuil and Soulanges, having been permanently removed to another registration district, are no longer represented by averages. The population of the six counties was 81,291 in 1861, to which the average increase, viz., 2,938, is added year by year. This alteration somewhat affects the averages as previously given:—

4. *Montreal City: Returns of Baptisms and Funeral Services.*

Year.	Supposed Population.	Births.	Deaths.	Excess of Births over Deaths.	Deaths per 1,000 Living.	Deaths per 100 Births.
Average of 7 years	93,583	4,545	3,390	1,155	36·2	74
Montreal City in 1865.......	103,363	5,543	3,761	1,782	36·4	68
" 1866.......	111,374	5,158	3,381	1,777	30·3	65
" 1867.......	116,608	5,598	4,247	1,351	37·7	76
" 1868.......	122,088	5,060	4,567	493	37·4	90
Average of 4 years	113,358	5,339	3,989	1,350	35·4	75

5. *Six adjacent Counties: Returns of Baptisms and Funeral Services.*

Year.	Supposed Population.	Births.	Deaths.	Excess of Births over Deaths.	Deaths per 1,000 Living.	Deaths per 100 Births.
Average of 8 Counties for 7 years	109,611	3,923	1,911	2,012	17·4	48
Six Counties in 1865	93,043	2,763	1,651	1,112	17·7	59
" 1866	95,981	2,591	1,415	1,176	14·8	59
" 1867	98,919	2,686	1,603	1,083	16·2	59
" 1868	101,857	2,588	1,532	1,056	15·4	59
Average of 4 years	97,450	2,657	1,550	1,107	16.0	59
Ditto, corrected to the Population of Montreal	113,358	3,091	1,803	1,288	16.0	59
Ditto, Montreal City	113,358	5,339	3,989	1,350	35·4	75
Balance for and against the City	0	2,248	2,186	62	19·4	16

It appears, therefore, that though our mothers give birth to more than 2,000 infants yearly, in addition to the infants born among the same number of country people, the city only gains 62 lives, as the fruit of all this suffering and loss!

The deaths registered by the Clergy, in the city of Montreal, as compared with those registered at the Cemeteries, present the following results.

8. *Comparison of Mortality-Records in Montreal City,* 1866—1868.

Year.	Cemetery Returns.	Clergy Returns.	Not Entered in Clergy Returns.	Or, per 100 Deaths.	Or, per 1,000 Living.
1866	3,610	3,381	229	6.3	2.0
1867	4,465	4,247	218	4.9	1.9
1868	4,842	4,567	275	5.7	2.2
Total	12,917	12,195	722	5.6	2.0

C.—Interments at the Cemeteries.

The allowances to be made in estimating the accuracy of these returns are stated at p. 147; for the comparison of years, of seasons and of ages *with each other*, they are invaluable. During the last year, the descriptive columns in the weekly sheets have been filled up with much more accuracy than heretofore, in consequence of urgent representations from the Sanitary and Medical Associations; but they are not yet accurate enough for the requirements either of medical, sanitary or statistical science. This is greatly to be regretted and deprecated; because in a large city, where all the interments are made at two cemeteries, a very little determination on the part of the officials would produce nearly all that can be desired.

7. *Rate of Mortality for the City of Montreal, from the Cemetery Returns.*

Year.	Supposed Population.	Deaths of Adults.	Or, per 1000 of all ages living.	Deaths of *Children.*	Or per 1000 of all ages living	Deaths of Children to every 100 d'ths of adults.	*Total* Deaths.	Or per 1000 of all ages living.	Or one Death in every	Yearly excess of Deaths of all ages as compared with adjacent c'unties.	Or, per 1000 living.
Average of 12 yrs.	89,860	947	10.5	2,224	25.0	238	3,191	35.5	28 living	1,696	18.9
1866	111,374	1,226	11.0	2,384	21.4	194	3,610	32.2	30 "	1,970	17.7
1867	116,608	1,274	10.9	3,191	27.3	254	4,465	38.3	26 "	2,576	22.0
1868	122,088	1,318	10.8	3,524	28.8	267	4,842	39.6	25 "	3,006	24.6
Average of 3 yrs.	116,690	1,273	10.9	3,033	25.8	238	4,229	36.7	27 "	2,516	21.4

Supposed present Population. 127,826.

The deaths in the city, according to the country rate of dying in the same year, ought to have been in 1866 1640
" " " " " " in 1867 1889
" " " " " " in 1868 1836

9. *Total Deaths in Montreal, of all ages, for each month.*

Month.	Total for each month, for 12 years.	1866.	1867.	1868.
January	2,792	227	260	230
February	2,539	234	281	363
March	2,920	297	381	346
April	3,068	293	321	387
May	3,051	258	324	481
June	3,381	284	469	416
July	4,858	415	667	631
August	4,321	387	696	713
September	3,245	394	363	406
October	2,741	265	234	329
November	2,567	260	274	284
December	2,814	296	195	256
Total of each year.	38,297	3,610	4,465	4,842

10. *Deaths of Children under 12 in Montreal, for each month.*

Month.	Total for each month, for 12 years.	1866.	1867.	1868.
January	1,897	150	164	160
February	1,679	146	175	230
March	1,980	183	241	234†
April	2,040	183	202	264
May	2,074	152	223	356
June	2,440	181	362	311
July	3,927	341	578	508
August	3,358	289	547	573
September	2,320	280	277	324
October	1,777	157	147	202
November	1,630	156	175	193
December	1,810	166	107	169
Total of each year.	26,932	2,384	3,191	3,524

† At the beginning of this month, after an unusually severe winter, there came a rapid thaw, with special stenches in the drains and on the surface of the low levels. This was succeeded by a sudden frost, with peculiarly severe N. E. storms. The children's deaths *rose* from 47 at the opening of the month *to 79 in the thaw*; and fell again in the week of cold storms to 46. The deaths of adults were scarcely affected by either change.

11. *Deaths of Adults (and childen above 12) in Montreal, for each month.*

Month.	Total for each month, for 12 years.	1866.	1867.	1868.
January	895	77	96	70
February	860	88	106	133
March	940	114	137	112
April	1,028	110	119	123
May	977	106	101	125
June	941	103	107	105
July	931	74	89	123†
August	963	98	149	140
September	925	114	86	82
October	964	108	87	127
November	937	104	99	91
December	1,004	130	88	87
Total of each year.	11,365	1,226	1,274	1,318

† This *includes* 3 *deaths from sunstroke* in a single week, in consequence of the excessive heat. Yet the average deaths of adults did not exceed that of April; these 30 extra deaths being compensated by unusual healthiness in other respects. At the same time, the children, none of whom died from sunstroke, *had nearly doubled* their April rate of dying.

Months.	12. *Average Weekly Mortality, of all ages, for each Month.*				13. *Average Weekly Mortality of Children under 12, for each Month.*				14. *Average Weekly Mortality of Adults (and Children above 12,) for each Month.*			
	Average of 12 Years.	1866.	1867.	1868.	Average of 12 Years.	1866.	1867.	1868.	Average of 12 Years.	1866.	1867.	1868.
January	52·7	56·7	65·0	57·5	35·8	37·5	41·0	40·0	16·9	19·2	24·0	17·5
February	52·9	58·5	70·2	72·6	34·9	36·5	43·7	46·0	17·9	22·0	26·5	26·6
March	54·1	59·4	76·2	85·5	36·6	36·6	48·8	58·5	17·4	22·8	27·4	28·0
April	60·1	73·2	80·2	96·7	40·0	45·7	50·5	66·0	20·1	27·5	29·7	30·7
May	57·6	64·5	81·0	96·2	38·9	38·0	55·7	71·2	18·5	26·5	25·2	25·0
June	65·0	56·8	93·8	103·9	46·9	36·2	72·4	77·7	18·1	20·6	21·4	26·2
July	93·4	103·7	166·8	157·7	75·5	85·2	144·5	127·0	17·9	18·5	22·2	30·7*
August	82·1	96·7	139·2	142·6	63·3	72·2	109·4	114·6	18·1	24·5	29·8	28·0
Sep ember	62·4	78·8	90·7	101·5	44·6	56·0	69·2	81·0	17·8	22·8	21·5	20·5
October	51·7	66·2	58·5	65·8	33·5	39·2	36·7	40·4	18·2	27·0	21·7	25·4
November	50·3	65·0	54·8	70·9	31·9	39·0	35·0	48·2	18·3	26·0	19·8	22·7
December	52·1	59·2	48·7	63·9	33·5	33·2	27·7	42·2	18·6	26·0	22·0	21·7
Average Week of Year	61·2	69·4	85·4	93·1	43·0	45·9	61·2	67·7	18·1	23·6	24·3	25·3

* Without the 30 deaths from sunstroke, the Adult average for July would have been only 23·2, (or a little more than that of November,) in spite of the unusually oppressive heat. Probably persons were afraid to drink so much liquor. In Lancashire, it has been found that the *health of the people is improved* in times of special privation, as during the cotton famine, simply because they cannot afford to swallow so much drink-poison.

18. *Weeks of Maximum and Minimum Mortality, for all ages, in Montreal.*

Year.	Highest Mortality, in week ending	Lowest Mortality, in week ending	Which is at the yearly rate, per 1,000 living, of Maximum	Minimum	Range of variation, at yearly rate per 1,000.	Actual Range of variation, between max. and min. weeks	General Average of the year, per 1000
1866	July 21 121	June 9.44 Dec. 1.45	54	19	35	77	32.2
1867	" 27..185	Nov. 2.39	82	17	65	146	38.3*
1868	" 18..209	Jan. 18.48	89	20	69	161	39.6

Or, for Children under 12 *years of age only:—*

1864	July 2..116	Oct. 22...25	58	12	46	91	34.1
1865	" 1..103	" 28...24	50	10	40	79	26.8
1866	" 21..102	Jan. 6...25	48	11	37	77	21.4
1867	" 27..157	Dec. 28...19	70	9	61	138	27.4
1868	" 18..152	Jan. 18 Oct. 24 32	64	14	50	120	28.8

Or, for Adults only:—

1864	Apr. 30..36	Sept. 3..... 7	18	3	15	29	11.2
1865	Aug. 5..33	" 23.....10	16	5	11	23	11.0
1866	May 19..37	July 14.....14	18	7	11	23	11.0
1867	" 11..35	June 22.....10	16	5	11	25	10.9
1868	July 18..57†	Sep. 12.....12	24	5	19	45	10.8

* If the mortality (corrected for increase of population) had been calculated from September 1st, 1866, to September 1st, 1867, it would have given the death-rate of the year as 40.6 per 1000.

† Thirty of these were from sunstroke: see note to Table 11. It appears that, with this exception, the range of variation for adults is remarkably uniform.

These tables, compiled with the greatest attainable accuracy for the space of 14 years, prove to an absolute demonstration, after making all reasonable deductions for possibilities of error, not merely on the average of years, but in each single successive year, (1) that the mortality of Montreal is excessive as compared with the immediately adjacent country districts, under the same climatal conditions, but less favoured as regards wealth and intelligence; (2), that this excess is utterly disproportionate in the ratio of the deaths of children and adults; (3), that this excessive mortality of children uniformly attains its greatest height during the heats of summer. It is possible to bring out these facts with even greater distinctness.

The mortality of July, 1867, having reached a higher point than that of any previous year without special epidemics or unusual heat, in spite of comforting assurances from the city authorities that the yards had never been so well cleansed, the Sanitary Association instituted enquiries into the condition, during the same season, of New York and Boston, and analyzed the returns on the cemetery sheets to ascertain during what period of life the special mortality prevailed. The following are the results.

21. *Analysis of Children's Deaths in Montreal, for the year* 1867.

Deaths.	Under 1 year, (including 201 blanks, or still-born.)	Above 1 year, and under 5.	Above 5 years, and under 12.	Total Children under 12.	Total, all ages above 12.
Interments of children	2,063	910	218	3,191	1,274
Or, per year of life	2,063	228	31	266	22
Condition, according to the prophecy of Isaiah.......	0	0	0	0	4,465
Proportion of total deaths per year of life; one in.......	2.1	19.6	144.0	16.7	203.0

	Under 1 year.	Total under 5.	....	Total under 12.	Total, all ages.
Total interments	2,063	2,973	....	3,191	4,465
Percentage of *total* deaths ...	46.2	66.6	....	71.5	100.0
Percentage of *children's* deaths	64.6	93.2	....	100.0	....
Supposed number of children living, corrected from the census of 1861	5,158	19,627	....	37,761	116,608
Deaths of children, per 1,000 living *at the same age* ...	399.9	151.4	....	84.5	38.3
Or, 1 in every .... (living at the same age.)	2.5	6.6	....	11.8	26
Ditto, average of 10 years	2.5	7 0	....	13.0	28
Ditto, average of Lower Canada, less principal cities .	....	....	....	27.0	96

	....	Between 5 and 12.	Total above 5.	Total above 12.	Total, all ages.
Supposed number of persons living in the city	....	18,144	96,981	78,837	116,608
Deaths per 1,000 living *at the same age*...............	....	12.0	15.4	16.1	38.3
Or, 1 in every .... (living at the same age.)	....	83	65	62	26

It is evident, therefore, that the children from 5 years upward are remarkably healthy in this city, the principal reason being that all the moribund children are killed off at an earlier age. It is *those children who are confined to the house* or to its immediate surroundings who are, in this city, so peculiarly unhealthy. The principal causes of the death-rate, therefore, must be looked-for in the condition of the dwellings.

But, as it is shewn that the special mortality of the city follows the months, not indeed for adults, but for children, let us examine whether it specially follows any particular period of childhood.

22. Deaths of Children in Montreal, 1867, *according to ages and months.*

	Under 1 year.		From 1 to 5 yrs.		From 5 to 12 yrs.		All ages under 12.	
	Total.	Weekly average.	Total.	Weekly average.	Total.	Weekly average.	Total.	Weekly average.
January	94	23·5	46	11·5	22	5·5	162	40·5
February	109	27·2	49	12·2	16	4·0	174	43·5
March	159	31·8	53	10·6	26	5·2	238	47·6
April	126	31·5	62	15 5	13	3·2	201	40·2
May	135	33·7	70	17·5	18	4·5	223	44·7
June	229	45·8	101	20·2	32	6·4	362	72·4
July...........	404	101·0	146	36·5	28	7·0	578	144·5
August	359	71·8	172	34·4	16	3·2	547	109·4
September	157	39·2	107	26·7	13	3·2	277	69·2
October	95	23·7	40	10·0	12	3·0	147	36·7
November......	101	25·2	25	6·2	14	3·5	140	35·0
December	95	19·0	39	7·8	8	1·6	142	28·4
Total.........	2163	39·7	910	17·5	218	4·2	3191	61·3

The numbers are so few in the third column that they cannot be relied on for averages in a single year; but the very slight increase of June and July over the early months of the year is very noteworthy. In the second column, while the July death-rate is three times that of February, in the first column it is is nearly four times. It would appear, therefore, that the summer influences affect but slightly children above 5; and, most of all, those under 1 year. A single average year of life in each of the columns gives the following death-rate for an average week:—

23. *Average Weekly Death-rate of Children in Montreal, 1867, for each year of life.*

	Under 1 year.	From 1 to 5.	From 5 to 12.	Total.
December	19.0	1.9	0.2	2.4
July	101.0	9.1	1.0	12.0
June, July, August	72.9	7.6	0.8	9.1
April, May, September, October	32.0	4.3	0.5	4.4
Nov., Dec., Jan., Feb., March	25.3	2.4	0.6	3.3
Average for year	39.7	4.4	0.6	....

It appears, therefore, that a boy of 5 years has about 100 times the chance of life that can be hoped for an infant of months, both in December and July. But according to seasons, the older child has 42 chances of life, as compared with his baby-brother, in winter; 64 chances in spring and autumn; and 91 chances in summer.

So the child under 5, as compared with the baby, has 10 chances in December, 11 in July, 9½ in summer, 7½ in spring and autumn, 10½ in winter.

On the average of the year, the child under 5 has *nine* chances of life as compared with the baby; the child above 5, *sixty-six* chances. Against what fearful odds do the infants in this city struggle into life!

24. *Comparison of Montreal Children's Death-rate in air-poisoning, open, and frost-bound months.*

Average.	Air-poisoning Months: June, July, August.	Open Months: April, May, Sept., Oct.	Frost-bound Months: Nov., Dec., Jan., Feb., March.
Average weekly death-rate of children, under 1 year, ... 1867	72.9	32.0	25.3
Ditto, between 1 and 5 years .. 1867	30.4	17.4	9.7
Ditto, between 5 and 12 years .. 1867	5.6	3.5	4.0
Ditto, all ages under 12 years .. 1867	108.8	53.0	39.2
Average week for 10 years, all ages,	61.9	39.2	34.5

That the excessive infantile mortality of July, 1867, was not due to exceptional climatal influences, will appear from the following statistics of Boston, obligingly furnished by Mr. Antonio, the

Registrar of that city. Boston is far more crowded than Montreal, with a much larger proportion of Irish lodging-houses, and with a raw, damp climate. But "the sanitary laws are good, and *faithfully executed.*"

25. *Comparative Sanitary Statistics of Boston,* 1867.

Average population of Boston for previous 10 years		178,500
Supposed " " for 1867		196,000
Total Yearly Deaths on the average of 10 years		2,474
Or, per 1,000 *of present population*		12.7
Deaths in *highest* month (*August*) on average of 10 years		461
Or, per 1,000 *of present population, at yearly rate of*		28.2
Deaths in *lowest* month (*June*) on average of 10 years		299
Or, per 1,000 *of present population, at yearly rate of*		18.3
Total Deaths during	July, 1866	482
"	July, 1867	365
"	August, 1867	452
Deaths of infants under	1 year, July, 1867	107
" children between	1 and 5 years, July, 1867	62
" "	5 and 10 years, July, 1867	18
" infants under	1 year, Aug., 1867	158
" children between	1 and 5 years, Aug., 1867	86
" "	5 and 10 years, Aug., 1867	22
Yearly rate of Deaths among 5,500 children under 1 year,	July, 1867, per 1,000	233.0
" " 24,000 " 5 years,	" "	84.5
" " 43,000 " 10 years,	" "	52.2
Deaths from *Cholera infantum,*	July, 1866	89.0
" "	July, 1867	49.0

By correcting these numbers according to the ratio of Montreal population, it appears that the July deaths were here *more than three times* those of Boston, although an unprecedented number of families had left our city; that of the total deaths in the year, only 39 per cent in Boston are of children under 5 years, instead of 65 per cent in Montreal; and that of these only 24 per cent in Boston were under one year, instead of 46 per cent in Montreal. *Of the children born in Montreal, two out of every five died within the year.*

These being the frightful facts of the case, so far as they can be at present ascertained, it becomes the duty of every thoughtful citizen to enquire into their causes.

The most evident of these is the fearful number of illegitimate children each year thrown away by their unnatural and most wicked parents, and placed under the fostering care of the Sœurs Grises at their Foundling Hospital. The condition in which they are received will be understood from the following table.

26. *Condition of Infants received at the Montreal Foundling Hospital.*

Condition.	1865.	1866.	1867.	1868.	Total.
Without covering	334	286	424	293	1,337
With only a cotton cloth	18	....	10	....	28
Almost frozen	6	....	7	20	33
Bleeding through want of the necessary offices at birth	15	11	13	25	64
Not washed after birth	31	29	18	30	108
Wounded by Instruments	8	4	8	7	27
Tainted with Syphilis	84	80	46	139	349
Sick	118	85	57	40	300
Dying	28	26	23	18	95
Dead	2	....	3	4	9
With bloody flux	....	15	13	....	28
With Hæmorrhage of the lungs	....	13	10	8	31
Not classed as above, but frequently covered with vermin	85	75	20	94	274
Total received	729	624	652	678	2,683

Whenever there appears a chance of life, these infants are sent into the country, in the care of nurses under surveillance. Even under favourable circumstances, there would be but poor chance of saving the lives of most of these abandoned ones; but it appears from a Report presented by the Medical officers to the City Council that the nurses are often unable to supply them with natural aliment. When they die, the corpses are sent to Montreal for interment, and are entered in our city bills of mortality, as their baptisms had been in the Protonotary's returns. The following statistics have been compiled from the Register of Deaths kept at the Hôpital Général.

27. *Mortality at the Montreal Foundling Hospital.*

Year.	1863	1864	1865	1866	1867	1868	Total.	Average of six years.
January........	26	49	58	39	32	34	235	39
February.......	32	22	38	34	34	33	193	32
March..........	38	54	52	43	47	48	282	47
April...........	48	53	67	68	47	61	344	57
May	59	43	51	66	53	61	333	55
June	80	65	68	68	82	101	464	77
July............	102	86	104	94	101	94	581	97
August.........	63	59	70	64	85	76	417	69
September......	48	36	41	35	43	49	252	42
October	43	50	43	50	31	29	246	41
November......	39	46	42	36	44	34	241	40
December	45	42	31	32	35	25	210	35
Total.........	623	605	665	629	634	642	3.798	†
Deduct *Adults*...	8	16	20	15	15	†	74	†
Total *Children*..	615	589	645	614	619	642	3,724	621
Of whom died, Under 7 days...	11	18	24	23	35	22	134	22
" 1 month..	427	404	401	402	368	348	2,350	362
Under 1 year...	590	573	612	593	583	610	3,561	593
Between 1 and 5 years.........	24*	14	32*	21	34	31	156	26
Between 5 and 12 years......	1	2	1	0	2	1	7	1

A more simple mode of keeping the register having been adopted at the suggestion of the writer, the following table has been eliminated for the past year. The numbers in the first column are included in the second, and both in the third.

---

* A large propoition of these deaths were from *rougeole*. It will be observed that the children, being in the country, escaped the fatal scarlatina which ravaged the city children in 1864, and also the unusual city mortality of July, 1867; also that last year June was in excess of July, which has never happened in the city. It is marvelous to observe that the coldest month is also the healthiest; even for these children who are so often received partially or entirely frozen, and so generally with insufficient clothing.

† In consequence of the mode in which the register was kept previously to 1868, some deaths of adults had been added-in with those of children; and for so small a number, distributed over the months, it was not thought needful to analyze the returns afresh.

28. *Death-rate, per months and ages, at the Montreal Foundling Hospital*, 1868.

	Under 1 week.	Under 1 month.	Under 1 year.	Between 1 and 5 Years.	Between 5 and 12 years.	Total Deaths.
January	2	16	26	5	0	31
February	1	16	26	7	0	33
March	2	16	44	4	0	48
April	2	33	59	2	0	61
May	1	31	60	0	1	61
June	2	58	100	1	0	101
July	4	42	93	1	0	94
August	1	47	72	4	0	76
September	3	33	46	3	0	49
October	0	19	29	0	0	29
November	2	23	31	3	0	34
December	2	14	24	1	0	25
Total	22	348	610	31	1	642

A comparison of figures in the second column fully bears out the common impression in the city that children born in winter have much greater chance of life than those born in summer. The following table exhibits the frightful loss of life to the community from parental neglect.

29. *Balance of Life at the Montreal Foundling Hospital.*

Years.	Infants received.	Died at the Hospital.	Died at the Nurses' Houses.	Total Deaths.	Remaining alive.	Or, per cent.
18 5	729	17	639	656	73	10.0
1866	624	15	566	581	43	6.9
1867	652	46	552	598	54	8.3
1868	678	14	623	637	41	6.1
Total	2,683	92	2,380	2,472	211	7.8

Many persons have attributed this excess of mortality to the existence of the Foundling Hospital; and one of the "religious" newspapers asserted (although the facts of the case were easily accessible) that "it was estimated that about 2,000 children die annually in it." * In order to correct these and other unfounded rumours, the Mère Supérieure of the Sœurs Grises has obligingly furnished the writer with the needful statistics, which, without any exaggeration, are appalling in the extreme. The Sisters are quite willing to allow that, with more knowledge, and with more means at their disposal to render available the knowledge already possessed, a much larger propor-

* See the *Echo* of June 19th, 1867.

tion of these "unwelcome children" could be saved, to become useful members of the community; but even this religious city cannot provide ladies more willing to do this most loathsome of works, and more devoted to the service which they thus offer to our common Saviour. Materials are not accessible to make an extended comparison of the mortality among Montreal foundlings with that of the same class elsewhere, but the following particulars are given in the "Fifth Annual Report of the Board of State Charities of Massachusetts," pp. 35, 37, 38, 45 :—

30. *Comparative Mortality of Foundlings, under one year of age.*

	Per cent.
Supposed yearly death-rate at the Neapolitan *Hospital*	90
In some *Hospitals*, as high as	95
In some well-managed *Hospitals*, as low as from	40—60
In good *Asylums*, from	30—50
In good *single families*, from	20—35
Average death-rate of infants in the whole of *Massachusetts*	13.5
" " " in the country districts of ditto	12.6
" " " in Suffolk county, including Boston	17.4
Mortality at the *Foundling Hospital*, Ward Island, *New York*, 1868 :—	
" Infants suckled by their own mothers	20.0
" " bottle-fed on milk by their own mothers	29.5
" Foundlings suckled by nurses	72.5
" " bottle-fed on milk by nurses	89.6
Montreal Foundlings, bottle-fed by nurses, 1868	89.9
Ordinary Montreal Infants, 1867	29.3
Total City mortality of infants under one year, (in Boston, 17.4 ;) in Montreal, 1867	36.8

It is an open question, which need not be here discussed, whether or not such institutions do more good, in the care of the forsaken, or harm, in the facility afforded to escape the shame of unlawful parentage. Two things are certain, viz., that while the passions of men remain uncontrolled by religion, especially when intensified by city life, these children will continue to be born; and that, where there are no such institutions, præ- and post-natal murder are common though often undiscovered crimes. Whether these children die scattered over the city, or collected into a hospital, or (as in our case) distributed through country homes, their deaths fairly belong to, as they have been thus far reckoned with, the city mortality.

One portion of the deaths, however, does *not* belong to us, viz., those who are sent into the city from other places; sometimes in a hamper or carpet-bag, by rail; and frequently, as may be supposed, in a moribund condition.

The following table embodies all that is known of their origin.

30. *Birth-place of Montreal Foundlings*, 1865-68.

Years.	Montreal City.	Canadian Cities. Quebec.	Ottawa.	St. Hyacinthe.	Three Rivers.	Country round Montreal.	Upper Canada.	United States.	Foreign Counties.	*Total* received from other places.	Total City and Country.
1865	443	147	20	26	8	44	15	25	1	286	729
1866	448	85	18	9	6	40	11	7	0	176	624
1867	413	98	20	21	12	42	15	29	2	239	652
1868	356	110	62	30	19	30	26	44	1	322	678
Total	1660	440	120	86	45	156	67	105	4	1023	2683
Yearly average.	415	110	30	21	11	39	17	26	1	256	671

A comparison may now be instituted between the mortality of ordinary children and those neglected by their parents.

31. *Comparative Mortality of Montreal Foundlings and Ordinary Infants.*

1867.	Baptized.	Interred.	Or, per 100 living at same age.
Total, Montreal Infants	5,598	2,063	36.8
Of whom were Foundlings	652	583	89.4
" Ordinary Children	4,946	1,480	29.9
Proportion of Foundlings to ditto	1 *in* 8	1 *in* 2,5	extra deaths) 59.5
Total, Boston Infants	.....	.....	17.4

In comparing Montreal with other cities, it would not be fair to make deductions for the peculiarities of our local institutions, because such peculiarities affect all large cities more or less; but, for the satisfaction of the inhabitants, the following table may be given. The strangers who are baptized in the city may be reckoned against those born here who are not baptized as infants.

32. *Corrected Death-rate for Montreal City.*

Year.	Total Deaths.	Proportion for Deaths of Imported Children.	Deaths of natives and ordinary inhabitants.	Corrected Death-rate per 1,000 living, at all ages.	Total Death-rate.
1865	4,025	258	3,767	36.3	37.8
1866	3,610	164	3,446	30.9	32.2
1867	4,465	219	4 246	36.4	38.3
1868	4,842	302	4,540	37.2	39.6
Average of 4 years	4,235	236	4,000	35.2	36.9

It follows that, although a portion of the lowered death-rate in 1866 was due to the unusually small number of infants received from the country, the balance, as compared with the average of the years before and after, viz., *no fewer than 550 lives, or 5·4 per 1,000 inhabitants*, may fairly be assigned to the anti-cholera cleansing. What a rebuke it gives to the members of the Council, and to the citizens who intrust to their care their own health and the very lives of their little ones, that in each succeeding year, notwithstanding the yearly boast that "the city was never so clean before," the death-rate has risen even above the previous number, humiliating as that is as compared with much larger and more crowded cities!

This table further rebukes those who attribute our excessive mortality to the strangers received at the Foundling Hospital, by showing that the average deduction to be made for this cause *only amounts to 1·7 deaths per 1,000 inhabitants.*

At the discussions which were held at the Natural History Society on this subject, a great variety of causes were assigned for the excessive mortality among our children. Probably all of these have more or less effect; but many of them apply with fully equal, if not greater force to other cities; and others again apply to the country districts just as much as to ourselves. Thus the frightful number of unwelcome children born among us, averaging 400 yearly, besides those who are provided-for by their parents, may be attributed in part to the large garrison which has been till lately stationed here; but it is the fruit of the same sin that curses humanity eslewhere. A large number of infantile deaths are undoubtedly caused by the drunkenness of their parents; but Montreal is not an unusually drunken city. The milk sold by many dealers is of inferior quality; but taking the city through, it is probably better and cheaper than in most English cities. Errors in diet, and deficiency of parental care are undoubtedly grievous causes of disease; but there is no reason to think that Montreal mothers are less careful and enlightened than in the country round: they ought to be more so. As to unripe fruit, &c., the country children get far more of it than we; and at the ages at which city children get most of it, it has been proved that they are *unusually healthy.* And as to the idea that catholic infants are predisposed to death from exposure to cold through the custom of early christening, it so happens that the coldest months, during which this cause ought to operate most, are by far the lowest in the death-rate.

It is only distracting attention from the main and solemn issue, thus to beat around the bush. Every thoughtful person who has observed and studied the simplest facts and first principles in sanitary science, must be aware that a *sufficient cause* for all our deaths is to be found in the filth and pollutions which are allowed to remain in our midst, and which poison the air, more or less, of the whole city, but most of all of the low and swampy districts. A large proportion of the inhabitants pour their slops daily on the spongy soil around their dwellings; house drains or even paved water-courses are little known; the contents of privies surcharge the porous earth around; and our back-yards, unusually large as compared with English cities, and which ought therefore to add greatly to our healthiness, are only so many more square feet soaked through and through with fœtid matter, forming (except during the merciful winter frost) an incesssant poison factory, wafting disease and death into our dwellings. A large number of our houses are built on stumps driven into this putrid soil or even marsh; the cellars are always charged with miasms, which find their way into the upper rooms; and too often the houses, even if not back to back, have no doors or windows except on one side. Very lately an M.D. of this city, with above the average of reputation, planted a group of cottages of this description on one of the worst undrained swamps in our midst. As if these evils, which may not meet the gaze of strangers, were not enough, the corporation persist in laying most of the streets in soft limestone, which in a very few days is ground to fine dust, and soon becomes charged with effete animal matter, in which form it enters our dwellings and lungs; or else it is in a state of mud, which emits so nauseous a stench that cottagers, who have shut their back windows to keep out the smell of the yards, are obliged to shut the front also to keep out the smell of the street. It is impossible faithfully to execute the contracts for street-cleaning, while this stone, long since reported against by the City Surveyor, and theoretically abandoned by the Road Committee, continues in full use: and as to the vaunted scavenging by-law, *the Council have refused the money to carry it out!* It may be said with very few exceptions, that in the more crowded parts of the city inhabited by all except the wealthy, there is scarcely a square yard of ground which is not charged with effete matter, ready to generate poisonous gases under the influence of every summer sun.

The foregoing may be regarded in great measure as errors of neglect or ignorance; but the very remedies applied at high cost are continual causes of disease. A large part of the older sewers in the city are made of absorbent and now putrid wood; and although the Council have determined to lay down no more, the brick sewers are often so badly constructed that the effete matter oozes through them, and deposits soon accumulate in their sluggish course. Moreover a large proportion of the house drains, even in high-rented dwellings, are still made of wood and untrapped. Only the new sewers are trapped at the gulley-holes; and at times, and in special places, the stench from these old poison-pits is insupportable. Thus our sewer and house drain system may be called (with few exceptions) an express contrivance for conveying the ordinary air-poisons, and the extraordinary infections of small-pox, scarlatina, &c., into every part of the city; and especially from the low into the higher levels, lest the rich should selfishly conclude that they were not affected by the evils which they allow to scourge the poor. The prevailing currents of air also, in the general direction of the river, while they serve somewhat to mitigate the unhealthiness of Griffintown, carry the air-poisons over the higher districts, where, being intercepted by the "Mountain," they impinge upon the fashionable streets and villas of our city.

Infants are more dependent on pure air even than children; they, more than adults; yet to all of us, unvitiated air is a necessary condition of health. Moreover, infants cannot escape from the air of their dwellings, nor from the poisons which fester there. The infantile death-rate is therefore the readiest thermometer, by which we estimate the virulence of poisonous emanations. How this thermometer rises and falls with the heat of the sun, has here been shewn. So far from wondering why so many children die in this city, we might rather wonder how so many manage to struggle into life, against such murderous forces. All these (as well as other) corrupting influences must be removed, if we hope to render up our account to the great Judge, free from the blood of these hundreds of children, to whom the Lord gave Life; who in their helplessness cry to us to nurture and guard it; but whom we, to save a few wretched dollars and a little toil and trouble, consign to a premature and therefore to a guilt-bearing Death.

MONTREAL, July 20th, 1865.

PROCEEDINGS

OF THE

NATURAL HISTORY SOCIETY.

(*From March 1st to July 1st*, 1869.)

MONIITLY MEETINGS.

Sixth monthly meeting, held March 29th, 1869, the President in the Chair.

The following donations were announced:

TO THE MUSEUM.

1,238 specimens (of 378 species) of Canadian insects, a small collection of fresh water shells, and a fasciculus of dried plants from Newfoundland: from Sir W. E. Logan, LL.D., F.R.S.

Pair of Barrow's Golden Eye (*Bucephala Islandica*) and female of the common Golden Eye (*Bucephala Americana*): from James Ferrier, Jr.

Pair of the Wood Thrush (*Turdus mustelinus*): from Mr. W. Hunter.

TO THE LIBRARY.

Annelides Chétepodes du Golfe de Naples, et Réponse à ses critiques, par M. de Quatrefages: from the author.

NEW MEMBERS.

James Shearer was elected an ordinary, and Cyril Graham a corresponding member of the Society.

PROCEEDINGS.

Mr. T. Macfarlane's paper "On the Geology and Silver Ore of Wood's Location, Thunder Cape, Lake Superior," was read by Dr. T. Sterry Hunt.

Dr. Girdwood read an essay "On the Application of Manures to Agriculture."

Dr. P. P. Carpenter made a communication "On Easy Methods for securing Effective Ventilation and Drainage in Dwellings."

Seventh monthly meeting, held April 26th, 1869.

DONATIONS TO THE MUSEUM.

A series of 25 named species of Graptolites from the Moffat

Shales: from W. Carruthers, F.L.S., &c. Seventy species of exotic shells, and a large series of European fossils: from A. Bell. One hundred and fifty species of European fossils, 4 rare minerals, 5 species of recent Echinoderms, 4 of crustaceans, and 2 of corals: from Bryce M. Wright. Seven skins of Jamaican birds, inner bark of the silk cotton tree (*Eriodendron*) and 4 species of exotic seeds: from F. A. B. Vinen. 6 English birds: from Mr. T. Cooke. Thirty-five skins of rare exotic birds, including three species of birds of Paradise; and 50 species of shells: from J. F. Whiteaves. Eleven species of exotic mammalia: from Mr. E. Gerrard, jr. Four species of foreign birds and 10 of reptiles: from the Liverpool Free Museum, per T. J. Moore. Japanese handkerchief case: from the St. George's Society. Russian soldier's sword, from Sebastopol: from J. T. Lacey.

TO THE LIBRARY.

Nature's Method of Controlling Noxious Insects, by Henry Shrimer, A.M., M.D.: from the Author.

NEW MEMBERS.

Hon. T. Ryan, Senator, Dr. W. Gardner, and Messrs. G. B. Burland, H. R. Ives, and R. Kellond, were elected ordinary members.

PROCEEDINGS.

Mr. J. F. Whiteaves then made some remarks upon some rare exotic birds recently added to the collection. In this communication the leading features of interest of a large series of birds recently acquired, partly by purchase and partly by donations, were briefly pointed out.

SOMERVILLE LECTURES.

The remaining two Lectures of this Course were delivered as follows:

5. March 4th, 1869. On the Recession of the Falls of Niagara: by C. Robb.

6. March 11th, 1869. On the Adulteration of Food: by G. P. Girdwood, M.D., &c.

ANNUAL MEETING.

The annual meeting was held on the 18th of May, 1869. the transaction of the usual business the Annual Address of the President was delivered by Principal Dawson; this will be found at page 121.

The report of the Council was then read by Dr. J. Baker Edwards, as follows:

REPORT OF THE COUNCIL.

Your Council, in reviewing the work of the past year, believe they may congratulate the members on the amount of progress attained.

The ordinary meetings have been fairly attended, and much interest has been evinced in the subjects brought forward; some of which have been of a highly practical and interesting social character, viz.:—

1. Oct. 26, 1868.—On some Specimens of Palæontological interest. By Principal Dawson.
2. " " On the remains of Mastodon found at Dunville, Ont. By E. Billings, F.G.S.
3. Nov. 30, 1868.—Notes on Beetles collected in the neighbourhood of Montreal. By A. S. Ritchie.
4. Dec. 28, 1868.—On some Recent Additions to the Society's Collection of Birds. By J. F. Whiteaves.
5. Jan. 25, 1869.—On the Prevention of Cruelty to Animals. By F. Mackenzie.
   " " " (On the) Vital Statistics of 1868. By Dr. P. P. Carpenter.
6. Feb. 22, 1869.—Notes on a Cruise in the Gulf of St. Lawrence. By John Bell, M.D.
7. " " Notes on the Introduced Plants of Ontario and Quebec. By A. T. Drummond, B.A., LL.B.
8. March 29, 1869.—On the Geology and Silver Ore of Wood's Location, Thunder Bay, Lake Superior. By Thomas Macfarlane.
9. " " On the Application of Manures to Agriculture. By Dr. G. P. Girdwood.
10. " " On Easy Methods for Securing Ventilation and Drainage in Dwellings. By Dr. P. P. Carpenter.
11. April 26, 1869.—On some Rare Exotic Birds recently added to the Collection. By J. F. Whiteaves,
12. " " On Disinfectants. By Dr. J. Baker Edwards.

During the summer recess, the Society held a second field meeting at St. Ann's. Owing to unsettled weather, the party was a comparatively small one, but those who ventured were well repaid.

The excursionists were, by courtesy of the Grand Trunk authorities, conveyed by special train, which stopped first at Pointe Claire, allowing an interval, during which the party walked to the Quarries, and listened to an interesting address from Principal Dawson on the Geological features there exposed. Many fossils were obtained and the rocks closely examined.

The train then proceeded to St. Ann's, where the company separated into groups; the first, to collect fossils, under the guidance of Dr. Dawson; the second, to Fort La Berre, on the property of the Hon. J. Abbott, who gave a brief history of the old fort, and kindly entertained the party, which was conducted by Dr. Girdwood and Mr. Ritchie; and lastly, a botanical and microscopical party, in charge of Messrs. Whiteaves, McCord, and Edwards, who crossed over the river to Isle Perrot, where a large number of specimens in flower were obtained. After the return to the station, the prizes were announced as follows:

Largest number of named species of Flowering Plants, Mrs. Dr. Girdwood.
" " unnamed, Miss Dawson.
Juvenile Prize for Bouquet, Miss Edwards.

The Course of Somerville Lectures was of considerable and general interest, it embraced the following subjects:

1. On Palæozoic Land Animals. By Principal Dawson, F.R.S., &c.
2. On the Chemistry of Soap-making. By J. Baker Edwards, Ph. D., F.C.S.
3. On the Zoology of the Bible. By Rev. A. DeSola, LL.D.
4. On Primæval Chemistry. By Prof. T. Sterry Hunt, LL.D., F.R.S.
5. On the Recession of Niagara Falls. By Charles Robb.
6. On the Adulteration of Food. By G. P. Girdwood, M.D., &c.

The thanks of the Council and members are due to the gentlemen who have thus volunteered their exertions on the behalf of public instruction in Science.

The Conversazione, held on the 18th of February, was lively and interesting, and the Council believe was very acceptable to the members generally. The President gave an interesting address on the value of Scientific Education and Schools of Science for Adults. Prof. Johnson and Dr. Smallwood exhibited and explained a variety of philosophical apparatus, kindly lent by McGill College. Dr. J. B. Edwards exhibited and floated in the Museum, Plateau's Soap Bubbles charged with gas, which Mr. Charles Baillie illuminated with the Electric Light and maintained it steadily throughout the evening. A programme of excellent music was provided by Herr Mayerhoffer and his friends, the German Choral Society. A good display of Microscopes under the charge of members of the Montreal Microscopic Club, attracted great attention in the Library, which was also adorned with some valuable works of art, arranged by Mr. J. P. Clark.

On the 2nd February, an address was presented at the Court House, to the Governor General, Sir J. Young, who accepted the same with cordiality, and expressed his willingness to lend his aid to the Society, by becoming its Patron. The following day His Excellency visited the Museum, and was received by the Officers of the Society. He carefully examined the collections, and expressed his pleasure and interest therein.

We are indebted to the exertions of our esteemed Scientific Curator, Mr. Whiteaves, for very valuable additions to our Museum, partly presented and partly purchased, which will be enumerated in his report. These add greatly to the attractive character of the collection.

The membership of the Society during the year has somewhat diminished. The additions have been 14—losses 17; other sources of income are below the average; and in consideration of the loss of income by the presentation of Life membership to subscribers towards the debt, it becomes the duty of the friends of the Society to seek further additions to its ranks, and your Council would recommend an active canvass for new members and for subscribers to the *Quarterly Journal*, during the coming year. To the active officers of the Society, especially our industrious Curator, Mr. Whiteaves, our skilful bird-stuffer, Mr. Hunter, and our indefatigibable Treasurer, James Ferrier, jun., Esq., the Society owes its best thanks for steady and hearty co-operation.

The Council have much pleasure in recommending to the Society that the silver Medal be presented to Dr. T. Sterry Hunt, F.R.S., for his valuable contributions to Science, in connection with the Geological Survey, and in the advancement of Chemical Geology in Canada.

The ventilation and lighting of the Lecture Room received the attention of your Council in the early part of the session, and some improvements in the admission of air were effected; it was found, however, absolutely necessary to provide means for carrying off the products of combustion, and by the kind assistance of Mr. M. H. Sanborn, the necessary amount was raised by voluntary contribution to complete the plan, by exchanging the open light for a Liverpool sunburner, which, being connected with a chimney, carries off all foul air, and will in future provide for the comfort and health of the audiences. One or two more improvements only require the necessary funds for their adoption, and your Council would appeal to some of the members to assist the future Council in carrying out these arrangements, viz., to provide a vestibule in the hall, and close in the lobby for a Curator's room, to fit double windows in the Lecture Room and Museum, and to colour and paint the premises.

In the Library a reading desk has been provided and the periodicals may there be found by members. The Library, however, requires urgently some clearances and additions, which duty we commend to the early attention of our successors.

During the year, the *Canadian Naturalist* has been put on a new and more popular basis, which your Council hope will make it more generally subscribed for among the members, and more acceptable to the public than heretofore. The Editing Committee has been re-organised, with a view to issue the Journal with greater regularity, and it will now appear Quarterly instead of Bi-monthly. It will contain a greater variety of matter, and be of a more popular scientific character. The Committee regret the delay in the appearance of the first number, which was partly due to the backward state of the two numbers of the last series, and partly to the printers' strike. The first number is now laid on the table and will be immediately in the hands of subscribers. Mr. Whiteaves, the Acting Editor and Recording Secretary, will be glad to receive the names of members who have not already subscribed for this Journal, and to receive communications or papers for publication therein, on subjects of natural or general science. The Society is responsible for 100 copies of the Journal which will be supplied to members at $2 per annum.

J. B. EDWARDS, Ph. D., F.C.S.,
Chairman of Council.

Mr. Whiteaves read his report as Curator and Recording Secretary, as under:

CURATOR'S REPORT.

During the past session, a large portion of the time has been spent in the active collection of new specimens. The additions to the Museum have been as follows:—

MAMMALIA.

Thirteen fine specimens of exotic mammals, new to the collection, have been added. These have been mounted, named, and placed temporarily in one of the large cases in the Museum. Two species have been added to our American series, a fine example each of the Water Mole (*Scalops aquaticus*), and of the Missouri pouched Rat (*Geomys bursarius*). Want of the necessary cases compels a temporary arrangement of many of the exotic mammals.

Several of the Canadian mammals are represented by very old and badly-preserved specimens, and these, as opportunity offers should be renewed.

BIRDS.

Efforts have been persistently made for some years past to make the series of Canadian birds as perfect as possible. Old specimens have been weeded out, and their places filled with fresh examples. During the past twelve months, twenty-two specimens have been added to our local collection. In the department of Foreign birds, great progress has been made. About 164 specimens have been added, all species of much interest, and some of considerable rarity. Among these latter may be noticed, three species of birds of Paradise, two species of the beautifully-coloured fruit pigeons (*Ptilinopus*), of the Indian Archipelago, Sonnerats' jungle fowl, three species of albatross, &c. The whole of the new birds have been skilfully mounted by Mr. Hunter, and are all named.

REPTILES AND FISHES.

Thirteen species of reptiles and three of fishes have been added during the past session. The space allotted to this part of the collection is altogether insufficient to exhibit even the whole of our present series. It is for this reason that we have not done anything towards completing our series of Canadian fishes, as at present we have nowhere to put them.

There are quite a number of reptiles and fishes in alcohol, which we are unable to exhibit from want of the proper bottles, and of suitable cases. The same reason has prevented the forming of a collection of the smaller and more critical Canadian fishes.

INVERTEBRATA.

In the kingdom mollusca rather over 100 species have been added. Large series of Canadian insects have been received from Sir W. E Logan, Mr. Billings, Mr. Ritchie, and Mr. Barnston. Over 500 species have been added, but many of these are duplicate specimens. Finally, five species of echinodermata, two of crustaceans, three cirrhipedes, two corals, and several sponges have been received.

GEOLOGY.

About 260 species of fossils, mostly from European formations, have been obtained. This has necessitated the re-grouping of the whole collection, which has been done, and the additions mounted, named, and incorporated with the general series. A few new minerals have also been received.

MISCELLANEA.

Several donations have been made to the ethnological and miscellaneous collections, but none of very special interest.

LIBRARY.

During the past year no new books have been purchased, and we still have to regret the absence of works of reference of recent date in every department of American natural history. Still, some improvements have been made in the library. By special application to the authorities we have succeeded in getting 35 volumes of the British Museum descriptive catalogues. During my stay in England efforts were made, with much success, to complete our series of English periodicals. Several of the numbers wanting to complete our American serials have also been procured, upon application to the editors; 20 volumes of serials have been bound since the last annual meeting; a reading-desk has been placed in the library, and the table re-covered.

Since the first of January considerable time has been spent in connection with the first number of the new volume of the Society's Journal, copies of which are now laid upon the table.

The most prominent wants in the Museum are additional cases for the series of mammalia, for fishes and reptiles, and for the formation of a collection to illustrate comparative anatomy and osteology. Further, special cases, with proper bottles, are urgently required to contain the collection of specimens preserved in alcohol, only a small portion of which can now be exhibited.

The additions to the collection during the session are the most important and numerous that have been received for years; and in conclusion, it is hoped that the work done has been in a satisfactory degree conducive towards the efficient carrying out of those objects, which it is the aim of this Society to foster and cherish.

J. F. WHITEAVES, F. G. S., &c.,
Curator and Rec. Secretary.

It was moved by W. Muir, seconded by L. A. H. Latour, and carried unanimously,

That the reports just submitted be accepted, printed, and distributed to the members.

On motion of Dr. Edwards, seconded by Dr. Smallwood, it was resolved:

"That the silver medal of the Society be voted to Dr. T. Sterry Hunt, F. R. S., to mark its appreciation of the value of his scientific labours, more especially in the department of Chemical Geology."

A vote of thanks to the President for his able and interesting address, having been moved by John Leeming, and seconded by Dr. Smallwood, was carried with acclamation.

The following resolution was also carried, having been moved by John Leeming, seconded by J. H. Joseph:

"That the thanks of the Society be voted to the officers for the past session, particularly to the Scientific Curator."

The following officers were then elected, Messrs. A. T. Drummond and Dr. John Bell acting as scrutineers:—

OFFICERS FOR 1869-70.

President.—Sir W. E. Logan, LL.D., F.R.S., &c.

Vice-Presidents.—Rev. Dr. De Sola; C. Smallwood, M.D., LL.D., D.C.L.; Principal Dawson, LL.D., F.R.S.; Dr. T. Sterry Hunt, F.R.S.; Dr. P. P. Carpenter; E. Billings, F.G.S. John Leeming; G. Barnston; C. Robb.

Treasurer.—James Ferrier, Jun.

Corresponding Secretary.—Prof. P. J. Darey, M.A., B.C.L.

Curator and Recording Secretary.—J. F. Whiteaves, F.G.S., &c.

Librarian.—A. T. Drummond, B.A., LL.B.

Council.—Dr. J. Baker Edwards, F.C.S.; A. S. Ritchie; D. A. P. Watt; D. R. McCord, M.A., B.C.L.; C. Baillie; G. L. Marler; J. H. Joseph; M. H. Sanborn; Dr. E. H. Trenholme.

Editing Committee of the "Canadian Naturalist."—General Editor, J. F. Whiteaves; Dr. J. B. Edwards (Chairman); Principal Dawson; Dr. T. Sterry Hunt; Dr. Smallwood; E. Billings; Dr. Carpenter; D. A. P. Watt; A. S. Ritchie.

Library and Membership Committee.—E. E. Shelton; R. McLachlan; R. J. Fowler; Dr. John Bell; D. A. P. Watt; and M. H. Sanborn.

The following financial statement was submitted by the Treasurer, James Ferrier, jr.:

TREASURER'S STATEMENT.

Dr. THE NATURAL HISTORY SOCIETY OF MONTREAL, in account with JAMES FERRIER, Jr., Treasurer. Cr.

1868.	Recapitulation.	
To Cash paid,	J. F. Whiteaves, salary	$400 00
" "	Wm. Hunter, "	250 00
" "	J. E. Pell, commission on collection	26 35
" "	Interest	120 00
" "	for Wood and Coal	163 25
" "	Gas bills	71 40
" "	Water "	40 60
" "	City Assessments	45 40
" "	Insurance	39 00
" "	Repairs, and petty expenses	119 85
" "	Books, Printing, and Advertising	124 54
" "	Fixtures	171 76
" "	Specimens	90 53
1869.		
" "	Excursion	64 99
May 1st, 1869.—	Balance in Treasurer's hands	60 99
		$1788 66

1868.	Recapitulation.	
By Cash received,	Government Grant	$750 00
" "	Donations towards liquidation of debt	50 00
" "	" " Glass Cases	50 00
" "	Members' yearly subscriptions	552 00
" "	Museum entrance fees	38 00
" "	Rent of Lecture Room, &c.	55 00
" "	Sale of Old Cases	8 00
" "	Excursion tickets sold	56 50
" "	Proceeds of Conversazione	9 57
		$1788 66

Montreal, May 1st, 1869.

E. & O. E.

(Signed,) J. Ferrier, jun., *Treasurer.*

STATEMENT OF LIABILITIES, MAY 1st, 1869.

Mortgage on Society's Building, favour Royal Institution	$2000 00
Dawson Bros.' account	128 75
Total	$2128 75

We, the undersigned, have examined the vouchers and compared them with the entries, and find them correct.

(Signed,) G. L. MARLER.
(Signed,) ALEX. S. RITCHIE.

18 May, 1869.

FIELD DAY AT BELŒIL.

The third of these pleasant social gatherings was held on Wednesday, June 9th—the place selected being Belœil Mountain.

By the courtesy of Mr. C. J. Brydges, a special train was provided to convey the party as far as St. Hilaire. A little after 9 o'clock a.m., some 150 or more of the members and friends of the Society, took their seats in the train at the Bonaventure street station. At about 11 o'clock the excursionists arrived at St. Hilaire. Here vehicles of various descriptions were in readiness to convey the visitors part of the way up the mountain. The more zealous naturalists, however, preferred walking, knowing that many objects of interest would be found at the base of the mountain. Nor were they doomed to disappointment, for not only were several scarce plants found that were not met with further up, but rocks of the Utica shale and Hudson river group were seen in situ, with their characteristic fossils. By noon the whole party had assembled at the lake, when Dr. J. B. Edwards explained the programme for the day, and stated that letters had been received from Major Campbell, C. J. Brydges, Rev. Dr. De Sola and Drs. Smallwood and Girdwood, in which they expressed their regret at not being able to be present. Half an hour was then given for the consumption of creature comforts, and after lunch, Dr. T. Sterry Hunt gave a short account of the history of the mountain.

He stated that he had expected Major Campbell would deliver an address, but that gentleman had said there was little of historical importance to relate. The mountain was known by three or four different names, Belœil, Rouville, Chambly, and St. Hilaire. It was called Rouville, from the seigniory of that name, and Belœil, from Belœil seigniory opposite. There was a grand religious demonstration here in 1841, when Monseigneur Forbin-Janson, Bishop of Nancy, came out to the country, and by his marvellous eloquence caused a great religious awakening among the French Canadians. The Bishops of the province determined to commemorate his visit by erecting a cross for pilgrimage upon this mountain. Accompanied by their clergy, and an enormous concourse of the faithful, they came here on the 6th October, 1841, and erected a cross on the top of the mountain, to represent the Cross of Calvary, previously making fourteen little stages up the mountain side, to mark the fourteen stages of our Lord's Passion. The people then gathered upon the shores of the lake, to the number of 10,000 or 20,000, as variously stated, filling even the trees, and the eloquent Bishop preached to them from a little boat on the lake. In 1844, or 1845, the support of the cross gave way, and it became a ruin. He feared that since that time, the faithful had almost forgotten this famous pilgrimage. The mountain had also been called *le pain de sucre*, or sugar loaf, but he trusted it would prove easier of ascent, than might be supposed from the name.

Two parties were then formed, one for the study of the geology of the mountain, under the guidance of Principal Dawson and Dr. T. Sterry Hunt; the other to collect botanical and zoological specimens, with Dr. Bell and Messrs. McCord, Ritchie and Whiteaves as leaders. The ascent was then made in a leisurely and excursive way, until in due course the summit was gained. The clink of the hammer during the ascent, and the fair faces around one, brought vividly before the mind's eye the scene described in the well-known lines from "The Princess":—

> Many a little hand
> Glanced like a touch of sunshine on the rocks,
> Many a light foot shone like a jewel set
> In the dark crag; and then we turn'd, we wound
> About the cliffs, the copses, out and in,
> Hammering and clinking, chattering stony names
> Of shale and hornblende, rag and trap and tuff.
> Amygdaloid and trachyte, till the sun
> Grew broader towards his death and fell, and all
> The rosy heights came out above the lawns."

The extensive panorama visible from the summit, was the theme of much admiration. To the south and east the mountains of Monnoir, or Mount Johnson, Montarville, Brome and Shefford met the eye, and in the haze, the Green Mountains were dimly perceptible. Nor was the charm of water lacking to complete the landscape; the St. Lawrence and the Richelieu Rivers, the mountain tarn at our feet, and a portion of Lake Champlain helped to make up the picture, which may be described as a flat, enormous plain of stratified rocks, here and there broken through by isolated trappean hills.

The gathering was then called to order, and Principal Dawson, standing upon the most convenient rock, said he had anticipated

Sir William Logan would have been present, but he had been unable to come. The duty of speaking about the geological features of this remarkable mountain would devolve upon Dr. Sterry Hunt, who knew so much more about it than any other person present. They might consider themselves standing upon the capital of one of the great pillars which support the earth; for the mountain was one of those solid masses of igneous rock which might be traced down into the far depths of the bowels of the earth. They were little mountains, it was true, but they were far older than some more pretentious ones, and deserved to be respected because of their venerable antiquity. These mountains give us a striking illustration of the condition of the country immediately preceding the time when it first became inhabited by man. The plains now spotted with farm-houses were, when visited by Jacques Cartier, one unbroken forest. But ages before that they were merely an extension of the Gulf of St. Lawrence, and the mountain upon which we now stand was a little island, around which great quantities of ice floated, just as they do now in the Strait of Belle Isle. On the companion mountain of Montreal, at a height of over 400 feet above the present sea level, might be found deposits containing sea shells and other marine animals, of the same species, for the most part, as those now living in the Gulf of St. Lawrence. The processes were then explained by which the present contour of the landscape was effected, and the country made as we now see it, fit for the habitation of mankind.

Dr. Hunt then gave a short account of the features of geological interest of the mountain, and of the surrounding country, as follows: He stated that he would prefer to give a dozen lectures respecting the mountain rather than condense what he would like to say into a speech of a few minutes. A fine view was offered of the geographical divisions of the country. The valley of the St. Lawrence, with the fine champaign country now in view, was bounded on the north by the Laurentide Hills, which stretched from Ottawa and the rear of Kingston to the Gulf of the St. Lawrence. In the south might be seen the Green Mountains, a continuation of which range, called by the early French settlers the Notre Dame Mountains, stretched along the south shore of the St. Lawrence to the sea. These southern mountains were a portion or spur of the great Appalachian chain. The Doctor then called attention to the trappean hills, including the one upon which the party was standing, which occur in the area between the two great mountain ranges just described. It had been stated that Belœil was a granitic mountain and belonged to the Appalachian chain; but this was a mistake. In the first place, these rocks are not granitic; in the second place, they do not belong to the Appalachians, to which they had been referred; and thirdly, they differ from the Appalachian hills, which are all stratified rocks. These mountains around us are all volcanic in their origin and are composed of unstratified rocks. There are marks of a great rupture of the earth at intervals, which might be traced in the valley. Along this fissure or line poured, in olden times, a great quantity of volcanic rock. This valley of the St. Lawrence was then in a state of great volcanic activity; and there were burning mountains, earthquakes, and disturbances such as now occur on the Pacific coast and along the Mediterranean; and some mountains poured out masses of lava. These hills are the bases or roots of so many volcanic cones. These cones were probably much higher than the present mountains, and their roots were altogether buried in the soft rock which then filled the whole valley to a level above some of these mountains.

At a very early period, much of this filling was removed by water, and subsequently, in the Post-pliocene period, the great polar current swept down this valley, carrying with it icebergs, and grinding and wearing away all the soft parts, until finally this harder mass resisting its action, remained in bold relief. This rock is of a harder, denser texture and is less liable to wear down than Montarville and most of the other mountains, and, for this reason, it is higher. These rocks have a distinct character: Rigaud and Montreal differs from this; Boucherville differs very widely from it, and Yamaska differs somewhat from either. Brome and Shefford are unlike anything else you find in these. You have in these mountain peaks some of the most remarkable and varied types of eruptive rocks. The erosion just mentioned will account for the very singular and level aspect of the scenery around these hills. It is extremely difficult to fix the precise age of these rocks, even geologically. But these mountains were old when the first sands of the Alps and the Himalayas were at the bottom of the deep. There was another curious story: from the evidence of the existence of Devonian limestone on the other side of the lake, it appeared that after the earlier erosion there was again a filling up of the valley with Upper Silurian and Devonian rocks, and this filling up was again swept away by water.

With reference to the lake, Dr. Hunt explained that the water shed and rainfall were quite sufficient to supply a little lake like that. The mountain was 1287 feet above the Richelieu and about 1300 feet above the sea.

After spending some time on the top, to enjoy the prospect and to collect specimens of the peculiar micaceous diorite of the mountain, together with other objects of Natural History, the company returned to the lake. Here the judges examined the collections made, and awarded three prizes, as follows:—

1. For the largest number of named species of flowering plants: Miss Isabella McIntosh, 37 species.

2 and 3. Best juvenile collection of flowers, not named: Masters G. T. Robinson and Rankin Dawson, equal, each 33 species.

Honourable Mention: Masters Robert Lewis, 21 species, and E. G. Penny, 17.

During the day the following results were obtained by the Zoological and Botanical parties. In the department of Zoology no unusual birds were noticed. Several examples of the wood frog (*Rana temporaria var-sylvatica*), a geographical variety of the common English species, were met with, as were also examples of a land salamander of the genus Plethodon. The only ophidian observed was the "small brown" snake (*Storeria Dekayi*). No scarce land snails were taken, though the beautiful *Helix Sayii* of Binney is not unfrequent here, and a rigorous search might have resulted in the capture of the still rarer *Helix dentifera*. Among the butterflies we noticed the yellow "swallow-tail" (*Papilio turnus*), the destructive small cabbage butterfly (*Pieris rapæ*), recently introduced into this country from Europe, the "Camberwell beauty" (*Vanessa antiopa*) and several "skippers." At the top of the mountain, upon beech trees, were found several specimens of the fine and scarce lunar moth (*Saturnia luna*), the crumpled wings of the specimens shewing plainly how recently they had emerged from the chrysalis. Ten species of beetles were taken, a list of which, kindly prepared by Mr. A. S. Ritchie, we subjoin:—

Cicindela repanda, Dej.	Aphodius fimetarius, Linn.
Platynus sinuatus, Dej.	Lachnosterna fusca, Frohl.
Pterostichus caudicalis, Say.	Corymbites æripennis, Kirby.

Staphylinus cingulatus, Grav. — Meloe angusticollis, Say.
Geotrupes excrementi, Say. — Chrysomela scalaris, Leconte.

In Botany about 60 species of flowering plants were collected. We give a list of the most interesting, omitting only extremely common species: *

Clematis Americana	American Clematis.
Ranunculus abortivus	Small-flowered Crowfoot.
" sceleratus	Cursed Crowfoot.
Aquilegia Canadensis.	Wild Columbine.
Actœa spicata	Bane Berry.
Chelidonium majus	Celandine.
Turritis stricta	Tower Mustard.
Viola blanda	Sweet White Violet.
" cucullata	Common Blue "
" rostrata	Long-spurred "
" Canadensis	Canadian "
" pubescens	Downy Yellow "
Cerastium viscosum	Larger Mouse-ear Chickweed.
Claytonia Caroliniana	Spring Beauty.
Acer Pennsylvanicum	Striped Maple.
Prunus Pennsylvanica	Wild Red Cherry.
" Virginiana	Choke Cherry.
Potentilla tridentata	Mountain Cinquefoil.
Pyrus arbutifolia	Choke Berry.
Amelanchier Canadensis	June Berry.
Ribes Cynosbati	Wild Gooseberry.
" prostratum	Fetid Currant.
Saxifraga Virginiensis	Virginian Saxifrage.
Mitella diphylla	Two-leaved Mitrewort.
" nuda	Naked Stemmed do.
Tiarella Cordifolia	False Mitrewort.
Hamamelis Virginica	Witch Hazel.
Aralia racemosa	" Spikenard."
" nudicaulis	Wild Sarsaparilla.
Lonicera ciliata	Fly Honeysuckle.
Viburnum opulus	Cranberry Tree.
" acerifolium	Maple-leaved Arrow-wood.
" lantanoides	American Wayfaring Tree.
Oldenlandia cœrulea	" Bluets."
Antennaria plantaginifolia	Plantain-leaved Everlasting.
Vaccinium Canadense	Canadian Blueberry.
Trientalis Americana	Star-flower.
Scrophularia nodosa	Knotted Fig-wort.
Pedicularis Canadensis	Wood Betony.

* We are indebted to Dr. John Bell for the identification of several species in this list.

Cynoglossum officinale ....Common Hound's Tongue.
" Virginicum ....Wild Comfrey.
Hydrophyllum Virginicum ....Water Leaf.
Asarum Canadense ....Canadian Wild Ginger.
Dirca palustris ....Leather-wood.
Juglans Cinerea ....Butternut.
Fagus ferruginea ....American Beech.
Corylus rostrata ....Beaked Hazel.
Ostrya Virginica ....Iron-wood
Arisœma triphyllum ....Indian Turnip.
Platanthera bracteata ....Bracted Green Orchis.
Corallorhiza innata ....Coral-root.
Iris versicolor ....Larger Blue Flag
Sisyrinchium Bermudianum ......Blue-eyed Grass.
Trillium grandiflorum ....Large White Trillium.
" erectum ....Purple Trillium.
Polygonatum biflorum ....Smaller Solomon's Seal.
Smilacina bifolia ....Two-leaved False Solomon's Seal.
Streptopus roseus ....Twisted Stalk.

The ferns gathered were all common species, and the most interesting cryptogam met with was the "apple" moss, *Bartramia pomiformis*, in fine fruit.

After the names of the successful candidates for prizes had been announced, Mr. Ritchie made a few remarks as to the number of species of insects taken during the day. An informal vote of thanks to the Committee who had organized the excursion, was proposed by Mr. Mackay, seconded by Mr. Champion Brown, and carried with acclamation.

About six o'clock tea was partaken of under the shade of the maples by the lake, and shortly afterwards the party returned to the Station. While waiting for the train several of the party were permitted, by the kindness of M. Valiquet, the Station-master, to examine his large collection of bees. The hives, amounting to from fifty to sixty in number, were placed each in a frame, out of one of which a portion of the comb was taken, which showed the workers in the act of making cells for three queens in a new swarm. M. Valiquet has devoted forty years to the study of bees, is President of an Apiarian Society, and received a medal at the late Paris Exhibition for improvements in bee culture.

The party arrived in Montreal a little after eight o'clock in the evening, apparently delighted with the pleasant day they had spent.

J. F. W.

MONTREAL MICROSCOPIC CLUB.

This Association was founded early in 1868 for the "promotion of microscopic knowledge amongst its members, by regular meetings for practical microscopic work, and for the interchange of ideas and experiences on microscopical subjects." The microscope is an eminently social instrument, for there is a natural craving in the mind of the observer of the beautiful, to share his pleasure with another. This Club is also of a highly social character, and its meetings are held fortnightly at the members' residences during the winter season. The "utile" is thus combined with the "dulce," and, without the reading of formal papers, valuable practical information is exchanged. From the pleasant and profitable working of this Club, we would strongly recommend the multiplication of such organizations in the cities of the Dominion—and look forward to a pleasant interchange of communication from such societies when formed. In England they have proved a remarkable success, and whilst in London such a Club formed the original nucleus of the Royal Microscopic Society, in the large county towns they have multiplied the number of microscopic observers an hundred fold. We hope to be able to chronicle a similar result in this country, where we have a glorious field for original investigation in every department of natural science. For the encouragement of similar efforts, we publish our plan of association, which we believe has been very successful, both here and at home, and therefore submit the following hints. It is desirable that such a Club should not be too numerous—from twelve to fifteen members is an amply sufficient number. It is better that these should be acquainted with each other, and that they should represent various professions. Here is a ground upon which clergy and laity, law and commerce, physician and patient, can meet on a common platform of intelligence and research; and no man's occupation or profession need prove the slightest barrier to his co-operation. Some may be proficient in the art, or be so favoured as to possess a valuable instrument; others may be disciples only, but rich in zeal; some may possess well-stored cabinets of choice objects, and others bring the

"Comely eels" from "the verdant mud"

All are welcome, and amongst the rich gifts of abundant nature comparisons are mute. Wherever six men can be found of the right sort, we would advocate the establishment of such a Club, even if only three microscopes could be raised amongst them to do the work—even one good instrument will do a great deal, with a good set of eyes. Our plan is very simple. The Club appoints a secretary, who arranges for the meetings, and suggests a special subject for illustration at each. The host for the evening is the president of the club; minutes are recorded and read, visitors introduced, miscellaneous business discussed, and microscopic investigation proceeded with. At 10.30 P M. the president announces the adjournment, the microscopes are returned to their cases, and a parting cup of coffee closes the "seance."

During the intervals of meeting the Monthly and Quarterly Microscopic Journals circulate amongst the members, and afford material for discussion and illustration.

The plan may be varied for different localities, but its general outline has borne good and useful fruit for nearly twenty years, at least such is the writer's own experience, and should further details be desired in furtherance of the establishment of similar organizations, the Honorary Secretary of the Montreal Microscopic Club will be glad to furnish them.

J. B. E.

REVIEWS AND NOTICES OF BOOKS.

* Disinfectants and Disinfection, by Robert Angus Smith, Ph.D., F.R.S., F.C.S.—Dr. Angus Smith, the author of the treatise here noticed, is well known in Lancashire as an able, cautious and conscientious chemist, and in connection with the various chemical industries of which Manchester is the centre, he, more than any other man of his day, has had ample opportunities of forming opinions on this vital subject, both from an economical and from a scientific point of view. These opinions are entitled to the highest respect, although they are often more suggestive than positive, and indicate rather the candid and cautious than the convinced mind. The introductory chapter gives us a

* Published by Edmonstone & Douglas, Edinburgh. 1869.

general history of Disinfection, from which it would appear that during past years mankind has been struggling against filth and disease, with various retrogressions, and with but partial success—with no rational conception of the evil to be avoided, or of the nature of the remedy to be sought.

From the East, however, he traces practices of public cleanliness, which were strictly adopted by the Romans, such as the use of drainage, of disinfectants applied to sewers, and of the daily removal of all refuse or decomposing animal matter from the roads. Pitch, and the substances derived from its distillation, appears to have been highly prized, and to the same products modern science turns with the greatest confidence.

The idea that epidemic disease was produced or encouraged by the decay of animal or vegetable matters, was deeply rooted in the minds of the ancient Greeks and Romans; and after a general laxity of such belief and carelessness of such consequence, modern science reverts to this idea, assisted by the researches of Dusch, Schroeder, Liebig and Pasteur. On this subject our author says:—

"The two great theories may be called Liebig's and Pasteur's—the first, (Liebig's), dealing with organic decomposing matter ready to communicate its action by its own activity. That idea has a sound scientific basis, and I am disposed to think it quite undeniable at present.

"The second, that of Pasteur's, leads to organized bodies or germs, and although he also has not originated the idea, its clearest proof and expression is due to him. He does not seem to have retained firm hold of a part of the battle ground gained from chemistry. There is probably a point where the 'organic' and 'organised' touch so nearly as to be difficult to distinguish, but here the distinction between the two is very real, and the point of contact is still to be sought."

Cases of disease our author says are caused:—

"1st. By gases.

"2nd. By vapours.

"3rd. By putrid or decomposing substances.

"4th. By organized bodies in various stages and ferments."

To meet these, disinfectants are employed of various natures, viz.:—

1st. To attack the gases and vapours – Oxygen, chlorine.

Thus nitrous oxide from saltpetre or nitric acid—chloric acid from chlorate of potash—chlorine from hypo-chlorite of lime—Ozone from permanganate of potash—(Condy's fluid.)

These are true disinfectants—that is, removers of smell, de-odorizers, and destroyers of decaying matter, but not antiseptics, that is preservers of organic substances.

De-oxidizers have a similar office, and sulphur fumigation is one of the most ancient forms of purification. In Cowper's translation of Homer's Odyssey, book xxii., line 492, we have:—

"Bright blast-averting sulphur, nurse, bring fire!
That I may fumigate my walls; then bid
Penelope with her attendants down,
And summon all the women of her train.
But Euryclea thus his nurse replied.
My son! thou hast well said; yet will I first
* * * * *
Not so. Bring fire for fumigation first.
He said: Nor Euryclea, his loved nurse,
Longer delayed, but sulphur brought, and fire,
While he, with purifying streams, himself
Visited every part, the banquet room,
The vestibule, the court."

Glauber, in 1689, part 3, p. 2, says:—"Whoever shall attempt to describe sulphur in a most accurate manner, will have need of abundance of paper. But he that knows nothing of sulphur, knows nothing at all."

The gas (sulphurous acid gas) is very valuable in arresting fermentation aud cryptoganic growth. It de-odorizes putrid matter, while it disinfects. Chlorine may act either as an oxidizing agent. It destroys putrid smells as if by magic, and thoroughly destroys animal matter.

Heat and cold are nature's own disinfectants, acting by dessication and condensation. The tar acids are among the most valuable disinfectants, chiefly because they retain their power under circumstances of extreme dilution. The available forms of these compounds—viz., carbonic acid and carbonate of lime—are highly recommended as antiseptics as well as disinfectants. But the subject of comparative values of these disinfectants we will reserve for a subsequent notice, as our space is exhausted.

J. B. E.

(To be continued.)

GEOLOGY AND MINERALOGY.

Gold Deposits of Nova Scotia.—Prof. Hind has recently issued a detailed report on the Gold Veins of Waverley, which, however, he regards as beds rather than veins. He notices the occurrence, in a bed of quartzite, of fossils or concretions, which he compares to *Palæotrochis* of Emmons, from the so-called "Taconic" Rocks of North Carolina. Such supposed fossils have, we believe, been previously found by Dr. Honeyman, but Prof. Hind has, for the first time, published them as probable organic remains, and, if this view be sustained, will have been the first to announce the discovery of fossils in the gold rocks of Nova Scotia. The following extracts exhibit some of the most important parts of this report:—

"Among the most remarkable peculiarities of the leads are the markings on the quartz and on the enclosing rock, whether Whin or hard compact slate. These markings vary from slickensides to huge rolls, several feet apart, and sometimes a foot in the swell. They are found in the slates, remote from leads, and often resemble ripple marks. To Mr. Campbell the credit is due of first calling particular attention to these markings, and Dr. Hunt, likewise impressed with their importance in regard to the structural geology of the Gold Districts, says:—

'Mr. Campbell has called special attention to what he has called the grain or reed-like marking often impressed on the surface of the beds in a direction parallel to the east and west axes of folding, and he points out that the angle of dip, eastward or westward, of these markings on the crown of the great anticlinals, enables us to detect the transverse or north and south lines of undulation, which have at a subsequent period disturbed the horizontality of the east and west anticlinal folds. The markings in question often appear as rib-like ridges or flutings, which are most conspicuous on the surface of the auriferous quartz layers and the enclosing beds. On the summit of the anticlinal folds they are sometimes so large, and so well defined, as to give to the layers a wrinkled or corrugated form, producing what is designated in the region as barrel quartz, and has, by some observers, been compared to the ripples on water, and by others to that parallel arrangement of logs which is seen on what is called a corduroy road. The best known samples of this is at Waverley, but it is also seen at Montague, Oldham, and at Upper Stewiacke.'

"A few yards west of the West main dislocation at Waverley a fine illustration of these corrugations is visible in the slates. The resemblance to ripple marks at the first glance is very striking, but a closer examination shows that the corrugation is not on the same plane as the bedding, and consequently the force which produced it must have been other than water.

"The direction of the axis of the small undulations is such that they might well have been produced during the folding of the greater or east and west anticlinal, but the occurrence of similar corrugations in other districts, at angles nearly approaching forty-five degrees, where there is no evidence of a cross anticlinal of such magnitude, gives color to the supposition that these markings were not necessarily associated with the first folding, and that they are untrustworthy guides in relation to that movement.

"At Montague, and at Mount Uniacke, there are small and large undulations and markings, which do not appear to have had any connection with the east and west folding, but it is very probable that they were connected with local disturbances in those districts, and may form valuable assistants in discovering the displacements. Under all circumstances they are well worthy of study, and such distinguishing characteristics may eventually be found as will enable them to be separated, and referred to the force which produced them, whether occasioning a fold or a dislocation.

"They have, however, an especial bearing on the structure of numerous leads, which give indisputable evidence of motion, either in their body or at one wall. The coincidence between the direction of the ripples on the slates at Waverley and the dip of the rocks resulting from the cross anticlinal, is so marked that in this instance they may with propriety be referred to the first folding; and the force which occasioned the ripples caused also a bodily sliding to a small extent of one bed of strata over another, and the production of a fissure which was subsequently filled with quartz and carbonate of lime constituting a segregated vein. Sometimes the fracture took place in or near the middle of a bed of quartz. At Mount Uniacke, for instance, there is a four-foot lead, which has a fracture near the centre, partially filled (subsequently) with arsenical iron pyrites, and in the cavities the crystals of quartz are seen with their apices pointing towards each other. The same peculiarity is not unfrequently observed in large leads. At Waverley the movement has occurred between the quartz and the Whin, or between the quartz and hard slate, or in bands of slate, and in all cases slickensides, reed-like markings, ripples and small undulations have been produced. In the Barrel Quartz no sliding motion is distinguishable, for the corrugations extend far into the overlying Whin rock until they assume the form of a series of connected arches five, six, and even seven feet in width. The corrugations are by no means confined to the quartz lead, but spread out, fan-like, into the overlying rock. At Montague the ripples or swells are at an angle of 45°, and are frequently from five to eight feet apart, and the swell rises as much as six inches above the plane of the bedding, the laminæ of the wall rock conforming to it. At Lawrencetown there are similar large ripples, but at an angle of about 30°. The leads in question, both at Montague and Lawrencetown, are synclinal forms. It is a popular belief that in the vicinity of these swells the lead is more productive than between them. It appears to be well established at Montague that the nodules of arsenical iron pyrites containing free gold, are more numerous and of larger proportions close to the swell than at a distance from it. But lenticular masses of arsenical iron pyrites are found in the Whin, remote from any visible vein, unconnected with one another, and sometimes lying at right angles to the bedding.

At Hammond Plains there are immense beds of feebly auriferous quartz, as much as 20 feet thick, and in these crystals of oxide of zinc are numerous, besides numerous cavities lined with crystals of calcareous spar; the surfaces of the crystals are spangled with cubical iron pyrites. At Renfrew, where the strata have evidently slid over one another, crystals of calcareous spar are common, and sometimes form as much of the lead as the rich gold-bearing quartz itself; these occur on the Free Claim, where a considerable twisting of the strata has taken place, and short unconnected, bnt thick auriferous veins, fill the cavities formed by the movement, which are newer than, and wholly distinct, from the bedded leads, contemporaneous with the strata. While the gold which the bedded leads contain, in common with the other metals, was most probably derived from the oceanic waters from which the quarty was deposited, the gold in the short segregated veins of subsequent origin was transferred from the bedded leads or auriferous interstratified slates.

"In every district in Nova Scotia it is remarked that the gold frequently "runs in streaks;" that is to say a zone of rich auriferous quartz occupies a certains breadth in the lead, while to the east and west of that zone the quartz is comparatively poor in the precious metal. It is also found that in different districts the "Gold Streak" has a different angle with the horizon, and that sometimes the course of the rich zone is coincident with the ripples or swells in the leads,—also that the Gold Streak varies in direction in different leads.

"At Montague the Gold Streak dips at an angle of 45 degrees to the west, so also do the corrugations in the lead.

"At Sherbrooke in some mines the Gold Streak on the south side of the anticlinal dips to the east at a high angle, and on the north side to the west at about the same angle.

"At Lawrencetown the dip is westerly at a low angle. The dip of the corrugations is the same.

"It is probable that in each lead the Gold Streak has a course peculiar to itself, with an easterly and westerly trend. Known facts respecting the Gold Streak are too few and too indefinite to permit of any conclusion being drawn for any number of leads, but where one lead is taken into consideration, much useful information may be obtained by studying the structure of the lead and the direction of the "Streak."

"In the shallow synclinal at Lawrencetown for instance, the dip of the Gold Streak being westerly at a low angle on the south side of the synclinal, its dip will probably be easterly at the same angle on the north side. On an anticlinal if the streak or zone dip easterly on the south side, it will be found dipping westerly on the north side, in the continuation of the same lead or sheet of auriferous quartz. At Montague there are two very rich zones on the same lead about 520 feet apart, dipping west at an angle of 45 degrees. The breadth of one zone is about 300 feet of the other 250 feet; the yield of gold in each has been tolerably uniform, and averaged 3½ ounces to the ton. On the west side of these zones the yield diminishes abruptly to 5 dwts. per ton; on the other side it shades off to 3 dwts. per ton.

"The distribution of the zones at Sherbrooke leads to the inference that the gold was originally deposited in belts from the oceanic waters, whether influenced by accumulations of organic matter or otherwise. It would be a simple matter to explain the structure of the Gold Streak, on the supposition that organic matter determined the deposition of the metal, in belts or zones, for it is easy to conceive accumulations of stranded organisms on subaqueous beaches, in a shallow sea, in the form of long, narrow bands. Organic matter determines the deposition of most metals from solutions, and whatever intermediate combinations and decompositions took place, accumulations of organic matter may have been the proximate cause which determined the distribution of the gold in zones or belts. According to this view the direction of Gold Streak will probably differ slightly in each lead, but there will be a general parallelism in a considerable number of adjacent leads, and the direction of one zone will be a clue to several.

"But other and more important deductions may be drawn when attention is given to one particular lead. The course of the Gold Streak being once known, it can be traced through all the deviations produced by anticlinals, synclinals, dislocations, and in general almost all varieties of disturbance.

"From Mr. Burkner's table, on page 36, it appears that the average yield of the Tudor Lead, between the depths of 55 feet and 100 feet from the surface, was as follows, from east to west:—

"Breadth of Zone, 55 feet.

Mean yield on areas 165, 164, 163.	450 feet.	22 dwts.
" " area 162	150 "	36 "
161 And one-third of 160 }	200 "	24 "
Mean yield of two-thirds of area 160	100 "	$3\frac{2}{3}$ "

"The falling off in the west 100 feet of area, 160 is not only sudden but extreme. But it must be remembered that on this area the work was stopped at a depth of 110 feet. It is worth while to consider what probabilities exist of discovering the rich zone at a greater depth.

"An inspection of the section showing the form of the east and west anticlinal, points out the remarkable coincidence that in area 160 (or more properly area 201, where Mr. Burkner's shafts are really situated, as shown on the large plan, in the Mines' Department), the strata dip suddenly to the west at an angle of about

50 degrees. At Mr. Burkner's last shaft they dip N. 50 W., and are already to the west of the crown of the arch, produced by the lateral crush or squeeze between the walls of the great dislocations.

" Hence the zone of rich auriferous quartz, dipping with the strata, has already begun to plunge to the west at an angle of about forty or fifty degrees, and must be sought for below the depth of 110 feet, at which depth the work was stopped.

" The course of the rich zone, west of area 201, will be nearly parallel to the axis of the anticlinal, through areas 202, 203, south part of 157, 156, 155, &c., but descending westerly at an angle of about 45°, in a word, being roughly parallel to the intersection of the Tudor vein, as shown in the east and west section.

" Mr. Clarke states that no visible Gold treak was met with in that part of the Tudor Lead which passes through some of the properties east of Mr. Burkner's areas. But the " Streak" on the North Lead dipped from west to east, and the " Streak" on the North Taylor, South Taylor and No. 6 Leads, dipped from east to west. It is much to be regretted that no reliable data exists from which diagrams, showing the auriferous zones on these leads, can be constructed. The circumstance of the quartz, from all being mixed before crushing, makes it impossible to collate the necessary observations. The general fact is stated as the result of observations during the time the work was going on.

* * * * *

"A section, in detail, across three thousand feet of the strata at Mount Uniacke, made last summer, enables me to institute a comparison with the Waverley beds, and to draw some general conclusions, which show a remarkable similarity between the structure of these districts.

" The east and west anticlinal, at Mount Uniacke, is similar in form to that of Waverley, and may be described as a sharp fold, with an overturn dip on the south side. The summit has not been flattened or compressed, and it is probable that the overturn is greater than at the last-named district,—and bends over to the south instead of to the north.

" The rocks are generally similar in composition, and are arranged in alternating bed of whin and slate, with a bed of gritty quartzite not less than 380 feet thick, where the section was made, and without visible partings of slate. Succeeding this enormous band of quartzite are alternating beds of whin and slate, the first-named greatly preponderating.

"The strata at Mount Uniacke, from the axis of the anticlinal, in which direction the section was made southwards, may be represented as given below.

"The cross anticlinal appears to be very gentle, so that the outcrop of the band of quartzite, and consequently of most of the leads, if no great dislocations have taken place, will be that of a very long and narrow ellipse, much flattened on the south side and bulging out on the north side.

SECTION AT MOUNT UNIACKE.

	Feet.	Rocks.
Axis of anticlinal to arsenical group of leads......	475	Alternating beds of whin and slate with leads.
Arsenical group to centre of twisted slates......	200	Alternating beds af whin and slate with leads.—Twisted slates about 50 feet thick, and micaceous.
Centre of twisted slates to base of great quartzite band................	110	Whin and slate.
GREAT QUARTZITE BAND .	380	Very coarse at base, in fact, a grit, with grains generally as large as a mustard seed, then gradually becoming finer as it approaches the summit, where it is a very fine light-coloured rock.
Dark coloured slates with plumbaginous surfaces interstratified with bands of "whin."............	20	Leads.
Whin with thin bands of slate—in the centre the slates are twisted......	775	Leads.

	Feet.	Rocks.
Dark coloured slates, with plumbaginous surfaces, with thin bands of whin.	60	Leads.
Heavy bedded "whin," with a few thin bands of slate	750	Leads.
Total thickness measured..	2770 feet.	

A coarse grit, or quartzite, much resembling the coarse grit at Mount Uniacke, has been already described as occurring at Waverley, where it is especially distinguished by concretionary forms and fossils, supposed to be the Palæotrochis of Emmons. Hence it has been marked on the map as Concretionary Quartzite.

In the following section, made by Mr. Clarke in the spring of last year, the concretionary quartzite occurs in that part of the section enclosed within brackets, and it is the 431 feet of strata at Waverley, composed of 421 feet of "whin," and 9 feet 3 inches of slate, which I propose provisionally to place as the equivalent of the 380 feet belt at Mount Uniacke.

Mr. Clarke's Section on Areas 370, 315, 304, 249, 238, *and* 183, *on North and South Course.*

NORTH.

	Feet.	Inches.		
Whin	51		....	
	1	0	.... Lead	
Slate	6	5	....	
	1	4	.... Lead.	
Slate	5	6	....	
	1	0	.... Lead.	
Whin	30	6	....	
Slate	26		....	
*Whin.............	178		....	Probable equivalent of the great band of quartzite at Mt. Uniacke.
Slate.............	1	3	....	
		6	..... Lead.	
Whin.............	161		....	
Slate.............	8		....	
Whin.............	83		....	
	0	3	.... Lead.	

	Feet.	Inches.		
Slate.................	1	3	....	
Whin.................	15	6	....	
Slate.................	2	2	....	
Whin.................	36		....	
Slate.................	35		....	
Whin.................	80	6	....	
		1	....	Lead.
Whin.................	5		....	
		2	....	Lead.
Whin.................	5	3	....	
		10	....	Lead.
Whin.................	77		....	
		2	....	Lead.
Slate.................	1	3	....	
Whin.................	64		....	
		3	....	Lead.
Whin.................	99		....	
	45		....	Concealed.
Whin.................	34		....	
Slate.................	41		....	

* * * * *

"Should the identity between these strata, in the two districts, be established, the following conclusions will be reasonable :—

"1st. That a large number of gold-bearing quartz leads lie underneath the lowest lead known at Waverley.

"2nd. That on the assumption that no very considerable differences in the aggregate thickness exist between the strata at Mount Uniacke and Waverley, there is a belt of auriferous strata, about six hundred feet thick, concealed beneath the barrel quartz at Waverley, which is exposed at Mount Uniacke.

"3rd. That the Taylor group may be identified at Mount Uniacke, associated with the "dark colored slates, with plumbaginous surfaces."

"4th. That the equivalent of the rich Tudor group may be found at Mount Uniacke.

"5th. That the majority of worked mines are on leads, which will be found below the barrel quartz at Waverley.

"There is no reason to suppose that the great quartzite belt, at Mount Uniacke, is destitute of leads or slate partings in other parts of the district. It has been already observed, that both slate and leads not unfrequently "thin out" and "take up" again; that they often form thin lenticular sheets, where whin occurs in massive beds. When leads are found in slate they are generally persistent.

"It is this intermittent form of some leads which has led to the opinion that they are segregated veins filling longitudinal cracks produced by the folding of the strata. It must be borne in mind that independently of the slaty structure of many leads, as described by Dr. Hunt, the pressure to which the strata were subjected during the folding, could not have been less than that of a mass of nine thousand feet in thickness, and, possibly, an incumbent ocean superadded. Under such pressure the formation of fissures would be problematical.

* * * * *

Several of the facts referred to in the above extracts, are supposed to indicate that the gold quartz is an original bedded deposit, formed under the same conditions as the containing beds. We are inclined to believe, however, that they admit of a very different interpretation, and that Prof. Hind, as well as other observers, have been misled by the supposed analogy of the bedded ores of the Quebec group of Lower Canada, which are very different from the veins parallel to the bedding so abundant in the metamorphic districts of Acadia.

The following observations are of a more practical character:

"The practice of mixing quartz from different leads, and crushing the whole together is to be condemned. It is impossible, by the adoption of this method, to ascertain whether a lead is paying or not. A poor lead worked at the same cost as a rich lead may neutralize all the benefits which would be obtained if the rich lead were worked alone. Each lead ought to be crushed by itself, and a statement of the result, with the cost of mining the quartz, recorded. This can be done without any difficulty in mills with from ten to twenty stamps, without retarding work, if system is adopted. Plans of all the workings are also essential, showing at least monthly progress. In case a fault is discovered in one lead, and difficulties should arise in ascertaining the effect of the disturbance, it can be speedily reached in a neighboring lead, and the question whether it is an upthrow or downthrow, or throw to the north or south, or two or more of these movements combined, settled generally without difficulty; but if no monthly plan of workings is kept on record, all is confusion. With the single exception of a plan and section, made some years ago by Mr. Bell, of the works on a few areas, together with a lithographed plan of the whole district, showing the position of the several properties, I was unable to obtain any plan of surface workings, much less any plan of underground workings, and the agents of the different companies uniformly informed me that none, to their knowledge, were in existence.

"The absorption of all returns to pay large dividends is, as a rule, as fatal an error in gold mining as in most other enterprises. When the different mines were yielding very handsome returns, it was most unwise to suppose that such unlooked-for prosperity would continue for any length of time. Nevertheless, it appears that nearly all profits were at once divided amongst the shareholders, and no reserve fund permitted to accumulate. Hence, when the returns grew less, the necessary means to provide machinery for deeper workings were not forthcoming, and, as a consequence, most of the establishments were closed.

"The narrowness of the properties is a great objection to permanent operations. Several companies at Waverley have only 450 feet on the leads. If, owing to the absence of appropriate pumping and hoisting machinery, the works are stopped at a depth of 300 feet, it is very easy to calculate the duration of a company with such a small quantity of available lead. The absence of any regulations defining the space which different companies shall leave between the workings on the same or adjacent lead, is likely to become a fruitful source of trouble. In one instance, at Waverley, the agents of two companies decided not to touch the quartz within four feet of their boundary on either side with a view to prevent, by means of an eight foot dividing wall, the water from one mine draining into the other. This agreement, I was informed, was faithfully kept on one side and as grossly abused on the other, the whole of the four feet of quartz being removed. The consequence is that the works on one mine being stopped, the proprietors of the other have been vainly endeavoring to drain both, on account of leakage through the dividing wall, which unfortunately has hitherto defied all their attempts to arrest.

It is an error to suppose that because a lead diminishes in average, so as to be worked at a loss, that it will necessarily continue poor. All experience in gold mining tends to prove that all leads or veins are more or less intermittent in yield. If we may be guided by Montague, the nearest district to Waverley, and a synclinal fold of the same auriferous belt, the rich auriferous zones follow one another within a few hundred feet. It has already been stated that many of the leads in California have a bedded structure, and they are profitably worked at a depth of 800 feet with intermittent degrees of richness. At the same time proper machinery for hoisting and drainage must be adopted in order to arrive at this result, which, it need scarcely be observed, cannot be obtained if shareholders insist on a division of all profits, without leaving any reserve for contingencies, and subsequently refuse to raise additional funds when the period for their application arrives.

It is to be feared that this system is too commonly pursued in Nova Scotia, and there is reason for supposing that other districts will soon be in the same condition as Waverley. But there is no present cause for apprehension, that with systematic mining, conducted on proper business principles, the leads will be less profitably worked in the future, or that there is any danger whatever of the yield of gold diminishing under the judicious management of mining properties. On the other hand, the remarkable uniformity and continuity of the leads, their great number in a small vertical space, their bedded structure, which implies indefinite prolongation, and the high percentage of gold they contain, are convincing proofs that when capital, skill, and forethought are combined, a very large proportion of both West and East Waverley will yet be profitably mined for many years to come.

BOTANY AND ZOOLOGY.

SHEPHERDIA CANADENSIS.—Most microscopists are aware of the extreme beauty of the scales of Elœagnus when viewed under a low power, and with polarized light. It may not however be so generally known that precisely the same kind of scale are to be found on the leaves of the *Shepherdia Canadensis*, the only Canadian example of the Elœagnus or Oleaster family.

The Shepherdia is a small shrub common in Lower Canada, and was named after Mr. John Shepherd, a former curator of the Liverpool Botanic Garden. J. F. W.

The Colours of Foliage.—The green colour of leaves, one element of which must be a vegetable blue, has led an American experimentalist to the conclusion that leaves turn red at the end of the season through the action of an acid, and that the green colour could be restored by the action of an alkali. The conclusion has been verified, the *Athenæum* declares, by experiment. Autumnal leaves placed under a receiver with vapour of ammonia in nearly every instance lost the red colour and renewed their green. In some, such as the sassafras, blackberry, and maple, the change was rapid, and could be watched by the eye, while others, particularly certain oaks, turned gradually brown, without showing any appearance of green.

Birds of the Guano Islands.—We copy the following extract, descriptive of "Life on a Guano Island," from a late number of the New York Times. "Among the chief objects of interest to a visitor on Baker's Island are the birds, and they are well worthy of study. During the first night of my stay on this forlorn spot it seemed at times as if the houses were besieged by innumerable tom-cats; then the tumult resembled the suppressed bleating of goats, and I heard noises as of bats grinding their teeth in rage; again it was the querulous cooing of doves; and soon the chorus was strengthened by unearthly screams, as of ghouls and demons in mortal agony. But on going forth into the darkness to learn the cause of this infernal serenade, all was apparently calm and serene, and the radiant constellation of the Southern Cross, with the neighbouring clouds of Magellan, looked me peacefully in the face, while from another quarter of the heavens the Pleiads shed their "sweet influence" over the scene. The most quiet time of night with the birds is about daybreak, when they seem to subside into "cat-naps," preparatory to the labours of the day. By day many of the birds range on tireless wing over leagues of ocean in quest of fish. But still the number of those that remain about the island is so great as to defy computation; and as you pass through their haunts, in some places they rise in such clouds as actually to darken the air above you. The eggs of some of the birds are of fine quality, and are much esteemed by the Americans, as well as by the Hawaiians on the island, Those of a bird called the nu-e-ko are the most valued. This name is an imitative word, derived from the cry of this restless creature, and is applied to it by the Hawaiians, who have quick intuitions in onomatopoetic matters. In regard to moral character, the birds of Baker's Island may be divided into two classes—those which make an honest living, and those which are robbers. The gannet stands at the head of the respectable birds, and is a thrifty and honest citizen of the air. The representative of the thievish class is the frigate-pelican, or man-of-war bird (*Tachypetes aquilus*). This species has a dense plumage of gloomy black, a light, wiry body, that seems made for fleetness, and wings of even greater spread than the gannet's. Its tail is deeply forked, its bill is long, sharp, and viciously hooked. Audubon regards the frigate-bird as superior, perhaps, in power of flight to any other. It never dives into the ocean after fish, but will sometimes catch them while they are leaping out of the water to escape pursuit. It is often content to glut itself with the dead fish that float on the water, but it depends mostly for a subsistence upon robbing other birds. The smaller ones they easily overtake, and compel them to disgorge their spoils; but to waylay and levy blackmail upon those powerful galleons, the gannets, is an achievement requiring strategy and address. As the richly-laden gannet approaches the coast of his island home, he lifts himself to a great height, and steadily oars himself along with his mighty pinions, until he sees his native sands extending to dazzling whiteness below. Now sloping downward in his flight, he descends with incredible velocity. In a moment more he will be safe with his affectionate mate, who is awaiting his return to the nest. But all this time he is watched by the keen eye of the man-of-war bird, who has stationed himself so as to intercept the gannet in his swift course. With the quickness of thought, the frigate-bird darts upon him, and, not daring to attack boldly in front, he plucks him by the tail and threatens to upset him, or he seizes him at the back of the neck and lashes him with his long wings. When the poor gannet, who cannot manœuvre so quickly as his opponent, finds himself pursued, he tries to buy his ransom by surrendering a portion of his fishy cargo, which the other swooping down, catches before it has time to reach the earth. If there is but one frigate-bird, this may be a sufficient toll; but if the unwieldly gannet is set upon by a number of these pirates, he utters a cry of real terror and woe, and, rushing through the air with a sound like a rocket, in his rapid descent, he seeks to alight on the nearest point of land, well knowing that when once he has a footing on *terra firma* not even the man-of-war bird dare come near him. The man-of-war bird is provided about its neck and chest with a dilatable sack, of a blood-red colour, which it seems to be able to inflate at pleasure. On calm days, about noon, when the trade-wind lulls, giving place to a sea breeze that gently fans the torrid island, these light, feathery birds may sometimes be seen at an immense height balancing themselves for whole hours without apparent motion on their outstretched fans. Whether they are able to increase their specific levity by inflating their pouches with a gas lighter than the atmosphere, or whether they are sustained by the uprising column of heated air that comes in on all sides from the ocean, is a question I am unable to answer. While floating thus, this bird has its pouch puffed out about its neck, giving it the same appearance as though it had its throat muffled in flannel."

A Chicken-Dance.—To see a chicken-dance requires a long journey. The performers are the sharp-tailed grouse dwelling in the north-western plains of America, and replacing on the west of the Rocky Mountains the well-known prairie-hen of the eastern districts. This beautiful bird is alike estimable for the admirable sport which it affords, and for its delicacy as an article of food; and it is very desirable that, if possible, it should be acclimatized in this country. Mr. Lord, the naturalist to the British North American Boundary Commission, is sanguine on this point, and believes it to be most admirably fitted for our hill and moorland districts. "It is very hardy," he observes, "capable of bearing a temperature of 30° below zero; feeds on seeds, berries, and vegetable matter, in every particular analogous to what it could find in our own hill country; a good breeder, having usually from twelve to fourteen at a brood; nests early and would come to shoot [Query, to be shot?] about the same period as our own grouse." He adds, that the young birds in May could be caught at any point up the Columbia river, and once on board the steamer, could be fed as readily as fowls. The fur-hunters term these birds spotted chickens. They pair very early in the spring, and their love meetings are celebrated by remarkable festivities called Chicken Dances. Their ball-room is a high round-topped mound, and the dancing begins either at sunrise, or in the evening, and by the time that the matrimonial arrangements are concluded, and the happy pairs set off for their respective homes, the mound is trampled down as bare as a road, Mr. Lord saw several of these dances, and gives a very graphic report of the first which he witnessed. Riding up into the hills early one spring morning, he heard the peculiar chuck-chuck which indicated that a dance was in progress. Tying up his horse and dog, he crept towards the knoll from whence the sound proceeded, and finally gained the shelter of a stump, from whence, unperceived, he had an excellent view. Like a true lover of Nature, he frankly admits the "joyous delight which the sight afforded him. There were," he observes, "about eighteen or twenty birds present on this occasion, and it was almost impossible to distinguish the males from the females, the plumage being so nearly alike; but I imagined the females were the passive ones. The four birds nearest to me were head to head, like game cocks in fighting attitude—the neck-feathers ruffled up, the little sharp tail elevated straight on end, the wings dropped close to the ground, but keeping up by vibration a continued throbbing or drumming sound. "They circled round and round each other in slow waltzing-time, always maintaining the same attitude, but never striking at or grappling with each other; then the pace increased, and one hotly pursued the other until he faced about, and *tête-à-tête* went waltzing round again; then they did a sort of 'cure' performance, jumping about two feet into the air until they were winded; and then they strutted about and struck an attitude, like an acrobat after a successful tumble. There were others marching about, with their tails and heads as high as they could stick them up, evidently doing the heavy swell; others, again, did not appear to have any well-defined ideas what they ought to do, and kept flying up and pitching down again, and were manifestly restless and excited—perhaps rejected suitors contemplating something desperate. The music to this eccentric dance was the loud chuck-chuck continuously repeated, and the strange throbbing sound produced by the vibrating wings." Mr. Lord subsequently watched several other balls, in all of which the same series of strange evolutions was carried out.—*Once a Week.*

CHEMISTRY AND PHYSICS.

On new Explosive Powders, by M. Designolle.—Many improvements having lately been made in the art of war, and particularly in the adoption of breech-loading arms, the want has been felt of new powders to meet the requirements of the present artillery. This want has been supplied by M. Designolle, who has invented a new system of powders of which carbazotate or picrate of potash is the base. These powders are of four kinds, viz, a musket powder, gunpowder for short bore cannons, slow gunpowder for cannons with long bores, and an explosive powder for torpedoes and projectiles destined for the undermining of fortifications. The principal advantages of these new powders are the following:—Increase of balistic power without increase of explosive power; the base remaining the same, possibility of regulating and varying the effects between the limits of one to ten; also of regulating, at will, the rapidity of combustion of this powder, and of increasing the balistic power without changing the mode of manufacture. Other advantages are—regularity in the manner of action; suppression of sulphur, and consequently of the vapours of sulphide of potassium and sulphuretted hydrogen; absence of action on metals and almost entire suppression of smoke. Into the explosive powders only two components enter—picrate of potash and nitrate of potash; the musket and gun powders contain carbon in addition to the above-named ingredients. To prepare these powders, the ingredients are beaten from three to six hours with a proportion of water varying from 6 to 14 per cent., according to the nature of the mixture; the powder is condensed by means of the hydraulic press, with a pressure of from 30,000 to 100,000 kilos., graining of the powder, and pressing and drying it according to the methods employed for the black powder. In order to increase the balistic power, the relative proportion of picrate of potash in the mixture must be increased- For musket powder it has been proved that no more than 20 per cent. of picrate of potash is required, while for gunpowders its proportion varies from 8 to 15 per cent. This component (picrate of potash) is of a beautiful golden-yellow colour, and crystallizes into prismatic needles possessing a brilliant reflection; it is insoluble in alcohol, but soluble in about 260 parts of water at 15° or 14 parts of boiling water. Heated with care, it becomes orange-red at a temperature of 300°, but on cooling, it assumes its original colour. Heated to 310°, it detonates wifh violence. The researches of M. John Casthellaz on the action of nitric acid on phenic acid improved the method of manufacturing picric acid, and produced chemically pure picrate of potash at such a reasonable price that the new powders are not more expensive than ordinary black powder.

MM. Designolle and Casthellaz give the following proportions for preparing deflagrating mixtures with coloured flames:—

Golden fire	Picrate of ammonia	50
	Picrate of iron	50
Green fire	Picrate of ammonia	48
	Nitrate of barytes	52
Red fire	Picrate of ammonia	54
	Nitrate of strontian	46

Chemical News; abstracted from the Bulletin de la Société d'encouragement.

MISCELLANEOUS.

Mr. Sorby's Blow-Pipe Bead Crystals. — These exquisitely beautiful Miscroscopic objects are prepared by fusing borax in a circular loop of platinum wire, and adding various earths and minerals thereto, in such proportion that they are entirely dissolved at a high temperature, but partially deposited, when kept for some time, at a heat below dull redness. The beads should be about $\frac{1}{8}$th inch in diameter, and $\frac{1}{3}$rd that thickness. After having obtained crystals of a satisfactory character, the ring-shaped loop may be cut off, and the bead mounted in a cell with Canada Balsam. When thus mounted, they may be thoroughly examined with a $\frac{1}{2}$ inch or $\frac{4}{10}$ object glass and achromatic condenser. The full beauty of the specimen can only be seen with a binocular miscroscope; and few objects are better fitted to show the advantage of that kind of instrument. The crystals then stand out in perfect relief, and are seen to be equally complicated in all directions.

Fews objects of the kind are more easily prepared than the crystals of borate of magnesia deposited from borax saturated with magnesia, They first form as thin prisms, and smaller crystals are afterwards deposited, so as to give rise to objects very much like a handle with a brush at each end.

Zircon or zirconia fused with borax yields crystals of the borate. In their most rudimentary state they are small prisms with a simple cross at each end, which afterwards becomes complicated.

The crystals of molybdate of zirconia, formed by fusing zirconia in borax with molybdic acid, are extremely elegant and beautiful objects. They are so delicate that their own weight would probably break them, if they were in an aqueous solution; but being supported in solid borax, like the insects enclosed in amber, they are secure from all enjury.

Scheelite — native tungstate of lime — fused in borax, is deposited in crystals of great beauty, and is an object easily prepared.

The molybdate of strontia, produced by fusing strontia and molybdic acid in borax, crystallizes in long spindle-shaped crystals; whereas the molybdate of lime yields very different crystals, of an intermediate form.

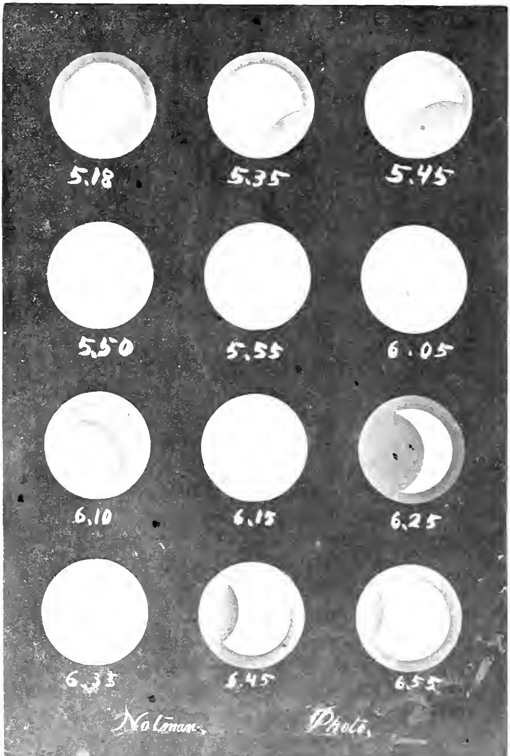
Apatite—native phosphate of lime—fused with borax, deposits in crystals which vary much in shape. Six-sided stars are often formed on the surface, and needle-shaped crystals grow from their centres into the interior of the borax, so that they look like nails with highly ornamented heads driven down into the bead. When formed with their axis parallel to the surface, the crystals are sometimes much like *diatomaceæ*. The addition of phosphate of soda to a borax bead containing lime, in almost any state of combination, gives rise to similar crystals.

On adding a certain amount of carbonate of soda to quartz or various silicates dissolved in borax, crystals are deposited, which vary much according to circumstances: but they all seem to be due to the variable growth of many small six-sided prisms with expanded ends. Another form shows a curious dice-box, resulting from a bundle of such crystals. Probably they are some silicate of soda, modified by the presence of other bases.

Columbic acid is deposited from borax in crystals which often have similar forms; whereas titanic acid gives hair-like prisms, variously grouped. Molybdic acid is sometimes set free as liquid globules, which coalesce, rise to the surface, and afterwards solidify as small spheres.

THE SOLAR HEAT.—M. Mouchat, who has been experimenting on the utilization of the solar heat, has sent in a paper on this subject to the Academy of Sciences. He states that, according to his experiments, upwards of three-sixths of the solar heat might be gathered at a small cost. At Paris, a surface of one square mètre normally exposed to the rays of the sun receives, on an average, at any time of the year, on a fine day, ten units of caloric per minute. Such a quantity of heat would make a litre of water at freezing-point boil in ten minutes, and is equivalent to the theoretical action of a one horse-power. He further states that he had proved the possibily of keeping hot-air machines going by means of solar rays, and had succeeded in making a few litres of water boil by exposure to the same agent; and in June, 1866, he had made a small steam-engine work by converting water into vapour with the assistance of a reflector one mètre square.

The American Association for the Advancement of Science will hold its eighteenth meeting at Salem, on Wednesday, August 18th. It is intended to give great prominence to microscopy, and the committee have issued a special prospectus calling on microscopists to aid in sending instruments and specimens. Communications should be addressed to Mr. F. W. Putnam, the Local Secretary, Salem, Massachusetts. The titles of papers should be handed in as early as possible, in order to secure their presentation to the Association. Each title should be written on a separate slip of paper, with the author's name and address, and an estimate of the number of minutes required to read the communication. As soon as practicable after entering the titles, the paper itself, or an abstract, must be handed to the Secretary, and until all these conditions are complied with, no title can appear in the programmes.


5.18
5.35
5.45
5.50
5.55
6.05
6.10
6.15
6.25
6.35
6.45
6.55
Notman Photo.

THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

ON THE PARTIAL ECLIPSE OF THE SUN, AUGUST 7TH, 1869.

By C. SMALLWOOD, M.D., LL.D., D.C.L.

The varied and beautiful phenomena presented in an Eclipse of the Sun, form an important era in the life and study of the astronomer. They form a sort of triumph of his science, a winning-post, planted, as it were, in the distant confines of space—a point of time graven on the history of the past—a land-mark placed as a beacon for the future—and a song of praise to Him, whose power and might are so manifest in the "Heavens that declare His glory, and in the moon and stars that He has ordained."

The occurrence of a total eclipse gives rise to appearances which have excited the admiration and wonder of the inhabitants of the earth in all ages; but the increase of knowledge, and a more definite theory of the properties of light, and the various improved and modern appliances of science for the investigation of these phenomena, have shed a bright lustre around these observations of a character at once sublime and of intense interest.

No experiments since the days of Newton, but the discovery by Fraunhöfer of the dark lines in the solar spectrum, with the more recent invention of the spectroscope, could have led to those results which the total eclipse of last year, 1868, so fully determined, and which would seem to afford such positive proofs of the composition and nature of those protuberances, which, up to that time, had caused so much speculation among men of science.

We are not aware to what point of investigation these several objects have been brought during the past month by our American scientific brethren, or by the two or three Canadian observers who have been enabled by the liberality of the Dominion Government to witness and record, in a more favorable locality, those interesting phenomena which may justly be deemed physical and astronomical, apart from those which may be termed photographic, which, indeed, are only of a secondary and less important character.

The recent investigations of Huggins and Lockyer on the sun's envelope, show that it is not necessary that an Eclipse should take place for the observation of these peculiar and hitherto mysterious prominences, the spiral form or rotary motion of which remind us of those similar forms of nebulæ, which Lord Ross has so well delineated from actual observation in his six-feet reflector.

As far back as the Eclipse which occurred on the 24th June, 1778, and was observed at sea by the Spanish Admiral Don Antonio Ulloa, these prominences were seen, and by him described as possessing rotary motion.

The observations here recorded were carried out at the Magnetic and Meteorological Observatory at this place, (Montreal,) latitude 45°31' N., and longitude 4 hours 54 m. 17 sec. West of Greenwich, and 182 feet above the mean sea level. Mr. Black kindly consented to act as assistant and time-keeper, an office he very faithfully and vigilantly fulfilled. Mr. Balch, one of the students in Arts, received some instructions, which he carried out at Tadousac, while on a visit to that place.

The Observatory possesses no telescope which could be used with advantage: a 42 in. Dollond, 3 in. aperture, with a power of 40, was the only one which was available. A small comet-seeker, of about the same power, possessing a large field, was also brought into requisition The screen glasses used in both cases during the whole time were red.

The first contact took place at 5 hours 7 min. 41.5 sec., Montreal mean time. The position at the telescope was taken at 5 o'clock, and my assistant was very exact, and marked well the calls and signals previously fixed upon. There was a slight agitation of the sun's limbs a second or two before the first contact occurred: it seemed as though the edge of the sun became suddenly lighted up as it were with rose-coloured prominences, shooting out coruscations of the same rose-coloured light towards the sun's bright disc, which display instinctively led to the strict observance of the position of the first point of contact. The contrast between the sun's bright disc and these rose-coloured protuberances was very distinct and well marked. The colour (as seen through the red screen) reminded me much of the *Strontium* light in a display of fireworks. These prominences increased, seeming to precede the moon's dark edge as a narrow band during the whole time, and preserving the same distinct rose colour.

The magnitude of the obscuration was 9½ digits, and was on the south side of the sun. The greatest obscuration occurred at 6 hours 6 min. 41 sec. The final contact, which occurred at 6 hours 58 min. 41 sec., was, from its position, hid from view.

Mr. Notman, the photographic artist, made, at my suggestion, (as he kindly did in 1860,) some photographs of these appearances, which are appended to this paper. He likewise exposed a collodion plate to the sun, moving it forward every five minutes, to show the effect of the sunlight on the sensitive surface. A like exposure of sensitive paper was made at the Observatory, with remarkably similar results. A piece of chromotype paper was there also exposed in a similar way, and formed a complete photometer scale, showing the action of the sunlight in the production of photographic effects.

On the Thursday previous, two large dark and prominent spots were observed on the sun, among others less conspicuous, but on Saturday (the day of the Eclipse) only one of these was visible on the N. W. aspect, and the progress of the moon across this spot was hid from view, owing to the passage of a somewhat dense *Cumulus* cloud, which obstructed distinct vision.

No distortion of the cusps was apparent. They appeared at all times sharp and well defined, and no flashes nor coruscations were seen on the moon, which presented the same apparently dark appearance and somewhat serrated edge throughout. The border of the moon before contact could not be observed by the small instruments employed.

Two polariscopes were used, one placed in a position due North and the other South. There was an absence of sky polarization in the one placed South during part of the time of the Eclipse, but that placed North showed the usual appearances. The change in the aspect of surrounding objects, and of the landscape generally, was very apparent, giving to the buildings (mostly of grey lime-stone) a peculiar lurid yellow hue, quite unlike the grey dawn of twilight. The leaves of the maple trees, close to the Observatory, were noticed to droop, and the petals of some flowers (the *Petunia Phœnicea*) were observed to be partially closed. The effects, if any, on animals, domestic poultry, or birds, were not perceived. This may be owing to the late hour at which the obscuration occurred, being but a short time earlier than the usual hour of retirement.

Table I.—*Showing the Gaseous and Hygrometric State of the Atmosphere.*

Montreal Mean Time, August 7th, 1869.	Gaseous pressure of the Atmosphere, in inches.	Temperature of the Dew Point.	Elastic force of Aqueous Vapour.	Weight of Vapour: In a cubic foot of Air.	Weight of Vapour: Required for Saturation of a cubic foot of Air.	Degree of Humidity.	Weight, in grains, of a cubic foot of Air.	Remarks.
P.M. 4*h*. 0*m*.	29·486	59·7	0·524	5·44	3·27	0.624	514·5	
5 "	......	60·5	0·532	5·81	3·23	0.643	514·4	
10 "	......	58·0	0·489	5·31	4·29	0·553	512·7	
15 "	29·545	56·5	0·465	5·06	4·54	0·527	512·8	
20 "	.	57·2	0·467	5·11	3·62	0·595	514·7	
25 "	......	56·0	0·428	4·68	3·82	0·551	517·0	
30 "	29·566	54·4	0·434	4·77	3·46	0·578	518·0	
35 "	...	57·5	0·481	5·28	2·91	0.640	517·7	
40 "	....	56·5	0·464	5·14	3·02	0.609	517·8	
45 "	29·451	58·0	0·489	5·38	2·62	0.672	518·7	
50 "	....	56·0	0·458	5·03	3·22	0.609	517·8	
55 "	......	55·8	0·456	5·01	3·20	0.607	517·6	
5*h*. 0 "	29·508	55·0	0·442	4·87	3·13	0.609	518·9	
5 "	..	54·6	0·437	4·82	2·94	0.621	519·9	
10 "	......	54·9	0·438	4·83	2·95	0.624	520·0	First contact,
15 "	29·463	54·6	0·437	4·82	2·94	0.621	519·9	5*h*. 7*m*. 41 5*s*
20 "	.....	55·0	0·414	4·37	3·19	0·598	520·1	
25 "	....	55·2	0·445	4·93	2·60	0.685	521·0	
30 "	29·455	55·2	0·445	4·93	2·60	0.655	521·0	
35 "	......	54·7	0·438	4·82	2·48	0.649	522·1	
40 "	....	54·2	0·431	4·77	2·33	0·651	522·0	
45 "	29·505	54·6	0·442	4·87	2·21	0.690	523·0	
50 "	....	55·1	0·443	4·76	2·42	0.687	522·1	
55 "	....	54·8	0·440	4·88	2.20	0.689	523·0	
6*h*. 0 "	29·500	53·8	0·425	4·72	2.15	0.687	524·2	
5 "	....	53·7	0·424	4·73	2.10	0·700	524·1	
10 "	....	53·6	0·424	4·74	1·93	0·710	527·4	
15 "	29·500	53·8	0·425	4·73	1·92	0·711	525·1	Greatest obs-
20 "	.....	54·2	0·431	4·81	1·67	0·724	527·1	curation, 6*h*.
25 "	......	54·8	0·435	4·86	1·59	0·731	531·4	6*m*. 41*s*.
30 "	29·483	53·7	0·427	4·89	1·51	0·754	534·7	
35 "	....	54·5	0·436	4·86	1·59	0·734	526·9	
40 "	......	54·1	0·434	4·83	1·57	0·741	526·7	
45 "	29·479	53·7	0·431	4·80	1·56	0·751	527·1	
50 "	....	54·5	0·435	4·86	1·59	0·753	526·0	
55 "	....	55·5	0·421	4·70	1·55	0·753	527·1	
7*h*. 0 "	29·455	53·2	0·445	4·99	1·26	0·789	527·4	End of Eclipse 6*h*. 58*m*. 41*s*.

No dew was observed appreciable on a prepared paper exposed for that purpose, although a very sensible increase of the moisture in the atmosphere was distinctly felt.

Ozone was much in excess. The ozoneometer, placed at 4 P.M, and removed at 7 P.M., showed a tint corresponding to 3 of the scale, while the usual measure, exposed from 4 P.M. till 7 P.M., showed somewhat less than 2.

The observations of the sky spectrum, by the spectroscope, were not carried out so well as was desirable. The only difference observable was a dulness in the colour of the red ray.

Peltier's Electrometer indicated but a very slight disturbance in the electric state of the atmosphere. The temperature of the air was observed every five minutes, as also the temperature of evaporation. The Barometer was read every fifteen minutes. From these combined observations the gaseous and hygrometric state of the atmosphere have been reduced.—(See Table 1.)

Table 2.—Showing the Height of the Barometer, the Temperature, Solar Radiation, Clouds and Wind.

Montreal Mean Time, August 7th, 1869.	Barometer corrected and reduced to 32° F., in inches.	Temperature of the Air—F.	Intensity of the Sun Rays.	Clouds.			Wind.	
				Name.	Direction.	Extent.	Direction.	Velocity, in miles.
P.M.		°	°					
4h. 0m.	30.010	74.1	83.6	Cirr. C. Str.	N. E.	4	W. S. W.	Calm.
5 "	......	74.7	....	....	.....	....	....	.....
10 "	......	76.0	....	....	.....	....	....	.....
15 "	30.010	76.1	90.5	Cirrus	N. E.	1	N. E.	1.0
20 "	......	74.0	....	....	.....	....	....	.....
25 "	......	72.0	....	....	.....	....	....	.....
30 "	30.000	71.0	85.0	Light Cirri.	N. E.	2	W. by N.	Calm.
35 "	......	70.7	....	....	.....	....	....	.....
40 "	......	70.9	....	....	.....	....	....	.....
45 "	29.956	70.2	82.9	Light Cirri.	N. E.	4	W. by N.	Calm.
50 "	......	70.7	....	....	.....	....	....	.....
55 "	......	70.7	....	....	.....	....	....	.....
5h. 0 "	29.950	70.0	87.7	Cirrus.	N. E.	1	N. E.	1.0
5 "	......	69.0	....	....	.....	....	....	.....
10 "	......	68.7	....	....	.....	....	....	.....
15 "	29.904	69.0	81.5	Cirrus.	N. E.	3	N. E.	Calm.
20 "	......	69.1	....	....	.....	....	....	.....
25 "	......	68.0	....	....	.....	....	....	.....
30 "	29.900	68.0	71.0	Cum.	N. E.	2	N. E.	Calm.
35 "	......	67.8	....	....	.....	....	....	.....
40 "	......	67.1	....	....	.....	....	....	.....
45 "	29.917	66.9	65.6	Cum. Str.	N. E.	2	W. by N.	Calm.
50 "	......	66.9	....	....	.....	....	....	.....
55 "	......	66.0	....	....	.....	....	....	.....
6h. 0 "	29.925	65.0	65.7	Clear.	.....	....	N. E.	Calm.
5 "	......	64.5	....	....	.....	....	....	.....
10 "	......	64.1	....	....	.....	....	....	.....
15 "	29.925	64.0	62.0	Clear.	.....	....	N. E.	Calm.
20 "	......	63.5	....	....	.....	....	....	.....
25 "	......	63.0	....	....	.....	....	....	.....
30 "	29.914	63.9	61.5	Clear.	.....	....	N. E.	Calm.
35 "	......	63.0	....	....	.....	....	....	.....
40 "	......	62.9	....	....	.....	....	....	.....
45 "	29.911	62.5	....	....	.....	....	....	.....
50 "	......	63.0	....	....	.....	....	....	.....
55 "	......	62.1	....	Clear.	.....	....	N. E.	Calm.
7h. 0 "	29.900	60.2	....	....	.....	....	....	.....

The intensity of the Sun's rays was also taken every fifteen minutes—see Table 2—which also shows the reading of the Barometer, and the temperature of the air, with the amount of wind and clouds, as bearing more especially on the meteorological effects of the Eclipse.

The wind was from the N. E., and veered occasionally to the W. For the most part it was calm. The clouds moved, during the whole time, from the N. E.

The weather, for some days previous to the 7th, was, for the most part, cloudy, accompanied by showers of rain, with wind from the S. W., and moderate, varying from five to ten miles per hour. Rain fell on the fifth and sixth days.

The Barometer, at 7 A. M. on the fifth day, stood at 29.811 inches; it rose steadily until 7 A. M. on the morning of the eighth day, and then stood at 30.141 inches: at 2 P. M. of the seventh day it stood at 30.034 inches, and at 4 P. M. the reading was 30.010; from fifteen minutes after 4 until 7 P. M. there was a continuous fall; it reached, at that hour, 29.900, and at 9 P. M. it again attained 30.110 inches. This fall of the Barometer accords with the observations made on the partial eclipse of 1860, at the St. Martin's Observatory.

The temperature of the air, at 7 A. M. of the seventh day, was 53°9; at 2 P. M., 75°0, and at 9 P. M., 63°0. These were the usual tri-daily observations. These observations, reduced as a standard, from which the departure in decrease of temperature is reduced, are given in Table 3, which shows the mean daily curve, and the depression caused by the withdrawal of the Solar heat. The Thermometer marked a constant and almost uniform depression (which was, in a slight manner, interrupted by the presence of clouds) from 5 P. M., when it stood at 70°0, and at 7 P. M., when it stood at 60°2, from whence it rose to 63°0 at 9 P. M. The decrease in the intensity of the Sun's rays showed a like uniformity.

The greatest degree of humidity occurred at thirty minutes past 6, or about twenty-four seconds after the greatest obscuration; in like manner the increase of aqueous vapour, and the other hygrometric states of the atmosphere, culminated at or near that time.

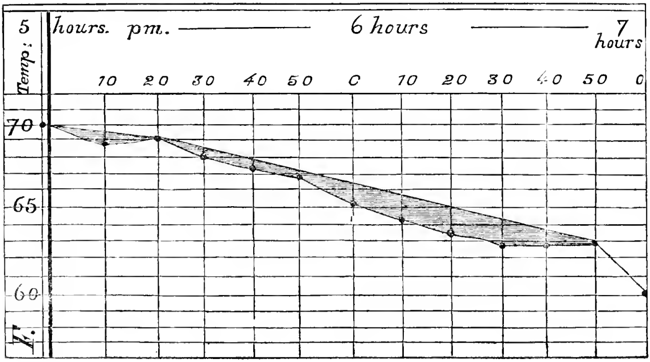
The wind, during the night of the fifth day, and up to noon of the sixth, was from the N. by W.: mean velocity, 8.33 miles; maximum velocity, 13 miles per hour. There were three hours of calm. From noon of the sixth day till noon of the seventh the wind was variable. It was due North, and calm, for forty-six minutes. It then veered by the West to W. N. W. At 9.45 P. M. it was N.N.W., and, from 11 to 12, it attained a velocity of 19 miles: mean velocity, 11.11 miles per hour. There was one hour calm from 12 noon to 1 P. M. At noon on the seventh day the wind veered to the N. by E., and, from that time, to the N. W. and N. E. by N. From 3 to 4 P. M. it was W. by S., 18 miles. During the Eclipse it was variable, from N. E. to W. S. W.; and it continued in that point until 11 P. M., when it veered to N. by W. until daylight. It was calm from 12 to 1; from 1 to 2 also calm; from 2 to 3, 2 miles; from 3 to 4, 18 miles; from 4 to 5, 2 miles, and was calm during the rest of the night.

No flurries or gusts of wind occurred during the eclipse, and no Aurora Borealis was seen.

Observations on the Magnetic Elements were attended to. The experiments on Vibration indicated nothing differing from the usual appearances. The vibrations did not seem at all affected by the Eclipse.

The Declination Magnet indicated a considerable variation in Eastern declination, and this continued increasing up to the seventeenth day. The Inclination Magnet showed a very slight variation in the dip, but one of very small amount.

Table 3.—Curve shewing the mean daily mean range of Temperature, and its departure below, during the partial Eclipse of the Sun, Aug. 7, 1869. —Montreal Observatory.



No stars were visible to the naked eye, and no telescopic search was made, although some of the first magnitude were well placed for observation, as were also some of the planets

From the time of the Eclipse, and for the next succeeding eight days, the weather assumed a warm and genial character, in contrast to the unfavourable st te of the previous month, and was a source of welcome and delight to the husbandman who so much required it to enable him to reap and secure a prolific harvest.

In reference to the observations of Mr. Balch, at Tadousac, the weather seems to have been very unfavourable. High wind, with rain and cloudy weather, impeded the view. The amount of Ozone would seem to have been somewhat in excess, and there was considerable variation in the Magnetic declination.

In reference to the twelve photographs made by Mr. Notm n, there is an error in time of three minutes compared with Montreal mean time, at the Observatory. Thus for 5h. 18m. read 5 hours 15 minutes, and so on, making a deduction in every case of three minutes from the time noted in the accompanying photographs; in other respects they are a most faithful and reliable delineation of the various phas s of the eclipse.

[In the accompanying photographs, the light part represents the sun, the dark projections upon its disk the portion of the moon showing the amount of eclipse at the time marked underneath each.]

MONTREAL OBSERVATORY,
August 20, 1869.

THE PLANTS OF THE WEST COAST OF NEWFOUNDLAND.

BY JOHN BELL, A.M., M D.

During the months of June and July, 1867, I had the pleasure of visiting the west coast of Newfoundland, in company with a party of two or three. The section of coast visited extended from the mouth of the Great Codroy River to the Bay of Islands.

A schooner was chartered at Quebec, and suitably fitted up for the voyage, also to serve as our abode when not camping-out during the expedition. A skiff and a couple of bark canoes for ascending the rivers completed our means of transit; and on the afternoon of the 12th June, *La Providence* set sail, and carried us quietly down past the Falls of Montmorenci and the Island of Orleans. After a sail of three days, with varying breezes, we anchored in Gaspé Basin after meeting large fleets of inward bound vessels and several schools of porpoises, seeing diverse whales spouting in the distance, admiring the scenery on the south shore, feeling a few qualms of sea-sickness and experiencing the other pleasures of a voyage down the Gulf. At Gaspé Basin the services of an excellent canoe-man, well known to tourists and explorers, were secured, and the schooner again headed out, in the direction of the Magdalen Islands. In thirty six hours we were sailing between the main island of the Magdalen group and Isle Byron, and shortly after, with a stiff S.E. wind and heavy sea, passed the small red-sandstone islands known as the "Bird Rocks," on account of the immense numbers of sea-fowl which continually float like a snow-storm in the air around them, and whiten their tops and craggy sides. The sea now becoming very rough, the captain put back, and, with reefed foresail, lay-to for the following day under the lee of the Magdalen Islands. The next day, however, we came in sight of Cape Ray to the S.E., and in a short time Cape Anguille, spotted with patches of snow, rose above the horizon. Having soon after passed between the high headland of Cape Anguille and the lower level land of Cape St. George, we sailed, with alternate breeze and calm, up the long tapering bay, or rather gulf, of the latter name, which, at its head and along the southern side, receives numerous streams and rivers. The water of the bay was covered with a coating of yellow pollen from the fir-trees, which, being often blown from the flowers in great quantities and washed down by the rain, is popularly believed to be sulphur. Porpoises played around the schooner, and numbers of gulls winged their way over-head, or rested like white specks on the dark blue surface of the water, while the slanting rays of the setting sun, reflected from the painted or iron-stained cliffs of part of the southern shore, added to the beauty of the scene.

A long, low tongue of land runs out at the south side of the head of the Bay, forming an excellent harbour. In the morning of the following day, a fair wind having sprung up, we ran merrily up to anchorage in this harbour; and it being high tide, we, happily, passed over some shoals, where, in our ignorance of the channel, we might otherwise have stranded. On the south side of the harbour, a long stretch of the bank appeared, quite black, which I afterwards found to be a section of one of the peat bogs, so numerous in the island, cut away by the action of the water.

In the evening I landed on the sandy point on which Flat Bay village is situated, and, wandering along the shore, collected the Sea-side Crowfoot (*Ranunculus Cymbalaria*), *Mœhringia lateriflora*, and the delicate *Primula Mistassinica*, growing a little above the waves that rolled in quantities of Eel grass (*Valisneria spiralis*), *Laminaria*, and *Fucus vesiculosus*, in tangled masses on the beach. Among the stunted spruces (*Abies nigra*) and Balsams (*Abies balsamea*), in the middle of the point, the Star-flower (*Trientalis Americana*), Strawberry, a species of Gentian, and the shrubby stems of the Cowberry (*Vaccinium Vitis-Ida*), found a grateful shelter,—the common blue and sweet white Violets (*Viola cucullata et blanda*) flourishing in the more moist and shaded places; while the Shepherd's-purse (*Capsella bursa-pastoris*), Sorrel (*Rumex acetosella*), Goose-grass (*Polygonum aviculare*), and Lamb's-Quarters (*Chenopodium album*,) found themselves more at home in the gardens and around the houses of the village.

Flat Bay extends in a south-westerly direction, and at its head receives the waters of a brook of the same name, which runs in a N.W. course through the mountains that lie along the south side of St. George's Bay. About ten miles up this brook, Cairn Mountain rises in a cone somewhat higher than its fellows, and is surmounted by a large pile of lichen-covered stones, which were no doubt placed there by Captain Cook as a point from which to take observations during his survey of the neighbouring coasts, and from which the mountain takes its name.

On stepping ashore on the south side of the harbour I observed the Silver-Weed (*Potentilla anserina*), with its bright yellow flower trailing over the gravelly ridge that separated the harbour from a marshy depression inside, in which the Marsh-Marigold (*Caltha palustris*) grew in luxuriant bunches. Here, too, the stately Cinnamon Fern (*Osmunda cinnamomea*) shot its light-brown fertile fronds up through the centre of elegant green vases, and the less ostentatious *Asplenium thelypteroides* spread its delicate foliage around. The Wild Mint (*Mentha Canadensis*) reared its formal spikes of pink flowers in tufts beside the pools, the mud around which, in many places, seemed as if iron-stained from the profusion of the low-lying clammy brown leaves of the Sun-dew (*Drosera rotundifolia*).

The small Cranberry (*Vaccinium oxycoccus*), Dwarf Raspberry (*Rubus triflorus*), and Creeping Snowberry (*Chiogenes hispidula*) wreathed the moss-covered stumps and fallen logs among the clumps of Alder (*Alnus incana*), Labrador Tea (*Ledum latifolium*), Sheep and Pale Laurel (*Kalmia angustifolia et glauca*), in which the little Smilacinas (*S. bifolia et trifolia*) found a quiet retreat, leaving the Polypodiums (*P. Dryopteris et Phegopteris*) and Bunch-berry (*Cornus Canadensis*), to mount guard on the hillocks outside. A striking feature of this place was the great quantity of the Pink Rhodora (*R. Canadensis*), which was now in full bloom, and reminded one of a fine greenhouse display of Azaleas. It was found growing in all the swampy ground on the way up to Cairn Mountain, near the summit of which I obtained a pure white specimen. A species of Willow and Wild Rose grew along the fence of a field, in which the Canadian Burnet (*Sanguisorba Canadensis*), and early Meadow-Rue (*Thalictrum dioicum*) found a suitable *habitat*.

After passing the swampy 'intervale' south of Flat Bay Harbour, the land rose considerably, became much dryer, and produced a different class of plants. The Rowan tree (*Pyrus Americana*), Shad bush (*Amelanchier Canadensis*) and Maples (*Acer rubrum et Spicatum*) with tangles of the Wild Red Raspberry (*Rubus strigosus*, Michx), Great Willow Herb (*Epilobium angustifolium*), and Bracken (*Pteris aquilina*), now appeared. The little Mitrewort (*Mitella nuda*, L.), Clintonia (*C. borealis*, Raf.) and Linnæus' favourite Twin flower (*Linnæa borealis*, Gronov.), were also found. The pathway, leading through a light wood and among Blueberry bushes (*Vaccinium Pennsylvanicum*, Lam.), brought us to the edge of one of those open areas or barrens which form such a peculiar feature in the scenery of Newfoundland. Mr. Comack, in the narrative of his journey across the southern part of the island, describes several which were many miles in extent; but this one was not more than two miles across. Its level surface was almost entirely covered with deep wet sphagnum moss, and relieved only here and there by a stunted spruce, or broken by deep circular ponds of brown water, in some of which I got the Buckbean (*Menyanthes trifoliata*, and around them *Andromeda polifolia*, a small Honeysuckle (*Lonicera*), and the tubular leaves of the Pitcher plant (*Sarracenia purpurea*). The little Cloud-berry (*Rubus chamæmorus*) dotted the cold boggy moss with its large white blossoms, and various sedges tufted the level surface. The dark level bushes of the Sweet Gale (*Myrica Gale*), in places bordered the barren, and in its dryer areas the Black Cowberry (*Empetrum nigrum*) matted its low woody stems together. Small Tamarac trees (*Larix Americana*), and the rank Cow-parsnip (*Heracleum lanatum*), with its large umbels of white flowers, bounded the barren on the opposite side.

From this point the road conducted us over higher land, among bushes of common Juniper (*Juniperus communis*), Ground Hemlock (*Taxus baccata* var. *Canadensis*), and Leather-leaf (*Cassandra calyculata*, Don), to a forest of Fir trees and Paper Birch (*Betula papyracea*), in which the following woodland plants were collected;—the Rosy Twisted Stalk (*Streptopus roseus*, Michx), Nodding Trillium (*T. recurvatum*, Beck), Baneberry (*Actæa spicata*, L.), Twayblade (*Listera Convallarioides*, Hook), Goldthread (*Coptis trifolia*), Rattlesnake Plantain (*Goodyera pubescens*), Star Lily (*Smilacina stellata*), Wild Sarsaparilla (*Aralia nudicaulis*), common Wood Fern (*Aspidium spinulosum*, Swartz), and on a rocky escarpment, *Woodsia Ilvensis*. The Pigeon Cherry (*Prunus Pennsylvanica*), and Mountain Holly (*Nemopanthes Canadensis*), were met with in the woods just before we reached Flat Bay Brook, which was here bordered by bushes of Green Alder (*Alnus viridis*), Sweet Viburnum (*V. Lantago*), and Maple-leaved Arrowwood (*V. acerifolium*). Nearer the shore ragged bushes of the Shrubby Cinque-foil (*Potentilla fruticosa*,) gave evidence of having been washed by many a spring flood, and the long runners of the Creeping Crowfoot (*Ranunculus*) timidly felt their way over the well-worn shingle, which formed a pleasing background to the glaucous leaves and rose-coloured petals of the *Epilobium latifolium*.

Next morning, having paddled up the brook to where it bends round the base of the mountain, we landed, and after a toilsome climb over its northern spur, reached the summit, from which a magnificent view of the hills and valleys in all directions was obtained. A mountain tarn, calm as a mirror, lay nestling below among the dark green woods of a depression, some hundreds of feet above the river, which wound along in the curving valley beneath, and from the opposite side of which the hills sloped away up to the south-west, verdant with the White Pine (*Pinus Strobus*), and various hard-wood trees. In the ascent from the river, near which a swamp afforded specimens of Meadow Rue (*Thalictrum Cornuti*), Flowering, Interrupted and Sensitive Ferns (*Osmunda regalis O. Claytoniana.* and *Onoclea sensibilis*), we first passed a thicket of Beaked Hazel (*Corylus rostrata*), and Red-berried Elder (*Sambucus pubens*); then up a wooded steep, the trees of which shaded the creeping vines of the Partridge Berry (*Mitchella repens*), and beautiful May-flower, or Trailing Arbutus (*Epigæa repens*), the floral emblem of Nova Scotia. From the edge of the forest, low Red Cedar (*Juniperus Virginiana* Var. *humilis*), and Bearberry bushes (*Arctostaphylos Uva-ursi*), carried vegetation a little further up the rocks, until, at the summit of the ridge referred to, almost the only plants to be obtained were the Bog Bilberry (*Vaccinium uliginosum*), Alpine Azalea (*Loiseleuria procumbens*, Desv.), and Mountain Cinque-foil (*Potentilla tridentata*.) Along the top of the rocks, quantities of crisp Reindeer, Iceland and Hedwig's Hoary Moss (*Cladonia rangiferina*, *Cetraria Islandica* and *Hedwigia ciliata*) crunched beneath the feet, while budding tufts of the graceful Harebell (*Campanula rotundifolia*), waved from the fissures in the cliffs below. A solitary bunch of the pretty Fragrant Fern (*Aspidium fragrans*, Swartz) was procured from the cleft of a shaded rock on the north side of the mountain, near its summit.

At a bend in the river below the mountain, I observed the broad leaves of the Pond Lily (*Nuphar advena*) floating on the surface of the deep quiet pool, overshadowed by the spreading branches of a Black Birch (*Betula lenta*.) Several miles above this, the Butterwort (*Pinguicula vulgaris*), dotted the cracks in the damp rocks along the shore, and on the moist banks I gathered the Enchanter's Nightshade (*Circæa alpina*), with its pellucid stems, the Twisted-stalk (*Streptopus amplexifolius*), Blue-eyed Grass (*Sisyrinchium Bermudiana*), Purple Avens (*Geum rivale*), and the *Potentilla Norvegica*, which in the woods always looks as if it had strayed from some more civilized regions. The thicket beyond was bordered by

Alternate-leaved Cornel bushes (*Cornus alternifolia*) and brushwood, over which the fetid Currant (*Ribes prostratum*) and Bramble (*Rubus villosus*) climbed in an impenetrable tangle.

Returning from Cairn Mountain to the harbour, the party passed over nearly the same ground as in going, and collected several species which had not been noticed on the way up. In an upland wood, several Yellow Birch trees (*Betula excelsa*) were observed, and over the rich shaded ground, beneath them, the Round-leaved and Lesser Pyrolas (*P. rotundifolia, et minor*), and the waxen white Indian Pipe (*Monotropa uniflora*), bashfully hung down their snowy blossoms. The Ground-Pine (*Lycopodium dendroideum*) and other species of Club Mosses (*L. lucidulum, S. clavatum, complanatum* and *alpinum*,) sent up evergreen tufts among the rustling leaves. The Petioled Willow (*Salix petiolaris*), the Pearlwort (*Sagina procumbens*), and, strange to say, the common Groundsel (*Senecio vulgaris*), in flower, were discovered on the sloping sandy shore of Flat Bay Brook. In one part of its course, the toilsome path led through a wet sedgy bog of Sphagnum, whose uneven surface here and there bore waving tufts of Cotton grass (*Eriophorum vaginatum, Virginicum et polystachyon*), angular bushes of the Dwarf and Alpine Birch, and white flowering branches of the neat little Chokeberry (*Pyrus arbutifolia*.) A few scapes of Arethusa (*A bulbosa*), which needs no foliage to "set off" its large rose-purple and sweet-scented flowers, stood alone among the bluish-green moss of the barren.

Another ramble along the Bay shore secured for me the Sea Sandwort (*Arenaria peploides*), and Lungwort (*Mertensia maritima*), the Sea Rocket (*Cakile Americana*), and the Glasswort (*Salicornia herbacea*.)

Beyond the spring-tide mark the Beach Pea (*Lathyrus maritimus*), and Orache (*Atriplex hastata*), spread themselves over the sand, while a large and small variety of the Blue Flag (*Iris versicolor*), alike in every particular, except size, mingled together in luxuriant bunches.

A large variety (?) of the Sea-side Plantain (*P. maritima*), with broad leaves and long tapering root, was found near the extremity of Flat Bay Point.

We sailed on the 4th July to the low gravelly Isthmus separating Port-à-Port from St. George's Bay. Eastward from this place, a high gravelly bank rises above the sea shore. On the oozy spots of this bank, the Yellow Mountain Saxafrage (*Saxafraga aizoides*) lay matted together in heavy masses, where also grew straggling bushes of the Shepherdia (*S. Canadensis*), whose rusty scales were noticed in the last number of this journal. The Yellow Evening-Primrose (*Œnothera biennis*) took a firm hold in the loose gravelly slopes, bordered above by the Low Bush Willow (*Salix humilis*). Among the grass, on the top and shelves, grew the Pasture Thistle (*Cirsium pumilum*), Pearly Everlasting (*Antennaria margaritacea*), Yellow Rattle (*Rhinanthus Crista-galli*), Mouse-ear Chickweed (*Cerastium viscosum*), Yarrow (*Achillea millefolium*), and in the moister places the Northern Green Orchis (*Platanthera hyperborea*) and *Epilobium coloratum*, besides many others whose names have been already mentioned The variety *juncides*, of *Plantago maritima*, the Birds-eye Primrose (*Primula farinosa*), and the delicate *Carex aurea* of Nuttall, grew from crevices in the rocks, occasionally wet by the salt spray from the breakers. The rich fronds of *Aspidium aculeatum*, variety *Braunii*, were collected in a wood immediately above the 'Gravel' or Isthmus, where I found the common English Garden Snail (*Helix hortensis*), which, from having been found extensively in Gaspé and in the islands of the St. Lawrence by Prof. Bell in 1858, I judge to be indigenous here, and in those parts of Canada bordering the Gulf.

During the night the schooner sailed across the mouth of the harbour, and next morning we found ourselves passing by Cape Anguille, *en route* to Cod Roy Island. The shore all along was apparently formed of red sandstone, on edges sloping at a very high angle, and indented with large clefts and chasms. The waves washed the bases of the rocks, which were fringed above with graceful shrubbery, and the dark green mountains, dotted with the light foliage of the deciduous-leaved trees, rose gradually to their heathy summits, which were divided from one another by deep and winding valleys which lodge huge masses of almost perpetual snow, and give rise to streams that wear away the gullies and dash in foaming torrents to the sea. As the sea-breeze blew over the land, the moisture in the air became condensed by the cold of the mountain tops, and soon formed clouds which hid the summits from our view.

NOTES ON TADOUSAC PLANTS.

By A. T. Drummond, B.A., L.L.B.

The hilly environs of Tadousac, and its position on the high northern coasts of the Lower St. Lawrence, along which sweeps the cold current which flows through the Straits of Belle Isle, are very favourable to the existence of a boreal flora. The hills on either side of the Saguenay here vary in elevation, but in some cases rise to heights of about one thousand feet. Their summits were some years since almost denuded of vegetation by destructive fires. Standing upon the top of the highest hill in the rear of Tadousac, and looking northwards, the nearly treeless surface of the Laurentian rocks extending, hill beyond hill, as far as the eye can reach, convey an idea of the desolation caused by the ravages of the fires. Still, even here, the botanist is delighted to find a few semi-alpine and boreal forms. The rocks are beautifully time-stained by *Buellia geographica*, Schaer, and *Parmelia centrifuga*, Ach.; by *P. stygia*, Ach., and *P. Fahlunensis*, Ach., the yellow hues of the former two presenting a striking contrast to the black appearance of the latter. Other boreal, but less conspicuous Lichens here, are *Cetraria pinastri*, Sommerf. a beautiful species sometimes found in a dwarfed condition in milder localities in Canada, *Peltigera malacea*, Ach. and *Stereocaulon paschale*, Laur.

On the bared surface of the gneiss are the blackish leathery Tripe de Roche (*Umbilicaria hyperborea*, Hoffm., *U. erosa*, Hoffm. and *U. Muhlenbergii* Ach.,) which, from the exposure to the rays of the sun, are very brittle to the touch. Among the higher forms of plant life here, as well as in the mossy depressions of the rocks near the sea shore, the Crowberry, (*Empetrum nigrum*, Linn.,) and the Cowberry, (*Vaccinium Vitis-Idæa*, Linn.,) thrive in great abundance. On the precipitous sides of these hills, and in the deep gorges between, the little Scrub Pine (*Pinus Banksiana*, Lambert) is sometimes met with, but the prominent feature which fixes the attention of the rambler on these and other hills of the Saguenay district, is the vast abundance of bunchberries and blueberries. The latter, during August, form an important item in the exports from the river.

At a considerable distance above the level of the sea, and hemmed in on all sides by the Laurentian hills, is a charming little sheet of water, known as Tadousac Lake. Here occurs a number of very interesting aquatic and other plants Near the beach, rearing their flowers above the surrounding water, are the water lobelia, *Lobelia Dortmanna*, Linn., the bog rush, *Juncus Canadensis*, Gay, Water Milfoil, *Myriophyllum tenellum*, Bigelow, and the little *Eriocaulon septangulare*, Withering, all of them plants of Eastern range. *Nephroma arcticum*, Fr., and *Sticta scrobiculata*, Ach., spread themselves on the neighbouring rocks, and long delicate trails of *Usnea longissima*, Ach , and *Bryopogon jubatus* Fr. var. *setacea*, Ach.

When strolling among the rocks on the shore at Cap Rouge, at the entrance of the Saguenay, the botanist meets with the Hemlock Parsley, *Conioselinum Canadense*, Torr and Gray, the sea side Plantain, *Plantago Maritima*, Linn., squirrel tail grass *Hordeum jubatum*, Linn., Tripe de Roche, *Umbilicaria hirsuta*, Ach., and *Stereocaulon Corallinum*, Fr.; and in his rambles to the different surrounding places of interest, in addition to numerous other forms, the equally familiar demizens of the forests and hills of more southern portions of the Dominion, he sometimes lights upon *Carex Houghtonii*, *Sphagnum acutifolium*, Ehrh., *Polytrichum piliferum*, Schreb., *P. juniperinum*, Hedw., *Bartramia fontana*, Brid., and *Mnium punctatum*, Hedw.

ON HYPONOME SARSI, A RECENT CYSTIDEAN.

By S. Loven.

(*Reprinted from the "Annals and Magazine of Natural History," September*, 1869.)

The general appearance of this very remarkable Echinoderm is that of a small starfish or a Euryalid. It has a disk, convex on the ventral surface, flattened on the dorsal, and five short and broad rays; each of these is divided into two short dichotomous branches, terminating in four very short rounded lobes. As in the recent genera *Antedon* and *Pentacrinus*, a large, conical, proboscis-like funnel rises in one of the interradial spaces of the ventral surface of the disk; and from a point situated a little before the centre of the same surface five narrow channels, protected by marginal scales, radiate and defurcating thrice, run out on the rays and their branches, giving off short branchlets to certain sacculate protuberances placed at regular distances. No pinnulæ. On the protuberances and on the rays the channels are open; but upon the disk, between their first bifurcation and their common starting-point, their marginal scales close over them, forming a vault, so that the five channels are converted into covered ducts, converging into a common subcentral aperture, concealed beneath the integument, and not visible from the outside. In the covered parts of the channels I found masses, consisting of miscroscopic Crustacea, larval bivalves, and other remains of the food of the animal, apparently taken through the ends and open parts of the channels, and on its way, through their covered parts, to the concealed mouth. On the rays, near their tips, are seen some few pores, perhaps indicating the existence of retractile organs. The ventral surface is clothed with rather small, thick-set, irregular whitish scales, among which, in certain places, some six or seven larger ones are seen forming a rosette. Between the rays and their bifurcations this scaly covering of the ventral surface extends back pn to tne dorsal surface, ending there with great regularity in triangular spaces pointing to the centre of the disk. The remainder of the dorsal surface of the disk end the rays, which, by this arrangement, assumes the form of a regular star with five broad dichotomous rays, is clothed with a soft and smooth brownish skin. There is no trace of a calyx. In the centre of the even dorsal face of the disk is seen a somewhat pentagonal space studded with minute pores.

To have the channels on the disk converted into tunnel like passages leading to a mouth concealed beneath the integument is a peculiarity hitherto not observed in any recent Crinoid; but it is, as shown by Professor Huxley and Mr. Billings, a characteristic of the palæozoic Crinoids and Cystideans. The absence of any indication of a calyx at once excludes *Hyponome* from the former. Among the Cystideans it recalls the genus *Agelacrinites*, of Vanuxem, by the depressed form of the body, the scaly covering, and the flatness of the dorsal surface, devoid of anything like a stem or peduncle, as also by the absence of pectinated rhombs and of pinnulæ. Branchlets running from the channels to sacculate protuberances are found also in the genus *Glyptocystites* of

Billings and *Glyptosphærites* of Johannes Müller; and bifurcations of the channels are met with in *Sphærocystites* and *Callocystites* of Hall. Lastly, the genus *Hyponome* shares with the surviving type of the Crinoidea the radiated form of the body and the simply conical unprotected funnel. The specimen described is from Cape York, Torres Strait.

Dr. Lutken has sent us the following note on the above:—

Hyponome Sarsi, a recent Australian Echinoderm, closely allied to the palæozoic *Cystidea*, described by Professor LOVÉN, with some remarks on the mouth and anus in the *Crinoidea* and *Cystidea*, as a reply to the note of Mr. BILLINGS, in the December number for 1868; by Dr. LUTKEN, of Copenhagen.

Certainly I was not, as Mr. Billings believes, "mistaken" in stating that, before the appearance of Professor Loven's paper on *Leskia*, it was merely ' a hypothetical supposition," that the "pyramid" in *Cystidea* was the mouth. I have allowed that this theory has been *very ingeniously advocated* by Mr. Billings, but I cannot allow that it was ever proved "according to the ordinary rules of comparative anatomy,"—the less so, as Mr. Billings himself confesses its being at variance with that capital fact in comparative anatomy, that in all other Echinoderms the mouth is situated in the very centre of the ambulacral system. This fact cannot be invalidated by the analogy furnished by the *supposed* combination of mouth and vent in palæozoic Crinoids. This supposition still remains to be proved, or rather it is, as I think I shall be able to point out, completely *disproved*. It is unnatural, as I have shown elsewhere years ago. We have instances enough of the mouth becoming a vent, but none of the vent becoming the mouth; and that would be the case if the proboscis (the anal tube) of recent Crinoids were also the mouth of the palæozoic. But we now know well where the mouth lies in these old sea lilies, and Mr. Billings has himself first shown the way that leads towards its discovery; but of this more afterwards. The first *apparently* (but only apparently, I believe) true analogy from recent nature, brought forward to corroborate the view of the *oral* character of the "pyramid" in Cystidea, is really that of *Leskia*. I therefore regret that I cannot recall my expressions as incorrect, though I am sorry that Mr. Billings (whose labours in this field I, of course, highly value and admire) should have thought them improperly used. I may add, that I do not conceive how "a simple inspection" can decide on the interpretation of facts, that can only be well understood through inference from analogy. "Reasoning" is here indispensable, and the only logical one is that which starts from a clear perception of the morphology, evolution, and comparative anatomy of the nearest *recent* representatives of the extinct types.

As bearing highly on the present question, I shall lay before the reader of the "Canadian Naturalist and Geologist" a translation of Professor Lovén's description of his newly-discovered recent remarkable representative of the palæozoic *Agelacrini* and *Cystidea*.

"Professor Lovén laid before the zoological section of the Scandinavian Association of Naturalists, at Christiania, in 1868, the figures of an Echinoderm hitherto unknown, viz., *Hyponome Sarsi*, Lovén,* and explained shortly its structure. Exteriorly it resembles an Asterid, with five short and thick dichotomously branching arms, but in other respects it differs from all other recent Echinoderms hitherto known; while in its most essential parts it agrees with the *Cystidea*, which were hitherto regarded as extinct during the palæozoic epoch. Among these it most nearly approaches, through the want of a stem and other characters, to *Agelacrinites* (Vanuxem), and in other respects to *Glyptocystites* (Billings.) As in *Antedon* and *Pentacrinus*, a conical proboscis arises from one of the interradial areas of the ventral surface. The ambulacral furrows, which distally branch dichotomously, also give off short branches to several small club-like swellings of the perisome. These parts of the furrows (the distal extremities and the branches) are open; *but in the ventral disk itself, in the vicinity of the point where they meet, the limiting plates are seen to unite so densely from both sides as to form a vault, converting the furrows into covered-up galleries, which open into the visceral cavity through a common orifice, situated near the centre, but invisible exteriorly.* Small heaps of microscopical Crustacea and other marine animalculæ found in these galleries, intimate that the food is picked up in the open parts of the furrows, and, through these means, conveyed to the hidden mouth. The covering of the ventral surface consists of

* At the risk of some slight repetition we give both Dr. Lovén and Dr. Lutken's description of this interesting addition to our knowledge of the Echinodermata.

small irregular calcareous plates and is continued between the arms, and there branches towards the dorsal surface, where it ends with a triangular limitation. The rest of the dorsal surface is covered with a smooth skin of a darker colour, and has in its centre a roundish spot, with many small pores."

Owing to the specimen described being unique, no account of the anatomy of this remarkable animal is yet given, and its bearing on the obscure and disputed points in the morphology of Echinodermata generally, and Cystidea especially, cannot be fully made out, though we may expect valuable suggestions from the pen of the distinguished author. Nevertheless, the evidence given by this astonishing discovery is clearly—

1. That the "proboscis" in palæozoic *Crinoidea* (and, I conclude, by analogy, that the valvulate "pyramid" in *Cystidea*, *Caryocrinus*, *Agelacrinus*, etc.,) is, as in recent *Pentacrini*, *Antedon*, *Rhizocrinus*, only an *anal* tube, as maintained by Prof. Wyville Thompson and myself, and has nothing to do with the mouth.

2. That the mouth can, where it *apparently* fails altogether, as in most palæozoic Crinoids, though present, be completely concealed through the converting of the ambulacral furrows into vaulted galleries. This will give the clue to the understanding of the true character of many palæozoic Crinoids. We now understand that these subtegminal galleries described by Mr. Billings, and by a contributor to the "Geological Magazine," did not only contain the continuation of the "water-vessels," but are the very ambulacral furrows of Crinoids, Asterids, etc., closed up and converted into vaulted corridors.

This correct theory of the mouth and anus of palœozoic Crinoids was, however, as I now learn, given already by Dr. Schultze, of Bonn, in the introduction to his excellent monograph of the Echinoderms of the Eifel limestone, published by the Imperial Academy of Vienna, and bearing the date of 1866. As this book is indispensable to all engaged in the study of palæozoic Echinodermata, it will not be necessary to give here an extract of his arguments. Happily, this controversy will now be at an end, but the details of the question may yet have to be worked up in many extinct types.

Note.—In my former paper on *Leskia*, reprinted in this magazine, several "errata" have crept in, obscuring the meaning in several instances. I will here only state that "clausu*r*" means "clausus,"—quinque*ralis*" "quinque*valvis*,"—"lissit" "lis sit," etc.

With the highest respect for Dr. Lutken, I do not entirely agree with him. I think that the rule on which he relies can only be accepted as having the value of an ordinary generalization, to which an exception may any day start up. The mouth in all the *known* species of existing Echinoderms, and also in a vast number of the extinct forms, does, unquestionably, lie in the very centre of the ambulacral system. But it does not inevitably follow, from this fact, that all Echinoderms, whether known, unknown, recent or extinct, must have it in precisely the same relative position. In proof of this we have only to refer to the instance of *Hyponome Sarsi*. A few months ago we could, with equal confidence, have declared it to be a general rule that "*no existing species of the Echinodermata has the mouth internal.*" If such a rule had been laid down by any one there would have been no way of disproving it by mere "inference" or "reasoning." Nothing but the production of a specimen in which it could be actually seen that the mouth was internal could be sufficient. Such a specimen has now been produced by Prof. Lovén. By his truly wonderful discovery the non-universality of the rule has been demonstrated by "simple inspection," or more properly speaking, "by actual observation." I believe that the function of the so-called "pyramid," of the *Cystidea*, can be determined by this latter method of proof. It is evident that the process of reasoning relied upon by Dr. Lutken, and by several others, all of them naturalists whose works I highly appreciate, is not perfectly conclusive.

E. BILLINGS.

ON SOME RESULTS OBTAINED BY DREDGING IN GASPÉ, AND OFF MURRAY BAY.

BY J. F. WHITEAVES.

During the past summer dredging operations have been carried on in Gaspé Bay and other localities in the Lower St Lawrence by Principal Dawson and myself.

My own investigations were confined to Gaspé Bay, on both sides, from Little Gaspé and Douglastown to Ship Head, and from the latter place to the village of Cap Rosier.

Principal Dawson dredged at two or three localities in Gaspé Bay, also in the River St. Lawrence opposite Murray Bay, at which latter place curious and somewhat unexpected results were obtained. The greatest depth at which the dredge was successfully used, was a little over 50 fathoms. A large number of marine invertebrata were procured, of which it is proposed to give a general and preliminary account, as at present the species have not been sufficiently studied to enable an accurate detailed description of them to be given. In the division Protozoa a number of species of Foraminifera and of sponges were procured. Of the Foraminifera upwards of forty species, and varietal forms, known to inhabit the Gulf of St. Lawrence, are in Dr. Dawson's M.S. lists, of many of which examples were taken. Of these *Truncatulina lobulata* was by far the most abundant, and *Miliolina seminulum* and *Lituola Canariensis* most conspicuous from their large size. Among the other species recognized are *Lagena vulgaris*, *Entosolenia globosa*, *costata*, and *squamosa*, *Polystomella crispa*, *Rotalia Beccarii*, *Polymorphina lactea*, and *Nonionina scapha*. Almost nothing is known with any certainty respecting the Canadian marine sponges, but if the external form is any criterion, it is probable that we have at least as many as from six to eight species in our waters. One curious form occurred,—a small species between two and three inches high, with a root of radiating siliceous fibres. Specimens of most of these are in the hands of Dr. Bowerbank, of the British Museum, for examination. Many fine hydroid polyps were procured, but these are at present undetermined. No example of a true coral has as yet been taken in the Canadian area, in our seas they seem to be represented by Polyzoans with stony cells, such as Myriozoum subgracile and species of Eschara. Alcyonium rubiforme was frequent; it is one of the nearest Canadian allies to the true corals, and our two common sea Anemones, *Metridium marginatum*, and *Actinia* (*Urticaria*) *crassicornis* were obtained in abundance. The latter is certainly identical with the European species, and presents the same series of varieties.

Among the Echinoderms a large sea cucumber new to our fauna, was taken, but no other species of special interest except Sars' brittle star, which occurs not unfrequently in Gaspé Bay. Many species of marine worms and crustacea were observed.

Wood bored by a species of Limnoria (?) was dredged off St. George's cove, and a large parasite isopod crustacean was found attached to cod fishes. Special attention was paid to the smaller crustacea, of which about twelve species were taken. Among these were four species of shrimp, which appear to be *Crangon vulgaris*, (the common English shrimp,) and another species, also *Hippolyte Fabricii* and *Gaimardii*. In addition to these, specimens of *Gammarus locusta*, *Alauna Goodsiri*, and *Caprella septentrionalis* were collected; also several undetermined Amphipods, and two species of Entomostraca, one of which is probably the *Cypridina excisa* of Stimpson. Fine examples of many species of Polyzoa and tunicates were dredged; these are in the hands of Principal Dawson for study and determination. Among the latter *Didemnium roseum*, *Boltenia Bolteni*, and two species of *Cynthia* have been recognized. In a previous paper published in this journal (vol. 4 p.p. 48–57), a list was given of all the marine mollusca then known to inhabit Lower Canada.

In addition to the 103 species there enumerated, the following have since been met with:—

Macoma inflata, Stimpson. Gaspé Bay.

Cochlodesma Leanum, Con. Near Douglastown. This is the most northerly locality yet recorded for this species.

Thracia Conradi, Couthuoy. Near Grande Grève.

Teredo dilatata ? Stimps. Gaspé Bay.

Philine lineolata, Couth. Gaspé Bay. Principal Dawson.

Utriculus ——?

Diaphana debilis ? Gould.

Margarita argentata ? Gould.

Rissoa, an additional strongly marked species, at present undetermined.

Mamma immaculata, Totten. Gaspé Bay.

" nana, Moller. " "

Amaura candida, Moller. " "

Bela. Two additional species, undetermined.

Besides these 14 additional species, the following new localities were observed for scarce shells:

Leda minuta, Mull. Plentiful off Cap Rosier village.

Crenella pectinula, Gould. Off Grande Grève.

Astarte lactea, Brod and Sow. Alive, between Ship Head and Cape Bon Ami, four miles from shore. This is the shell catalogued in my list as A. borealis, Chemn, on Mr. J. G. Jeffreys' authority.

Tellina (Angulus) tenera, Say. Off Douglastown.

Amicula Emersonii, Couth. A living specimen of this species more than an inch long was taken by Principal Dawson off Murray Bay.

Molleria costulata, Moll., sp. Frequent in Gaspé Bay.

Rissoa castanea, Moll. Gaspé Bay.

Scalaria Groenlandica, Perry. One living off St. George's Cove.

Astyris Holbollii, Beck. Several specimens were taken in Gaspé Bay.

Chrysodomus tornatus, Gould, sp. One fine adult specimen was taken alive in 10-15 fathoms off St. George's Cove.

By dredging in the St. Lawrence opposite Murray Bay, 60 species of marine mollusca, identical with well-known Ladrador shells, were obtained by Principal Dawson. It was not previously known that such strictly marine species lived so far up the river. Among the most interesting of these shells is an Astarte which will go far to prove that the A. Laurentiana of Lyell, a well-known Canadian post pliocene fossil, is a local variety of the recent A. Banksii of Leach. Not only, too, are these Murray Bay shells of a very marine type, but in many cases they are of an unusually large size. The force of the tide in the River St. Lawrence is such that it is often difficult and almost impossible to dredge except in sheltered situations, but the results obtained are very encouraging, and should stimulate to renewed exploration. The observations recently made have shewn that the range in depth of the Canadian marine mollusca is very variable, the same species having been taken living in from 10 up to 50 fathoms. We are still, however, profoundly ignorant as to what creatures live at great depths in the Gulf of the St. Lawrence, and there is little doubt that, were the dredge used in the deeper parts of the Gulf and River, most interesting and valuable results would be obtained. My thanks are due to Mr. J. Gwyn Jeffreys for the loan of a dredge of improved construction ; and I am again much indebted to my friends Messrs. John Luce and P. De Carteret, of Grand Grève, for their kindness and assistance, without which these investigations could not have been carried out.

ON MICROSCOPIC ACCESSORIES.

By J. Baker Edwards, Ph.D., F.C.S.,

Hon. Sec'y Montreal Microscopic Club, and Cor. Mem. Liverpool Micro. Club and New York Microscopic Society.

Next to the possession of a good, solid, smoothly-working stand, with good powers and good illumination, is the desire for the acquisition of those useful accessories which the zealous microscopist soon finds are essentials to his progress in practical study. Of these I shall first notice simplifications which amount to permanent improvements. Thus the shutter or graduating diaphragm is an improvement likely to supersede the rotating diaphragm beneath the stage; and the adjusting side-light as a parabolic reflector is a useful substitute both for the bull's-eye condenser and the various Lieberkuhns. The orthoscopic eye-piece, in its double service as an achromatic condenser, is also a valuable and economical accessory. I have already stated that the binocular prism is an essential to the best form of stand, and is entitled to a higher place in the estimation of the working student than a mere accessory.

The new rotating glass stages of either Messrs. Crouch or Collins certainly accessions to the instrument and can be recommended to those who do not care about the expensive mechanical stage. The movement is smooth and true, and the fingers may soon become educated so as work the object with all the precision desired.

A rotating diaphram, furnished by Crouch or Collins, also gives all the effects of the dark well and oblique illuminations.

The parabolic condenser of Wenham is an invaluable illuminator for foraminifera, polycystina, and transparent injections.

The camera lucida, lever compressorium and object glass reflectors may, I think, be considered as luxuries, not at all essential to the student. So also the "Erecting Eye-piece," although invaluable under exceptional circumstances, may be generally dispensed with, as, for ordinary dissections, the binocular folding stand, called the "Collins' Lawson Dissector," holds the preference.

Every real student should procure at least a stage micrometer, and he will probably not regret the possession of a "cobweb ditto" for the eye-piece. Accuracy in the expression of the size of objects described is often of the greatest importance in original investigation.

Must I call the "Brook's nose-piece" an accessory? I suppose I must; yet I am accustomed to regard it as one of the most essential parts of my instrument. So valuable is the ready exchange of two object glasses, that it is almost essential where high powers are often used. I may here state incidentally that I have tried the multiplication of this rotatory movement to the extent of three and five object glasses, but have found that the strain and leverage upon the fine adjustment is too great, and therefore prefer the double nose-piece.

The polariscope is an essential part of a good microscope. It cannot be dispensed with, and should therefore not be deemed a mere accessory. Still it often is so called, and various contrivances have been suggested to reduce its cost. I should recommend, however, large prisms and thin selenites, and would by no means advise any experiments with tourmalines or Herapathites. I have tried them, and find no polariscope is so satisfactory as the Nichol's prism, with a good selenite below the object; the analyser being placed immediately behind the object glass. In the Harley Collins' microscope, the arrangement is excellent; the same slide carries the analyser and the binocular prism into the body, thus saving a great amount of screwing and unscrewing.

I would urge upon the microscopist the importance of this mode of illumination, as it frequently gives valuable delineations when least expected. Objects required for investigation, such as parasites and tissues, are often obscure and unsatisfactory by ordinary modes of illumination, owing to their great transparency. In these cases polarized light is of the greatest assistance in the delineation of structure.

Some confusion exits in the popular mind as to the comparative value of the polariscope and a mode of illumination introduced by Mr. Heys, of Machester, of a very different character, called the kalescope. By passing the rays of light through the bull's-eye, obscured by a coloured glass, and through the condenser below the stage, through a diaphragm of various coloured glasses, Mr. Heys obtained brilliant fields. Opaque objects are thus illuminated with bright lights of different colours, and are tinted with fringes of considerable beauty and delicacy. But such an illumination affords no information as to the real nature of the object, for these tints are as artificial as those which fall upon the faces of people in church from an oriel window; the colours may be beautiful, but they certainly do not improve the complexions of the worshippers; and as a microscopic accessory, the kalescope is a mockery, a delusion, and a snare.

The Sorby micro-spectroscope is a specialty which appeals only to the chemist or toxicologist. The live box and the Zoophyte trough are necessary accessories to the naturalist, and will afford ample return from the employment of several forms of them.

I do not think it necessary to enter into the merits of those contrivances which are invented for the mounting and preservation of objects; but, in the above short sketch, have endeavoured to give my experience as to the necessary desiderata for the working student.

The most complete working instrument that I have yet seen is the Harley Collins' binocular, with its appurtenances, and I doubt whether anything can be obtained of greater working value for the moderate price of $100. I shall therefore conclude with a detailed description of it:—

A compound binocular body, with two sets of eye-pieces and eye-shades; neutral tint reflector for camera lucida; rotatory glass stage, with lever movements; shutter to body to carry polarizing and binocular prisms; Brook's double nose-piece; 1 inch and $\frac{1}{4}$ inch object glasses (good); a wheel of side-light diaphragms, stops and adjusting shutter diaphragm; achromatic condenser, polariscope and double mirror; side-light reflector, and bull's-eye; together with a good mahogany box, and packing for the apparatus.

In conclusion, I would recommend a good selection of "accessories" in preference to a long series of "object glasses;" but I am satisfied that the ingenious student will contrive many of these without the aid of the optician. I have endeavoured herein to indicate the most profitable investments, leaving many excellent inventions unnoticed; for a description of such in detail, let the reader consult the last edition of "Carpenter on the Microscope."

NOTES ON THE STRUCTURE OF THE CRINOIDA, CYSTIDEA AND BLASTOIDEA.

By E. BILLINGS, F.G.S., Palæontologist of the Geological Survey of Canada.*

1. POSITION OF THE MOUTH IN RELATION TO THE AMBULACRAL SYSTEM.

The earlier Paleontologists, Gyllenhal, Wahlenberg, Pander, Hisinger, and others, described the large lateral aperture in the Cystidea as the mouth, apparently on account of its resemblance to the five-jawed oral apparatus of the sea-urchins. In his famous Monograph "Uber Cystideen," 1845, Leopold von Buch advocated the view, that it was not the mouth but an ovarian aperture; and that the smaller orifice usually situated in the apex, from which the ambulacral grooves radiate, was the true oral orifice. These opinions were adopted by Prof. E. Forbes, in his Memoir on the British Cystidea, by Prof. J. Hall, in the Paleontology of New York, and by most others who have described these fossils, including myself, in my first paper on the Cystidea of Canada, published in the *Canadian Journal* in 1854. In 1858 I re-investigated the subject while preparing my Decade No. 3, and came to the conclusions that the lateral aperture was the mouth, in those species which were provided with a separate anus; and in all others it was both mouth and anus. The small apical orifice I described as an ambulacral aperture. According to these views, the mouth of a Cystidean does not stand in the

---

* This paper was prepared for the press last December, but, as my collection of the Blastoidea was small, I thought it best to delay publication until I could examine a greater number of specimens. In January I applied to S. S. Lyon, Esq., of Jeffersonville, Indiana, and he replied that, if I would let him know what points I wished to investigate, he would supply me with the materials. On my giving him the desired information, he, in the most liberal manner, sent me a large collection—much larger than I expected to receive—consisting of numerous specimens of several genera, many of them in the state of preservation best adapted for investigation—some of them empty and others silicified in a matrix of limestone. Prof. E. J. Chapman (Prof of Geology and Mineralogy, Univ. Coll., Toronto) also kindly supplied me with several Russian Cystideans. To both of these gentlemen I here tender my thanks.

centre of the radial system, as it does in all the existing Echinodermata. On this point Prof. Wyville Thompson has the following observations:

"I can see no probability whatever in the opinion lately advocated by Mr. Billings, and which has received some vague support from the writings of De Koninck, and others, that the 'pyramid' in the Cystideans is the mouth, and that the aperture whence the ambulacra radiate is simply an 'ambulacral orifice.' Such an idea appears to me to be contrary to every analogy in the class. There can be no doubt of the existence of distinct openings for the passage of the ambulacral nerves and vessels from the calyx of many of the paleozoic crinoids; but I think we must certainly assume that in this, as in all other known instances, these vessels had their origin in an annular vessel surrounding the mouth. In the whole class the æsophageal circular canal seems to be the origin and centre of the ambulacral system. It is the first part which makes its appearance in the embryo, and is so permanent and universal that one could scarcely imagine a radiating ambulacral vessel rising from any other source. The early origin of this important vascular centre, in this annular form and in this position, evidently depends upon, and is closely connected with, the origin of the nervous system in the æsophageal nerve ring, constant in the whole invertebrate series."*

With all due deference I cannot admit that we must assume that, in the Cystidea, the ambulacral tubes had their origin in "an annular vessel surrounding the mouth." It is true that such a vessel does surround the mouth of existing Echinodermata, but there is no essential or direct physiological connection between the two organs. Their functions are exercised independently of each other. There is no organ issuing out of the alimentary canal that communicates with the annular vessel. This latter might be situated in any other part of the body and still perform its functions, provided there were a connection between it and the ambulacra. In this class, the position of the various organs, in relation to each other, and also to the general mass of the body, is subject to very great fluctuations. Thus, the mouth and vent are separated in some of the groups, but united in others, while either, or both, may open out to the surface directly upward, or downward, or at any lateral point. The ovaries may be either dorsal or ventral,

---

* Edinburgh N. Phil. Jour., vol. xiii., p. 112, 1861.

internal or external, and associated with either the mouth. the anus, or with neither. The ambulacral skeleton may be imbedded into and form a portion of the general covering of the body, or lie upon the surface, or borne upon free moving arms. In genera belonging to the same family these relations are constant, or nearly so, but are found to be extremely variable when different orders, or when remotely allied families are compared.

While preparing my Decade No. 3, I investigated this subject, and satisfied myself that in, at least, a large proportion of the paleozoic Crinoids the mouth was disconnected altogether from the radial system. A great many species might be referred to in which we can see both the centre, from which the ambulacra proceed, and the mouth; and at the same time see that they are not in the same place. A long train of reasoning is not necessary – only simple inspection. It will be quite sufficient to notice a few of these species to prove that the rule laid down by Prof. Wyville Thompson is not a general rule.

1. 2. 3.

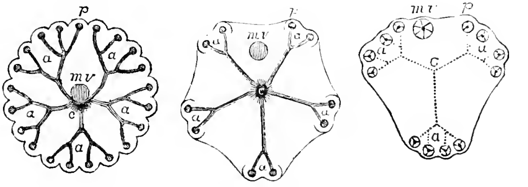


Fig. 1.—This figure is a diagram of the interior of the vault of a Crinoid, which appears to be *Batocrinus icasodactylus* (Cassiday,) a fossil that occurs in the Carboniferous rocks of Kentucky. It was sent to me by Mr. S. S. Lyon, of Jeffersonville, Indiana, several years ago. The test is in a beautiful state of preservation, and perfectly empty, so that all of the markings on the inner surface can be distinctly seen. There are twenty-one arms, arranged in five groups (*a*,) and the same number of ambulacral openings (*p*,) each just large enough to admit of the entrance of a slender pin. The mouth (*mv*) is nearly central, and close to it, on the posterior side, there is a small rudely pentagonal space (*c*) with no markings, except several small tubercles. The grooves are scarcely at all impressed, and, indeed, I think they never are so in any Crinoid, except in those which have a thick test. In this specimen their course is clearly indicated by

the remains of the thin partitions which either separated them or to which the vessels were attached. They do not run directly toward the mouth, as they would do if that organ were the centre of the ambulacral system, but to the small space (*c*) behind it, where there appears to have been situated a vesicle or some other apparatus, to which all of them were united. Whatever may have been the structure of this central organ, from which the five main grooves radiate, it no doubt represented the annular vessel of the recent Echinodermata, to which Prof. Thompson alludes.

Fig. 2—represents the structure of an *Amphoracrinus*, from the Carboniferous rocks of Ireland,—precise locality and species not determined. There are ten arms; the test is very thick; the ambulacral channels converge to the central point (*c*,) but do not quite reach it; the mouth (*mv*) is about half-way between the centre and the margin. In this Crinoid it is perfectly impossible that the mouth can be the centre of the radial system, because the two anterior passages, between which it is situated, are for their whole length tunnelled, as it were, through the substance of the plates, and only penetrate downward into the interior at the central space (*c*.)

Fig. 3—is a plan of the summit of the widely known and remarkable fossil, *Caryocrinus ornatus*, (Say.) In this species there are only three, instead of five, groups of arms. In large individuals there are from twelve to twenty free arms (but always arranged in the three groups) with a small pore at the base of each. This pore is about the size of the ovarian pore of an *Echinus*, and can only be seen in well preserved and clean specimens. The ambulacral grooves have not yet been observed, but their course is indicated by three low rounded ridges, which may be seen, in some specimens, radiating from a large heptagonal plate situated at (*c*). The mouth (*mv*) is valvular, composed of from five to eight or ten plates, and is always situated near the margin betwen the two anterior groups of arms. With the exception of the ambulacral pores there is positively no other aperture in the summit of *Caryocrinus*. If it be true that the mouth of an Echinoderm must be always situated in the radial centre, then *Caryocrinus*, and also nearly all the paleozoic genera were destitute of that aperture.

Caryocrinus is a genus which seems to form a connecting link between the Crinoidea and the Cystidea. By examining numer-ous well polished sections, I find that the structure of the respiratory areas is the same (in general plan) as that of the genera *Glyptocystites*, *Pleurocystites* and *Echinoencrinites*, as will be shown further on. The arms are also arranged in three groups, as in *Sphæronites* and *Hemicosmites*, while the mouth is valvular. On the other hand, the long cylindrical column, and the arrangement of the arms around the margin, with the ambulacral pores at their bases, are crinoidal characters.

In addition to the above, the following species may be referred to, as examples of Crinoids, with the mouth separate from the centre of the radial system.

Amphoracrinus tesselatus (Phillips).—Figured by J. Rofe, Esq., Geol. Mag., vol. ii, p. 8, f. 3. The figure represents a cast of the interior of the vault, showing the five ambulacral grooves in relief. The mouth is situated in the angle between the two anterior grooves.

Strotocrinus perumbrosus (Hall, sp.).—Figured by Meek and Worthen, in the Geology of Illinois, vol. ii, p. 188, f. 5. The specimen is 13 lines in diameter, the ambulacral centre 13 lines from the anterior margin, and the mouth 11 lines.*

Glyptocrinus armosus (McChesney sp.).—This extraordinary Crinoid is figured by McChesney in his "New Pal. Foss.," pl. 7, f. 6, and also by Prof. Hall, in the 20th Reg. Rep., N.Y., pl. 10, f. 11. The specimens are between 2 and 3 inches in length. There are ten arms, the anterior side is much inflated, the proboscis appears to be large at its base, and eccentric in its position; but instead of standing erect, it bends down to the surface of the vault, and lies upon it, crossing over to the posterior margin. Judging from the figures, the centre of the base of this organ must be distant from the radial centre at least one-fourth of the

* In April last I received from Messrs. Meek and Worthen a paper entitled, "Notes on some points in the structure and habits of the Palæozoic Crinoidea." Of all the papers relating to this subject yet published on this continent, this one, at least, so it appears to me, is the most interesting and important. It is written with a clearness and particu larity rarely to be seen in palæontological memoirs. In some respects it confirms the opinions advocated in these notes, but bears directly against my views on the question here under discussion, *i e.*—"the position of the mouth with relation to the radial centre." As I wish to give the remarkable observations of the authors full consideration, I shall not discuss them now, but delay until the September No. of this Journal. I shall only state here, that I believe that the grooves on the ventral disc of *Cyathocrinus*, and also the internal "*convoluted plate*" of

whole width of the vault. *G. siphonatus* (Hall), figured on the same plate, shows, that the anterior grooves curve round to the posterior side of the proboscis, as they do in *B. icosadactylus* above cited.

I should also state here, that two or three years ago, Mr. Meek, to whom I had written for information on this subject, wrote me that, in all cases, where he had observed the grooves on the interior of the vault, they radiated, not from the mouth, but from a point "in front of it." (This would be not in front of, but behind the mouth, according to the terminology used in these notes. I think that the side in which the mouth is situated should be called "anterior" or "oral," even although both the mouth and anus should be included in it.)

In all the species above cited, the figures (with the exception of *C. ornatus*) exhibit the relative position of the mouth and radial centre, as it has been actually seen in casts of the interior of the vault. But besides these, numerous examples may be found in the works of Miller, Austin, De Koninck, Phillips, Meek, Worthen, Shumard, Hall, Lyon, Cassaday, and others, of Crinoids whose external characters show that, in them, the mouth cannot be in the central point, from which the grooves radiate.

With respect to Prof. Thompson's theory, I freely admit that if it is true that in all the echinodermata, fossil and recent, the mouth is the radial centre, then, that aperture must be the one which I call the ambulacral orifice in the Cystidea. The views, however, advocated by me in my Decade No. 3, appear to be gradually gaining ground. As these fossils are rare, few have occasion to study them, and consequently the subject has not been much discussed since 1858, the date of the publication of

---

the Palæozoic Crinoids, with the tubes radiating therefrom, belong to the respiratory and, perhaps, in part, to the circulatory systems—not to the digestive system, as is supposed by the authors. The convoluted plate, with its thickened border, seems to foreshadow the "æsophageal circular canal," with a pendant madreporic apparatus, is in the Holothuridea. To me the final determination of this question is of much importance, for, if Meek and Worthen are right, then I must be wrong so far as regards nearly all that I have published with reference to the functions of the apertures of the Palæozoic Echinodermata. It is fortunate that the solution of this curious problem is now undertaken by men who have access to the magnificent cabinets of the geologists of the Western States, and by men who habitually discuss scientific subjects with the sole object in view of arriving at the truth.

that work. The following are the only authors, so far as I have ascertained, who have given their opinions on this vexed question during the last eleven years:—

Prof. Wyville Thompson, op. cit., p. 111 (1861), agrees with me that the lateral aperture is not an ovarian orifice, but, as we have seen, is strongly opposed to the view that it is the mouth. He calls it the anus.

Prof. Dana (Man. Geol., p. 162, 1863) recognizes it as the homologue of the simple aperture (oral and anal) in the summit of those Crinoids which have but one. This is exactly my view. [J. W. Salter agrees with Prof. Thompson, that it is the anus, not the ovarian aperture. (Mem. Geol. Sur. G. B., vol. iii., p. 286, 1866.) Prof. S. Lovén, of Stockholm, has described, in the "Proceedings of the Royal Swedish Academy," 1867, the remarkable sea Urchin, *Leskia mirabilis* (Gray), which has the mouth constructed on the same plan as that of the Cystidea, that is to say, with five triangular valve-like plates, which are imme-attached to the interambulacral plates, without the intervention of a buccal membrane. After comparing this structure with the valvular orifice of *Sphæronites pomum* (Gyll.) he says, "that the 'pyramid,' which in *Leskia* is the armature and covering of the mouth, is the same thing in the *Cystidea* is now quite certain; in the last-named group it was, doubtless, also the vent. The mouth does not lie where J. Müller and Volborth sought for it, viz.: in the centre of the ambulacral furrows; and the organ, interpreted as the vent by Volborth and von Buch, is more correctly regarded as an external sexual organ." Geol. Mag., vol. v., p. 181, Dr. Lütken's trans.]

2. *On the pectinated rhombs and calycine pores of the Cystidea.*

None of the organs of the Echinodermata have been the subject of so much speculation as the calycine pores and the so-called "pectinated rhombs" of the Cystidea. Their relations and function long remained in doubt, but there seems to be now sufficient data to shew that they are respiratory organs, and also, that they are the homologues of the tubular apparatus which underlies the ambulacra of the Blastoidea. J. Müller suggested a comparison between these peculiar organs and the respiratory pores of the *Asteridæ*. (Uber den bau der Echinodermen, p. 63, 1854.) Prof. Huxley has placed them in the same relation.

(*Medical Times*, Dec., 1856.) Eichwald calls them respiratory pores. (Lethaea Rossica, vol. 1, p. 614, 1860.) Prof. Dana says, "they are probably connected with an aquiferous system and respiration." (Man. Geol., p. 162, 1863.) Mr. Rofe, after showing that their structure is the same as that of the striated surfaces between the rays of *Codaster*, says, "From the construction of these striations on the face of *Codaster*, and on the 'pectinated rhombs' of the cystidea, may we without assumption suggest the possibility of their being respiratory sacs, lined with cilia, and constructed of a porous test, through which air from the water could pass by diffusion." (Geol. Mag., vol. ii., 251, 1865.) As for myself, when I prepared my decade on the cystidea, I gave this subject a great deal of consideration, and studied a large number of specimens, but could arrive at no conclusion satisfactory to myself. I am now convinced that the view of the above named distinguished authors is the correct one. These are respiratory organs. In all the species in which they occur, they seem to be constructed on the same general plan, *i.e.*, the interposition of an exceedingly thin partition, between the circumambient water, and the fluid within the general cavity of the body. They are usually of a rhomboidal shape—each rhomb being divided into two triangles by the suture (*c c*, figs. 4, 5,) between two of the plates. In several of the genera, the two halves of the hydrospires are reniform, ovate or lunate, and either internal or external.

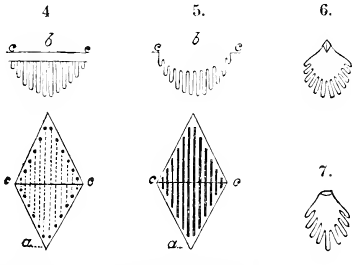


Fig. 4 Hydrospire of *Caryocrinus ornatus*. *a*, surface view; the dots around the margin are the spiracles, the small dotted lines represent the course of the flat internal canals; *c,c*, suture between the two plates; *b*, transverse section. 5. Hydrospire of *pleurocystites*. *a*, surface view: *c,c*, suture; *b*, transverse section. 6. The same with the points, *c,c*, drawn together. 7. Internal gill of a spider.

In order to avoid the use of double terms, I propose to call them "*hydrospires*," and their apertures, "*pores*," "*fissures*," or "*spiracles*," according to their form.

In *Caryocrinus ornatus* the hydrospires (fig. 4,) are of a rhomboidal form, and have each of the four sides bordered by a single row of small tubercles. Some of these tubercles have a single pore in the summit, while others are perforated with a variable number,—from two to twenty, or perhaps more,—thus becoming vesicular or spongy. It is only the apex of the tubercle, however, that has this structure, for, when this is worn off, there is only a single pore to be seen. The pores penetrate through the plates, but do not communicate directly with the general cavity of the body. Internally each hydrospire consists of a number of flat tubes arranged parallel to each other and lying side by side, in the direction of the dotted lines in fig. 4, *a*. Each tube receives two of the pores seen on the exterior—one pore at each end. These tubes are composed of a very thin shelly membrane, which, although possessed of sufficient rigidity to maintain its form, was no doubt of such a minutely porous texture as to admit of the transfusion of fluids in both directions, outward and inward. In a large hydrospire there are about twenty of those tubes. Their greatest breadth is at their mid-length, where they are crossed by the suture *c c*; and as they become narrower accordingly as their length decreases, the one in the middle projects the deepest into the perivisceral cavity. In consequence of this arrangement, when a section is made across the hydrospire at the suture *c c* fig. 4 *a*, the form *b* is obtained where *c c* is the surface of the shell, while the comb-like structure below represents the tubes.

Specimens of *C. ornatus* almost entirely empty are often found, and in some of these the internal form of the hydrospires is sometimes preserved. Those that I have seen have the form of small rhomboidal pyramids, with four slightly convex sloping faces, and composed of a number of vertical parallel plates—the casts of the interior of the tubes—the substance of the tube itself not being preserved. I have, however, several polished transverse sections, in which I think the thin walls can be seen.

The structure of the hydrospires is such, that there can scarcely be any doubt that they are respiratory organs. The sea-water entered through the pores, and ærated the chylaqueous fluid, contained in the perivisceral cavity, by transfusion through the exceedingly thin membranous shell that composed the walls of the tubes. The number of pores varies with the size of the individual. In large specimens these are from 800 to 1000.

It has been stated by some authors that the pores were passages for the protrusion of internal organs connected with the vitality of the animal. The fact, however, that the pores do not penetrate into the general cavity of the body, disproves this theory; and, moreover, through many of the tubercles—those with a vesicular and spongy summit, such protrusion would be utterly impossible.

In *Caryocrinus ornatus* there are thirty hydrospires arranged as follows:

1. Ten at the base—half of each on a basal plate, and the other half on one of the subradials, their longer diagonal vertical.

2. A zone of six around the fossil at the mid-height—their longer diagonals horizontal. These seem to be imperfectly developed, for, on the inside, the tubes occupy only a small space in the centre.

3. A third band of fourteen—two of them with their longer diagonals vertical, and the others arranged in six pairs, the diagonals of each pair inclining toward each other, upward, at an angle of about 30°. There are only three interradii in *Caryocrinus:* the mouth is placed in one of them, and the two hydrospires with vertical diagonals in the other two.

In *Pleurocystites* the hydrospires are also of a rhomboidal form, but instead of having the tubular structure of *Caryocrinus*, they consist of a number of parallel inward folds of an exceedingly thin part of the shell. These folds no doubt represent the tubes of *Caryocrinus.* If we grind down a hydrospire of this latter, so as to remove all the shell, and expose the edges of the tubes, it then exhibits precisely the same form as fig. 5 *a*, *i.e.*, the form of a rhomb, longitudinally striated at right angles to the suture, and with no pores. The tranverse section in *Pleurocystites* only differs from that in *Caryocrinus* in having no shell between the points *c c*. In the hydrospire of *Pleurocystites robustus*, of the Trenton limestone, we have the commencement of the formation of an internal gill with a single spiracle. The surface is not flat, as it is in many species, but concave, as shown in the section; and it is evident that if the concavity should be carried further, and, at the same time, the points *c c* made to approach each other, the effect would be to produce an elongated sack, deeply folded on one side, and with a fissure extending the whole length on the other side. The transverse section of such a sack would be fig. 6, the same as in *Pentremites*. Again, if we contract the four sides, gradually curving them outward at the same time, but not diminishing the superficial extent of the walls of the folds, although altering the form to correspond with the decreasing aperture, the result would be a deeply folded, flask-shaped sack, with a small round orifice like fig. 7, which is the internal gill of a spider.

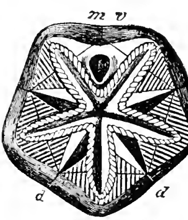
In *Palæocystites tenuiradiatus*, a species very characteristic of the Chazy limestone, the whole surface (in the condition in which the fossil is usually found) is covered with deeply striated rhombs, the fissures being deepest where they cross the suture, and growing gradually shallower as they approach the centre of the plates, where they die out altogether. Detached plates occur in vast abundance, but no perfect specimens have ever been found. I discovered, however, several fragments of the body sufficient to give the general form, and to show that, when the surface is perfect, all these fissures are completely covered over by a very thin shell, and that, when they cross the suture, there is a small pore in the bottom of each, which penetrates to the interior. The rhombs of this species are thus external hydrospires. The fissures seen in the ordinary weathered specimens are the remains of flat tubes, like those of *Caryocrinus*, situated on the outer instead of the inner surface of the test. The chylaqueous fluid passed outward through the pores and filled the tubes, to be ærated through the thin external covering by the surrounding water. In *Caryocrinus* the water passed inward, through the pores, into the tubes, and ærated the fluid within the general cavity of the body.

The discovery that the fissures and pores of the Cystidea, do not communicate directly with the general cavity of the body is entirely due to Mr. Rofe. After reading his highly important paper, I re-examined a great number of specimens, and found sufficient to confirm his observations.

3. *On the genus Codaster.*

Every author who has described a species of this genus, has remarked the peculiar striated areas in the interradial spaces. Prof. McCoy, the founder of the genus, pointed out their resemblance to the hydrospires of the Cystidea; but it was Mr. Rofe who first showed that they were also identical in structure therewith. On comparing one of those with that of the cystidean *Pleurocystites*, fig. 5, we at once perceive that they are the same in the external form, while Mr. Rofe's figures show that the section at *d d* has the structure of fig. 9, which only differs from fig. 5 *b* in being straight above instead of concave, and in being divided into two parts. This division is the result of the position of the arm which cuts the hydrospire in two, in a direction parellel to the fissures. By drawing the points *d a* and *a d* together, we get fig. 10, which is, in general plan, a section across one of the ambulacra of a Pentremite. On examining nearly all the published figures of species of this genus, I find that there is a series of forms which exhibit a gradual passage from those with the hydrospires, almost entirely exposed, as in fig. 8, through others in which they are crowded more and more under the arms, until at length they become altogether internal.

8.



9.

10.

11.

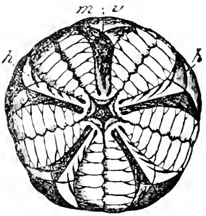


Fig. 8. Summit of *C. acutus* McCoy, *m v* mouth and vent; *d d* suture across the posterior hydrospire. 9. Section across the hydrospire from *d* to *d*, at *a* is the place of the arm. 10. The section contracted, as in fig. 6. 11. Summit of *Pentremites caryophyllatus* De Koninck.

In *C. acutus*, fig. 8, only a small portion of the hydrospire is concealed under the arm. In *C. Canadensis*, a new species, lately discovered in the shales of the Hamilton group in Canada West, each of the four interradial spaces, in which the hydrospires are placed, is excavated in such a manner as to form *a small triangular pyramid*, with two of its faces sloping down toward the sides of the two adjacent arms. On these two slopes are placed the hydrospires, which appear to have one fissure entirely under, and another partly under the arm, five others being fully exposed. S. S. Lyon has described a species under the name of *C. alternatus* in the "Geology of Kentucky," vol. iii., p. 494, from the Devonian rocks of that State, which closely resembles *C. Canadensis*, but is still distinct therefrom. Speaking of the structure of the summit, he says: "the depressed triangular intervening spaces are filled with seven, or more, thin pieces, lying parallel to the pseudambulacral fields, articulating with the summit of the second radial, and the prominent ridge lying between the pseudambulacræ. These pieces were evidently capable of being compressed or depressed; the "*point*" at the lateral junction of the second radials is in some specimens folded over toward the mouth, so as to entirely obscure these triangular spaces by covering them." This important observation proves that, even in the same species, the hydrospires may be either partly or wholly concealed under the arm. The "*point*" to which Mr. Lyon alludes is seen above, in fig. 11, just below the letter *b*. It is the same as the "*small triangular pyramid*" in *C. Canadensis*. It is evident that (supposing the shell to be flexible) if these points were to be drawn inward, the movement would gradually cause what remains exposed of the hydrospire to be covered, until at length it would be entirely concealed under the arm. The five points would then be situated in the angles between the five ambulacra, as they are in the genus *Pentremites*, fig. 15. The concealment of the hydrospires may also be the result of the widening of the arm. This is well known in *P. caryophyllitus* DeKoninck (*P. Orbignyanus* according to Roemer), *P. Schultzii* De Ver., and several other species. In these the apices of the pyramids remain near the margin, but the hydrospires are nearly covered by the wide arms. This is shown in fig. 11, where the ends of the fissures of the hydrospires are seen along the sides of the angular ridges which extend from the apices of the pyramids to the angles between the arms. I do not think that such species can be referred to *Pentremites*, and if I had specimens before me, instead of figures only, I would most probably institute a new genus for their reception.

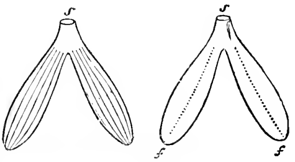
Our specimens of *C. Canadensis* are well preserved, and show the characters of the arms perfectly. After many careful examinations under the microscope, I can state positively that in this species the so-called "pseudambulacral fields" have no pores.

The markings that have hitherto been mistaken for ambulacral pores in *Codaster* are not pores, but the small pits or sockets which received the bases of the pinnulæ. The rays therefore in this genus are not "pseudambulacral fields" in the sense in which that term is used in descriptions of species of *Pentremites*, but simply recumbent arms, identical in structure with those of the cystidean genera *Glyptocystites*, *Callocystites*, *Apiocystites*, and others. They lie upon the surface of the plates which constitute the shell of the animals—not imbedded into them, as in *Pentremites*. The large lateral aperture is both mouth and vent, and the central opening, heretofore called the mouth, is the ambulacral, or, more properly, the ovarian orifice. As, therefore, *Codaster* has the arms of *Apiocystites*, the hydrospires of *Pleurocystites*, and the confluent mouth and vent, common to all *Cystideans*, I propose to remove it from the *Blastoidea*, and place it in the order *Cystidea*.

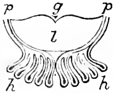
4. *On the genus Pentremites.*

In *Pentremites* the hydrospire is an elongated, internal sack, one side of which is attached to the inside of the shell, while the side opposite, or toward the central axis of the visceral cavity, is more or less deeply folded longitudinally. There are two of these to each ambulacrum, attached along the two lines of pores. There appears to be a fissure extending nearly the whole length, in the direction of the dotted line *f*. One edge of this fissure is attached to the lancet plate along one side of the line of pores; the other to the shell, on the other side of the row. The pores all enter the hydrospire through this fissure. There are ten hydrospires, connected together in pairs, each pair communicating with the exterior through a single spiracle. The arrangement of the folds varies according to the species. In *P. Godoni* there are five folds, the outer sides of which are close up to the inner side of the lancet plate, fig. 13. In a specimen of *P. obesus* Lyon, nearly two inches in diameter at the mid-height, the hydrospires extend inward about three lines, the main body being about one line from the lancet plate. There are five folds, each two lines deep; and thus, if the thin shelly membrane, which constitutes the wall of the hydrospire, were spread out, it would have a width of 22 lines,—and the ten together would form a riband, about 18 inches in length, and nearly two inches wide. The object of the folding is, of course, to confine this large amount of surface to a small space, an arrangement which at once proves the function to be respiratory. Of those figured by

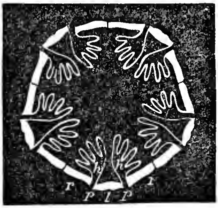
12.



13.



14.



15.

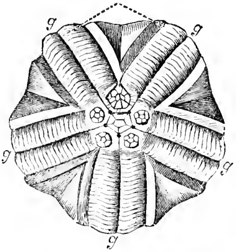


Fig. 12.—Diagrams of one pair of the hydrospires of a *Pentremite*,—*a* the inner side; *b* the outer, or side attached to the shell; *f* the fissure. 13. Section across an ambulacrum of a specimen of *P. Godoni*, enlarged 3 diameters.—*l* lancet plate; *g* ambulacral groove; *p p* pores leading into the hydrospires; *h h* the two hydrospires, in transverse section. 14. Ideal figures of a transverse section through an entire specimen, showing the ten hydrospires.—*l* one of the five lancet plates; *p p* pores; *r r* the two branches of one of the radial plates. 15. Summit of *P. conoideus*,—*a* anterior side; *g* ambulacral grooves (copied from Dr Shumard, but with the ovarian pores added).

Mr. Rofe, *P. ellipticus* Sowerby appears to have only one fold, *P. inflatus*, id., shows eight folds in one, and eleven in the other hydrospire of the same ambulacrum. Another specimen, figured by Mr. Rofe, under the name of *P. florealis* Say, has five folds, situated at a distance from the inner surface of the lancet plate, as in *P. obesus*. From the form of the organ, I think that Mr. Rofe's specimen cannot be the species called *P. florealis* by Say.

If it be granted that these organs are respiratory in their function, then their five apertures should be called *spiracles*,—

not "ovarian orifices." The large anterior aperture would thus be the *oro-anal spiracle*. Applying this system of terminology to other groups,—the so-called ovarian orifice of the Cystidea, the homologous aperture of *Nucleocrinus*, *Codaster*, *Granatocrinus* and of the Paleozoic Crinoidea generally (but not of the recent forms), should be styled the *oro-anal orifice*.

I think that the side of an Echinoderm in which the mouth is situated should be called "anterior" even although the anus and the mouth be confluent in one orifice. Most star fishes have but one aperture for mouth and vent, and yet it is called the mouth by naturalists generally. Why not call the under-side of a star-fish "the anal or posterior side," and the central aperture the "anus?"

Dr. B. F. Shumard has shown (Trans. Acad. Nat. Sci. St. Louis, vol. 1, p. 243, pl. 9, fig. 4,) that in perfect specimens of *P. conoideus* Hall, the six summit apertures are closed by several small plates. In a specimen of the same species sent me by Mr. Lyon, in which those plates are partly preserved, I find that there is a small pore in each of the five angles of the central apertures. The five ambulacral grooves enter the interior through these pores. I have copied his figure, but modified it by adding the pores, fig. 15. He also found that the summit of *P. sulcatus* Roemer, was covered with an integument of small plates, arranged in the form of a pyramid. From these facts he infers that in all the pentremites the summit apertures will be found in perfect specimens, to be closed in a similar manner.

Dr. C. A. White, at present State Geologist of Iowa, in a paper on the same subject, (Bost. Jour. N. H., vol. 8, p.p. 481—488,) describes *P. Norwoodii* Owen and Shumard and *P. stelliformis*, id., as having a similar structure—but he goes further,—he considers the central orifice "*not to be the mouth*," and I believe that he is the first naturalist who ever published such an opinion. His idea of its function is thus expressed: "It seems more probable that, as the ova were germinated within the body, they found their exit through the central aperture, and were conveyed along the small central grooves of the pseudambulacral fields before mentioned, beneath the plated integument, to the bases of the tentacula, where they were developed and discharged, as in the true crinoids." I perfectly agree with Dr. White in this view. The central aperture is not the mouth; in fact, it is not a natural orifice, but a breach in the summit, caused by the destruction of a portion of the vault. The true natural orifices of this part are those that I have discovered in *P. conoideus* as above mentioned. They are the homologues of the *ovarian pores* at the bases of the arms of *Caryocrinus* and in part, as I shall show in another part of these notes, of the ambulacral orifices of the true crinoids.

With regard to the structure of the calyx of *Pentremites*, it is generally supposed that there are only three series of plates—the basal, radial and interradial. Mr. Lyon has advanced the opinion that there are three small plates below those now called the basals (Geol. Ky., vol. iii., p. 468, pl. II, fig. 1*c*). I have examined a number of specimens with reference to this point, and I think he is right. There are three small pentagonal basals, the two upper sides of each are excavated to receive the sub-radials, *i.e.*, those at present designated "the basals." They are, in general, anchylosed to the subradials, but in one of Mr. Lyon's specimens that I have seen, they are distinctly separate. *

(To be continued.)

NOTES ON THE SMALL CABBAGE BUTTERFLY, PIERIS RAPÆ.

By A. S. Ritchie.

The effects produced by insects, either beneficial or injurious to man, have not been studied by the people as the subject deserves. Their benefits are taken as a matter of course, whether in their capacity as scavengers, fertilizers of plants, or as producers of silk, dyes, wax, honey, &c.; but when injuries, which affect either our persons or our property, directly or indirectly, are caused by the presence of insects, the "hue and cry" begins.

More natural history ought to be taught in schools, so that the habits of the many creatures composing this world of ours might be better known and understood by the youth of the country.

This article, with the author's permission, is reprinted from the *American Journal of Science and Arts*, for July, 1869.

Kirby says, in connection with the injuries caused by insects: "You will be disposed to admit, however, the empire of insects over the works of creation, and to own that our prosperity, comfort, and happiness are intimately connected with them, and consequently that the knowledge and study of them may be extremely useful and necessary to promote these desirable ends, since the knowledge of the cause of any evil is always a principal, if not an indispensable, step towards its remedy."

The object of the following few notes is to give some account of an injurious insect, which has made its appearance in Canada within the last nine or ten years, namely, *Pieris Rapæ, Linn.*, or the small cabbage butterfly of England. As a colonist, it thrives; and to all appearances there is no fear of the race dying out. This country, for some reason or other, is peculiarly fitted for the development of certain introduced insects, which do not thrive so well in Europe. For instance, another butterfly, *Vanessa Antiopa*, or the Camberwell Beauty, of England, is one of our most common insects, while there it is rare. *Pieris Rapæ* threatens also to become very common here.

"This insect was first introduced from Europe into Quebec about 1859 or 1860. It soon became abundant within a circle of forty miles round that city, and has even spread into Maine and Vermont, along the line of railway leading from Quebec."*

The first notice of its appearance in Canada was by Mr. Couper, in a paper on "The Genera and Orders of Insects," read by him before the Literary and Historical Society of Quebec, on the 20th April, 1864.

He says:—"Another species, supposed to be the *Pieris Rapæ* of Europe, is one of the most common butterflies of this neighborhood. Four years ago (1860) I captured the first specimen of this species in Quebec, and then looked on it as a great rarity, but, unfortunately, I cannot do so now. In England it is called the Turnip Butterfly, where it appears at the end of April or middle of May, and the beginning of July or middle of August; therefore the species is double brooded in England, and, as far as I have studied the introduced butterfly, it is the same with us. Here it appears to have discarded its British food plant and taken to our cabbages. The chrysalides can be found now on any garden fence where cabbages were grown. It would be very

* Packard's "Guide to Insects."

interesting to ascertain how far this butterfly has penetrated the country. Westwardly it has not reached Montreal, and it has not been traced south of Point Levis; eastward it has not been taken at St. Anne's, where a collector of Lepidoptera resided at the time of its occurrence here; north-west it appears to have made the greatest inroad, for it has been noticed at a distance of thirty miles in that direction. I am safe in stating that five years have not elapsed since this butterfly was introduced into Lower Canada, and it is now brought before the public as an unprofitable addition to our insect fauna."

The first paper on *Pieris Rapæ* was read by S. J. Bowles, Secretary of the Quebec branch of the Entomological Society of Canada, on the 7th July, 1864, wherein he describes the species as first captured by him in the vicinity of Quebec in 1863.

"Its identity with the English species was established by Mr. Saunders, of London, Ont., and Mr. S. H. Scudder, of Boston, Mass."—(See Bowles on *Pieris Rapæ*, *Canadian Naturalist*, Vol. 1, New Series, 1864, p. 258.)

I first noticed the insect in Montreal about the 26th May, 1867, and again in August of the same year. In 1868 the increase was very visible,—they could be seen flying in numbers about the streets, alighting on any weeds growing by the footpaths.

The appearance of the insect was the subject of much discussion among a few of my entomological friends at the time. On comparing it with Stainton's description in his "British Lepidoptera," I found it to be sometimes smaller, although resembling in all particulars his description, which I will give: "Expanse of wings, 1" 10"' to 2" 2"'; wings white; fore-wings faintly blackish at tip, and bare; male spotless, or with one blackish spot; female, with two black spots and a clouded dash on inner margin; hind wings; a black spot on costa. Larvæ green, irrorated with black; a row of yellow spots on each side in a line with the spiracles." Mr. Stainton adds: "This insect in its larva state feeds on cabbage, mignonette, tropæolum, also on various cruciferæ." The insect may be easily known from the Canadian species of *Pieris*, *P. oleracea* (the "grey veined white"), and *P. protodice*, by the blackish tips of its wings and the spots; by these characters it may be told from the genus *Colias* of the same family. The first are called the "whites," the latter the "yellows."

The fecundity of insects makes them formidable as enemies to man when they attack his crops. I shall quote a few illustrations of this fact from entomological records: The loss sustained in the turnip crop, in Devonshire, in 1886, was not less than £100,000. This was caused by individuals of the genus *Haltica*, or turnip flea, belonging to the Beetles.

The loss sustained by the hop growers in England, when the *Aphides*, or plant lice, prevail, is great, the difference to the revenue in the amount of duty on hops being often as much as £200,000 per annum.

The editor of the *American Entomologist* writes:—" Taking one year with another, the United States suffers from the depredations of insects to the annual amount of three hundred millions of dollars."

The *Canada Farmer* says, to take one single instance:—" We are all familiar with the frightful losses occasioned by the wheat insect in past years, which, for a time, almost prevented the sowing of fall wheat throughout the most fertile portion of Canada. How many thousands, may we not say millions of dollars, were thus lost to the country? Take, again, the apple crop, which is rapidly becoming one of great importance to the Province; this very year (1868) about one-half of the apples grown in Ontario have a worm in the core,—the larva of the codling moth."

And now another insect, in the shape of *Pieris Rapæ*, threatens destruction to our cabbages and other vegetables. I have heard of its ravages as far west as Chateauguay, so that it is now spreading westward, on the opposite side of the St. Lawrence, as well as this. The question to be answered is,—Can we do anything to stop the ravages of destructive insects? Most assuredly we can, to a great extent.

The following extracts will serve to illustrate what has been done and is doing in the neighboring States with regard to injurious insects.

The *Canada Farmer* says:—" During the last year or two State Entomologists have been appointed in Illinois and Missouri. For many years skilled Entomologists have been employed, at the public expense, in New Jersey, in Massachusetts, and at Washington. For twenty years Dr. Fitch has been hard at work, as State Entomologist in New York, with what success the following statement will show:—" At a meeting of the New York Agricultural Society, Senator A. B. Dickinson gave it as his deliberate opinion that the writings of Dr. Fitch had saved, annually, to the single State of New York, the large sum of fifty thousand dollars; and, so far as appears from the record, not a single dissentient voice was raised against this most remarkable assertion." The article concludes thus:—"Surely Canada, with her world-renowned Geological Survey, cannot long afford to neglect the encouragement of this most utilitarian pursuit."

As all farmers and agriculturists are not likely to become Entomologists, it is the duty of Natural History Societies to spread such knowledge as they possess regarding insects and their habits, their benefits or injuries, direct or indirect, so that the benefits from insects may be reaped, and the injuries averted.

The following means are suggested for keeping in check the cabbage butterfly:—As has been shown, the insect produces two broods a year, which appears, first, as eggs; secondly, as larvæ, or caterpillars; then as chrysalides; and, lastly, appears the imago, or butterfly. In the egg state of these insects little can be done to eradicate them. The larval state of most butterflies consists of four or five periods, or ages. When they come out of the egg they immediately commence eating till the first skin is too small for the body. They cast this skin, a new one having been formed underneath the old one. This takes place during the other periods, until they arrive at full growth. The caterpillar state affords opportunities for thinning them out by what is called hand-picking. It would not be a hard matter to pick them off cabbages in a small garden, but, when fields containing acres are to be taken into account, the task becomes very different, although hand-picking has been very beneficial, as the following instance will show.

In the transactions of the Entomological Society of London appears the following:—"A striking instance of the use of hand-picking (in most cases by far the most effective mode of getting rid of insects) appeared in the *West Briton*, a Provincial paper, in 1838, stating that Mr. G. Pearce, of Penmare Goran, had saved an acre and a half of turnips, sown to replace wheat destroyed by the wire worm, and attacked by hosts of their larvæ, by setting boys to collect them, who, at the rate of three halfpence per hundred, gathered 18,000, as many as fifty having been taken from one turnip."

Thus, at an expense of only twenty-two shillings and sixpence, an acre and a half of turnips, worth from £5 to £7 sterling, or more, was saved; while, as the boys could each collect 600 per day, thirty days' employment was given to them, at 9d. per day, which they would not otherwise have had.

When the caterpillar has attained its full growth it changes into a chrysalis, which may be found attached to fences and hothouses in the immediate neighborhood of the fields where the cabbages are grown. In my opinion this is one of the best times for their destruction. Half a dozen boys could gather and destroy thousands in a day for a small remuneration. A friend of mine, in the city, has gathered handfuls of them in this stage, and destroyed them.

A great deal may be done by netting them in the perfect or butterfly state, which, no doubt, is the best and surest method. Bring the boys into the field with nets, and, by capturing all they see, they prevent the depositing of the egg, and thus cut off the supply. When the larvæ have once got among the plants, to any extent, the destruction commences. When they appear in great numbers the best plan would be to plough up, and plant neither cabbages nor turnips on the farm, for a time, in the infested localities. This, of course, would be only in extreme cases.

Encourage the small birds on the farms: abstain from their destruction: they are undoubted benefactors of the agriculturist. It would also be a wise plan to turn fowls into the fields, and allow them full scope: they will give a good account of themselves. Nature will also help, no doubt. The innumerable ichneumons will soon find out the larvæ of the cabbage butterfly; in fact, they have already found them this summer. Their operations, on our behalf, will be felt a few seasons hence.

Insects, when first introduced into new countries, may find this food more juicy or better suited to their tastes than in the countries they left, and, therefore, commit greater havoc; besides, there are what are termed "insect years,"—that is, a certain species will be noticed in greater abundance one year than another. This may be accounted for by the mildness or severity of the season; or it may be influenced, to a very considerable extent, by "parasitic attacks," which latter is one of the many ways which nature takes to keep in check the many varieties of insects. We believe firmly that all insects, as well as other animals, have their peculiar parasite, and, in the majority of cases, are preyed upon by those creatures internally and externally. The most beneficial parasites to us, in connection with insect pests, are the ichneumons.

One of the reasons that *Pieris Rapæ* does not commit such ravages in England, is, no doubt, owing to the fact—one well attested by Entomologists—of the powerful check kept on this species in Europe by ichneumons.

Reaumur writes as follows:—"Out of thirty individuals of this common cabbage caterpillar, put into a glass to feed, *twenty-five* were fatally pierced by an ichneumon (*Microgaster globatus*)." Such a percentage of mortality must tell on a colony of caterpillars.

The question may here be asked, after the recommendation of hand-picking, netting, &c., is nature doing anything to help us in the matter of the cabbage butterfly in Canada? We answer in the affirmative. Any observer of the larvæ on cabbages will have noticed a small four-winged fly very actively running over the plants, looking as if it had lost something, running down this rib, then up that, under one leaf, then flying to another. By close attention you will see the cause of this uneasiness on the part of this little *hymenopter*, for so we call her, as she belongs to the Hymenoptera, or membranous winged order of insects. She is hunting the caterpillars of the cabbage butterfly, for the purpose of depositing her egg or eggs in their bodies. This she does by means of her ovipositor, piercing the body of the creature—but not in a vital part—so that her young may have a nidus where food will greet them immediately on their coming out of the egg. They then live on the juices of the caterpillar until they (the parasites) undergo their metamorphosis and attain the imago or winged state, when they eat their way out of the caterpillars' bodies and fly away. This is given as an illustration of one of Nature's methods of keeping in check noxious caterpillars. We noticed this circumstance last summer in connection with the cabbage butterfly. In all probability the preponderance of ichneumons will so affect the prospects of this insect that in a year or two they will become good colonists, and instead of producing want and famine they will ornament our Canadian landscape by their airy gambols and spare the cabbages.

Still farmers and gardeners should not leave all to nature, but would do well to use all precautions, those recommended here, or any other, which will be beneficial in keeping them in check.

There is no one particular remedy. The combined experience of all interested is necessary for the removal of the evil, by watching the habits, and thus learning more of the natural history of these creatures.

In conclusion, we would say that in a new country like this, where immigration is going on among *insects* as well as among men, it should be part of the duty of the Minister of Agriculture to know what insect emigrants may be taking up their abode with us to the injuries of our crops. And to this end it would be a wise step to appoint competent Entomologists throughout the Dominion (an appointment which has been so beneficial in the neighboring States) to warn the Agriculturist of his many enemies among insects and the best mode of getting rid of them.

In the last number of the *Naturalist* appeared a paper, by Dr. Sterry Hunt, on "The Probable Seat of Volcanic Action," which was reprinted from the *Geological Magazine* for June, and should have been credited to that journal, to which it was originally communicated. This explanation is rendered the more necessary from the fact that the paper in question is reprinted in *Scientific Opinion* for October 20, and there credited to the *Canadian Naturalist* as having been read before the Natural History Society of Montreal,—a very natural though incorrect inference, from the fact that the paper, by an oversight, appeared in our pages as an original communication.

MEETING OF THE BRITISH ASSOCIATION AT EXETER.

Want of space forbids our giving a detailed account of the proceedings at this interesting meeting. We have thought it advisable to give summaries only of some of the papers in the departments of Geology, Zoology and Botany. The next meeting will be held at Liverpool, with Prof. Huxley as President:—

GEOLOGY AND PALÆONTOLOGY.

THE DEVONIAN GROUP CONSIDERED GEOLOGICALLY AND GEOGRAPHICALLY, BY PROFESSOR GODWIN-AUSTEN.

This paper dealt with the probable distribution of land and water during the Devonian period, its fossil Zoology and Botany, and the physical changes which have taken place subsequently. Mr. Godwin-Austen briefly and popularly sketched the order of successive sea-beds, and showed that these represented geological periods. Of these the Devonian group was amongst the earlier. Our rocks, sandstone or otherwise, were simply sea-bottoms, and the geologist only referred them to their original condition in order that he might deduce their physical and zoological history. The Devonian rocks had a wide geographical extent in Europe, Asia, and America. In the latter country there was a broad band of old Silurian rocks which existed as dry land during the Devonian epoch. In Great Britain the Devonian rocks had a general direction from north-east to south-west. From the nature of the fossil fishes of these rocks, Mr. Austen came to the conclusion that the Old Red Sandstone was of fresh-water origin, as of all the existing fishes only six genera were related to the Ganoid family, and all of these were essentially of fresh-water habits. The dry land was covered with a series of great fresh-water lakes, like those of North America. Besides the strata deposited along the bottoms of these lakes there was a series of vast marine deposits, which are termed Devonian. The Old Red Sandstone group was a very perplexing one, and passed down into the Silurian at its base, and into the Carboniferous towards its upper portion. The most northern portion of Devonshire where rocks containing true Devonian fossils came up was Lynton. The author then traced the easterly direction of the Devonian group, showing how they cropped up beyond the chalk of Boulogne, and thence across Belgium and Prussia, into Bohemia and Russia. Prof. Phillips said the division of Old Red Sandstone as fresh-water, and Devonian as marine, made by Mr. Godwin-Austen, was very distinct. The former extended towards the north, and the latter towards the south. He expressed himself, however, as opposed to the fresh-water origin of red sandstones, simply because few fossils were found in them. Mr. Pengelly said he had found 300 specimens of Pteraspidian fishes in the Devonian rocks, as well as Cephalopoda. Mr. Edward Hull, F.R.S., expressed his hope that geologists would withhold their decision on Mr. Godwin-Austen's separation of the Old Red Sandstone and Devonian, and pointed out the three subdivisions of these formations in various places. He thought the evidence of fossil fish was not sufficient to establish the fresh-water origin of the Old Red Sandstone.

THE GRANITE OF THE NORTHERNLY AND EASTERNLY SIDES OF DARTMOOR, BY G. W. ORMEROD, F.R.S., &c.

This short paper was intended to serve as a guide to geologists visiting Dartmoor. Schorl and tourmaline are of frequent occurrence in the granites. South of Torquay are rock basins, of various shapes and sizes. Throughout the whole of Dartmoor the granite is much jointed, and sudden changes in the joints and stratification frequently occur. On the north of Dartmoor, near Belston, the granite bends under schistose rocks, and the present contour of the country may be attributed to this phenomenon. It was an uncertain point whether the Dartmoor granite was all of one age, but the "elvans," or veins crossing the mass, were of undoubtedly later age. A vein of fine porphyry may be seen on the road from Okehampton to Exeter. Mr. Ormerod said geologists visiting Dartmoor could not help asking what had become of the overlying rock masses, and what had been the agents which had cut the granite down to its present form. Mr. Pengelly had stated that some of the beds in the Isle of Wight had been formed out of the wear and tear of the granites of Dartmoor. The author had not found any glacial scratchings, but last year Professor Otto Jorell had visited with him the gravels near Hunt's Tor, and that geologist had declared it as his firm opinion that these were remains of *moraines*.

SOURCE OF THE MIOCENE CLAYS OF BOVEY TRACEY.

W. Pengelly, F.R.S., F.G.S., read a few notes on the above subject. All the beds of clay and sand at Bovey thin out towards Dartmoor. Most of these were formed of disintegrated granite. The clays are interstratified with the lignite, or coal beds, and the author thought that Mr. Maw and himself had referred to two different beds.

NOTES ON THE BRACHIOPODA HITHERTO OBTAINED FROM THE "PEBBLE-BED" OF BUDLEIGH SALTERTON, BY T. DAVIDSON, F.R.S., F.G.S.

The author had examined the specimens forwarded to him by Mr. Vicary and others. None of the rocks known to occur in England presented such a fauna, although in Normandy we have a bed of Silurian rock extant containing the same. Mr. Davidson could not account for the extraordinary mixture of Devonian and Silurian forms, except by supposing that some old land had been broken up. There were ten Silurian, ten Devonian, and fifteen undescribed species of brachiopoda. Mr. Winwood, Mr. Vicary, and Mr. Godwin-Austen afterwards spoke on the subject, the latter gentleman entering into a popular detail of the occurrence of these fossils. Mr. Salter was of opinion that when these "pebble-beds" were formed there was no break between England and Normandy. The fossils were derived from rocks which occur nowhere else than in Normandy. Mr. Davidson thought that at least one-half of the fossils found in the pebbles had been derived from local sources. Mr. Austen said that Lower Silurian fossils were found on the south coast of Cornwall. Mr. Pattison thought that the remarks which had been made only bore out the theory of Mr. Godwin-Austen, that a reef of palæozoic rocks had formerly stretched across what is now the English Channel. Mr. Etheridge pointed out that the Budleigh pebble-bed lay on the trias of Teignmouth, and thought that the pebbles had come from Normandy.

THE SOURCE OF THE QUARTZOSE CONGLOMERATES OF THE NEW RED SANDSTONE OF CENTRAL ENGLAND, BY EDWARD HULL, F.R.S., F.G.S.

The author referred to a supposed statement of Dr. Buckland, that the quartzite pebbles of the New Red Sandstone had come from the rocks of the Lickey, in Worcestershire. That geologist, however, only said they were very similar to them. Mr. Hull then proceeded to trace the probable origin of these pebbles. In South Lancashire and Cheshire these conglomerates attained a thickness of six and seven hundred feet. They were thicker as we proceeded northerly, and the author therefore thought we ought to look in the latter direction for their source. He produced pebbles from various counties, all of them liver-colored quartzites. One peculiarity about them was their well-rounded, water-worn form, never sub-angular. The author thought that these pebbles had gone through at least two periods of trituration, and he had some time ago come to the conclusion that all were originally derived from the Old Red Sandstone formation. This idea was verified when he went to study the old red conglomerates near Loch Lomond; and he thought the question of the origin of the new red conglomerates of Central England might now be regarded as settled. Mr. Maw, Mr. Pengelly, Mr. Godwin-Austen, and Prof. Huxley then continued the discussion of the subject, Mr. Austen objecting to the idea that a great amount of time is required to produce well-rounded shingle. Professor Huxley objected to the idea that a shingle bed could thicken seawards.

FRESH-WATER DEPOSITS OF THE VALLEY OF THE RIVER LEA, IN ESSEX, BY MR. HENRY WOODWARD, F.G.S., F.Z.S., OF THE BRITISH MUSEUM.

Certain excavations made by the East London Water Works Company had revealed the presence of shell marl, on the Walthamstow Marshes. The marl was accompanied by vegetable remains, and bog iron ore. All the shells are recent, and the most notable fact connected with the bed was the presence of bronze spear-heads, arrow-heads, knives, &c. These were accompanied by bones of man, wolf, fox, beaver, wild boar, red-deer, roebuck, fallow-deer, *rein-deer*, &c., as well as of the sea-eagle, and fishes. As late as the year 1700 the entire tract was forest-land. In 1154 the same country is described as abounding in wolves, wild boar, wild bulls, &c. Mr. Woodward thought that the maintenance of a Royal Forest had been the means of preserving this bed. In the deep cutting of the bed remains of the Mammoth were met with. The author thought much of the deposit might fairly be ascribed to the beaver working and making dams in the old valley of the Lea. Mr. Pattison said the implements were found in the upper, or historical portions of the beds mentioned. Mr. Woodward, in reply, said the discovery of the beaver, red-deer and rein-deer, within seven miles of London, was something astonishing.

EXPLORATION OF KENT'S CAVERN.

Mr. Pengelly, the Secretary of the section, read the fifth report of the Committee on the Exploration of Kent's Cavern, with notes on the Mammalian remains, and described the locality and the position of the different portions or apartments of the cavern. In that part of the cavern known as the vestibule is a layer of black soil from two to six inches thick, known as the Black Band. In that Black Band were found 326 flint implements, chips, bone tools, &c., and bones of extinct animals, some of which were partially charred. The theory was that this formed a portion of the residence of an ancient British family. To test the disputed question whether it could be used as a cooking place without suffocating the animals, half-a-dozen fagots were lighted, and five persons who acted as the judges decided that the objection on that score was not tenable. All the bones which had been collected had been separately packed and labelled, showing their original position. Over 50,000 bones were collected, and all separately marked. When they came to be examined there was found among them a bone needle with an eye capable of receiving small twine. It was broken, but was supposed to have been originally two-and-a-half inches in length. It had been exhumed on the 4th December, 1866, and belonged to the Black Band beneath the stalagmitic floor. A bone harpoon, or fish-spear, was also found beneath the Black Band. The report next gave an account of the researches made during the present year. Mr. Pengelly mentioned that there was a perennial spring which a mercantile company had proposed to utilize for the purposes of a brewery, using the cavern as their store for "the beverage" which they brewed. He described the narrow passage leading from certain portions of the cave to other portions. These were, in some cases, so small as to require explorers to progress in a recumbent position and by a vermicular motion. In the cavern were found initials of individuals, and names and dates. One remarkable one was "Robert Hedges, of Ireland, February 20, 1688," and it was believed that the date was genuine. It was inscribed on the stalagmite, and proved that the drip of two-and-a-half centuries had not been enough to obliterate the inscription. Mr. Pengelly caused some amusement by exhibiting a collection of modern articles found in the lake, which had been emptied, consisting of such things as a ginger beer bottle, a mutton bone, an oyster shell, a hammer, a chain, candle, and candle sconce. An elephant's tooth was also found. They had also, this year, made a most important advance in their researches by the discovery of evidence of the existence of man at a point in the remote portion of the cavern—" the lower cellarage," as Mr. Pengelly called it. On the 5th of March last a flint flake was found, which there could be no doubt had been produced by human agency. The flake has been laid before Mr. Evans, F.R.S., who had examined and reported upon it. He said it was undoubtedly of human workmanship, and carried on it evidence of its having been used as a tool, the edge being slightly worn away and jagged. The hill was tunnelled by burrows of foxes and other animals. A small bell had been found—such as was used to tie on a terrier when sent into a burrow. The depth of the lake was mentioned as an average of 5ft.

Professor Dawkins added some remarks on the " dry bones " of the animals found in the cavern. The various strata of the cavern, he said, contained remains of animals of different epochs from the post-glacial upward. During the time the Black Band was being formed it would appear from the remains found in it that the cavern was inhabited by a race of men, who not only lived on the other animals, but on their own race. The older deposits contained undisputable traces of the glutton, a species of hare, known to the French palæontologists, and rather larger than our own. He concluded with remarks on the antiquity of the human race as indicated by the facts mentioned in the report.

ON THE " ENTRANCE OF THE MAMMOTH " BY MR. H. H. HOWORTH.

He reviewed the various historical notices in old authors of the mammoth remains in Siberia and elsewhere. The common idea once was that the mammoth was a sort of huge mole which burrowed beneath the surface of the earth, and whose motions could be traced by the upheaving of the soil as the creature traversed its cave below. This was one way by which they accounted for the vast remains found, and another that at the deluge, the bodies, after floating about were washed into caverns. Mr. Howorth did not think the extinction of the mammoth ought to be ascribed to the men of the early stone age. He believed the extinction of the mammoth was simultaneous with the disappearance of a specific and distinct race of men from the same region.

Professor Phillips offered some remarks on the history of the mammoth generally. He dwelt at some length on the more popular geological notions of the former condition of northern geography. The great points received, he observed, were—the mammoth being contemporaneous with man—"When did it cease to live?" and "Where did it appear for the last time?" They would never understand Kent's Hole completely until they had solved these points.

Professor Boyd Dawkins in reply to a portion of Mr. Howorth's remarks, said he had been misunderstood. He had never said that the extinction of the mammoth in Siberia was owing to its been hunted down, but he had stated that in England and Western Europe generally there was no doubt that the mammoth had become extinct by the hand of man. He also shewed that the mammoth had lived when arctic animals existed.

Mr. Howorth, in reply, still differed from Professor Dawkins as to the cause of the extinction of the mammoth. The race of men existing at the time in the regions where the mammoth was found was not able to cope with so gigantic a creature. With regard to the second question put by Professor Phillips, he fixed the north-east corner of Siberia as the spot where the last mammoth lived.

"ON THE TRAPPEAN CONGLOMERATES OF MIDDLETON HILL, MONTGOMERYSHIRE," BY M. G. MAW.

This was a description of the contemporaneous traps of Lower Silurian age in the ridge known as Middleton Hill, running parallel with the Breiddens, on the borders of Shropshire and Montgomeryshire. Especial reference was made to the great beds of bouldered trap, consisting of boulders of compact felstone imbedded in a softer matrix of felspathic tuff. The nodules occupy about half the mass of the conglomerate, and are unaccompanied by pebbles of any other rock. They vary from the size of a walnut to rounded masses of more than a hundred weight. Sir R. Murchison's description of these beds was referred to, and the author took exception to the term "concretionary traps" employed in the Silurian system, as he considered that the rounded outline of the boulders was unquestionably due to mechanical causes. The interbedded traps, bounded on either side by Lower Llandeilo Flags, are of a collective thickness of about 780 feet, including two beds of the bouldered felstone 115 to 140 feet thick, alternating with two beds of whitish-green felspathic breccia, 210 to 315 feet thick. The line of separation between the breccia beds and the beds of boulder trap is remarkably sudden and no gradation of character occurs between them. The breccia is worked for hard felspar used for pottery purposes, and contains small nests of steatite. The bouldered condition of the felstone beds was considered due to their partial breaking up on being erupted under water, the soft matrix of felspathic tuff being the portion more intimately divided, and the compact boulders, fragments that had resisted disintegration. The sudden alternation in Middleton Hill of eruptive beds of very dissimilar character was noticed; they seem all to have been emitted in immediate succession, as although overlain and underlain by sedimentary deposits. There is no evidence of interstratification of sedimentary beds. The author, in conclusion, pointed out the close geographical association with these bedded traps, of the much later porphyritic greenstone of the Breidden Hills, which it was suggested might have been emitted from the same points of eruption; and the local association of the intrusive greenstones with the lower silurian interbedded felstones was noticed as being very general in N. Wales.

Professor Dawkins said he had by accident very recently explored the same district as had been described by Mr. Maw, and he could corroborate his statements. There could be no doubt that the boulder track was due to the attrition of waves. He asked for some further information as to the appearance of the great mass of freestone after the close of the triassic era.

Mr. Maw replied to Mr. Dawkins by citing the authority of Sir R. Murchison.

ZOOLOGY AND BOTANY.

COLOUR IN BIRDS.

(From the President's Address.)

The Turaco, or plantain-eater, of the Cape of Good Hope is celebrated for its beautiful plumage. A portion of the wings is of a fine red colour. This red colouring matter has been investigated by Professor Church, who finds it to contain nearly six per cent. of copper, which cannot be distinguished by the ordinary tests, nor removed from the colouring matter without distroying it. The colouring matter is in fact a natural organic compound of which copper is one of the essential constituents. Traces of this metal had previously been found in animals—for example, in oysters, to the cost of those who partook of them. But in these cases the presence of the copper was merely accidental; thus oysters that live near the mouths of streams which came down from copper-mines, assimilated a portion of the copper salt, without apparently its doing them either good or harm. But in the Turaco the existence of the red colouring matter which belongs to their normal plumage is dependent upon copper, which, obtained in minute quantities with the food, is stored up in this strange manner in the system of the animal. Thus in the very same feather, partly red and partly black, copper was found in abundance in the red parts, but none or only the merest trace in the black.

This example warns us against taking too utilitarian a view of the plan of creation. Here we have a chemical substance elaborated which is perfectly unique in its nature, and contains a metal the salts of which are ordinarily regarded as poisonous to animals; and the sole purpose to which, so far as we know, it is subservient in the animal economy is one of pure decoration. Thus a pair of the birds which were kept in captivity lost their fine red colour in the course of a few days, in consequence of washing in the water which was left them to drink, the red colouring matter, which is soluble in water, being thus washed out: but except as to the loss of their beauty it does not appear that the birds were the worse for it.

REPORT OF THE "CLOSE TIME" COMMITTEE.

On behalf of the Committee, Mr. Dresser advocated a close time being secured for various birds in the same manner as is secured in foreign countries. The discussion was principally remarkable for the remarks of Professor Huxley against having a close time at all, and against the Preservation of Animals, &c., Act, particularly in its application to the deep-sea fisheries. Professor Huxley contended that that Act was useless, mischievous and meddling; and stated that the gulls, which had been protected by recent legislation, were of no further use, and could be put to no higher service, than when they furnished their plumage to surmount the bonnets of the interesting sex. He generally ridiculed the idea of having a legislative "close time" for such birds. Opposite views were advocated by the Rev. H. B. Tristram, Mr. Wallis, Professor Newton and Miss Becker. Some very interesting examples were given by Mr. Smith of the effect of the preservation of birds in the Scilly Isles. He had preserved birds there for many years, and found that while some would increase, others would decrease, being pushed out by stronger and more rapacious kinds of birds. The Rev. H. B. Tristram read a paper on the "Effect of Legislation on the Extinction of Animals," strongly advocating legislative means being used to prevent the extinction of wild animals, and particularly birds. In the discussion which ensued, the opinions generally expressed were in favour of this view.

DEEP SEA DREDGING.

The Rev. A. Norman, F.G.S., read a letter from Professor W. Thomson on the successful dredging of H.M.S. *Porcupine* in 2,435 fathoms. He said—in a few words of introduction—there could be no great progress in the work of sea dredging without the aid—first, of the Royal Society, and secondly, of the Government. They would remember that Professor Forbes had laid it down as an axiom that life did not exist in the sea below 300 fathoms in depth, to which conclusion he was led by his investigations in the Ægean and Mediterranean Seas. The results was a warning to them not to theorise on individual facts. Subsequently living forms were obtained from the Atlantic at greater depths. But since the last meeting of the British Association at Norwich, an enormous stride had been made in these investigations. At that meeting Professor Huxley read a paper on a form of life drawn up from the Atlantic. Since then great efforts have been made in several parts of the world by deep sea dredgers, amongst whom was Dr. Percival Wright, who had made investigations off the Spanish coast. Professor Sars had made a communication on the distribution of animal life in the depths of the sea, and enumerated 427 species. The work had been assisted by the Royal Society and the Government. The late Government had sent the *Lightning* to dredge in the sea between the Hebrides and the Faroe Islands, and an account of that expedition was given by Dr. Collins in the Transactions of the Royal Society. That expedition showed that there were currents of different temperature running side by side. In one place the temperature at the surface was 54°, and at the bottom 47°; and in the other the surface was 54° and the bottom 32°. He considered that one was the back current of the water that had coursed from the tropics to the poles. Mr. Norman then read the following letter from the Professsor:

"BELFAST, Aug. 7, 1869.

"My dear Norman,—You are already aware that, during the first cruise of this year, Mr. Jeffreys and his party dredged and took most important thermometrical and other observations to a depth of 1,476 fathoms. When I took Mr. Jeffrey's place for the second cruise, it was the intention to proceed northwards, and to work up a part of the north-west passage, north of Rockall. I found, however, on joining the vessel, the gear in such perfect order, all the arrangements so excellent, the weather so promising, and the confidence of our excellent commander so high, that, after consulting with Capt. Calver, I suggested to the hydrographer that we should turn southwards, and explore the very deep water off the Bay of Biscay. I was anxious that, if possible, the great questions of the distribution of temperature, &c., and of the conditions suitable to the existence of animal life, should be finally settled, and the circumstances seemed singularly favourable. No thoroughly reliable soundings have been taken beyond 2,800 fathoms, and I felt that if we could approach 2,500, all the grand problems would be virtually solved, and the investigation of any greater depths would be a mere matter of detail and curiosity. The hydrographer at once consented to this change of plan; and on the 17th of July we left Belfast and steered round to Cork, where we coaled, and then stood out towards some soundings, about a couple of hundred miles south-west of Ushant, marked on the Admiralty charts 2,000 fathoms and upwards. On the 20th and 21st we took a few hauls of the dredge on the slope of the great plateau, in the mouth of the Channel, in depths from 75 to 725 fathoms, and on the 22nd we sounded with the 'Hydra' sounding-apparatus, the depth 2,435 fathoms, with a bottom of fine Atlantic chalk-mud, and a temperature registered by two standard Miller-Six's thermometers of 35·5° Fahrenheit. A heavy dredge was put over in the afternoon, and slowly the great coils of rope melted from the 'Aunt Sallies,'—as we call a long line of iron-bars with round wooden heads, on which the coils are hung. In about an hour the dredge reached the bottom, upwards of three miles off. The dredge remained down about three hours, the Captain moving the ship slowly up to it from time to time, and anxiously watching the pulsations of the accumulator, ready to meet and ease any undue strain. At nine o'clock P. M., the drums of the donkey-engine began to turn, and gradually and steadily the 'Aunt Sallies' filled up again, at the average rate of about 2 ft. of rope per second. A few minutes before one o'clock in the morning 2 cwt. of iron—the weights fixed 500 fathoms from the dredge—came up, and at one o'clock precisely a cheer from a breathless little band of watchers intimated that the dredge had returned in safety from its wonderful and perilous journey of more than six statute miles. A slight accident had occured. In going down the rope had taken a loop round the dredge-bag, so that the bag was not full. It contained, however, enough for our purpose—1½ cwt. of 'Atlantic ooze'; and so the feat was accomplished. Some of us tossed ourselves down upon the sofas, without taking off our clothes, to wait till daylight to see what was in the dredge. The next day we dredged again in 2,098 fathoms, practically the same depth, and brought up 2 cwt. of ooze—the bottom temperature being 36·4°; and we spent the rest of the day in making what will, I am sure, prove a most valuable series of temperature observations at every 250 fathom-point from the bottom to the surface. These enormously deep dredgings could not be continued. Each operation required too much time, and the strain was too great both upon the tackle and upon the nervous systems of all concerned, especially of Capt. Calver and his officers, who certainly did all that could be compassed by human care, skill and enthusiasm, to ensure success. We crept home, dredging in easier depths. We start again to-morrow, and, as you may suppose, I have enough to do. I can, therefore, only give you the slightest possible sketch of our results, anticipating fuller information when I have time to collate the diaries and to look over the specimens. First, as to the temperature. The super-heating of the sun extends only to the depth of about 20 fathoms. Another cause of super-heating, probably the gulf-stream, extends to the depth of from 500 to 700 fathoms. After that the temperature gradually sinks at the rate of about 0·2° for every 200 fathoms. This is probably the normal rate of decrease, any deviation being produced by some special cause—a warm or a cold current. Secondly, the aeration of the water. Mr. Hunter, who accompanied me as physicist, found the water from great depths to contain a large excess of carbonic acid, and he found the water from all depths to contain a considerable proportion of dissolved organic matter; thus in every way bearing out the observations of Mr. W. L. Carpenter during the first cruise. Thirdly, distribution of life. Life extends to the *greatest* depths, and is represented by all the marine invertebrate groups. At 2,435 fathoms we got a handsome dentalium, one or two crustaceans, several annelids and zephyrea, a very remarkable new crinoid, with a stem 4 inches long,—I am not prepared to say whether a mature form or a *Pentacrinoid*,—several star-fishes, two hydroid zoophytes, and many Foraminifera. Still the Fauna has a *dwarfed* and Arctic look. This is, doubtless, from the cold. At 800 to 900 fathoms, temperature 40° Fahr. and upwards, the Fauna is rich, and is specially characterized by the great abundance of vitreous sponges, which seem to be nearly related to, if not identical with, the ventriculites of the chalk. This year's work has produced many forms new to science and many new to the British Fauna. Among the most remarkable in the groups I have been working at I may mention a very singular Echinoderm, representing a *totally new group* of the sub-kingdom,—a splendid new Ophiurid,—many specimens of Sars's Rhizocrinus Loffotensis, —many vitreous sponges, including specimens of Aphrocallistes, Holtenia and Hyalonema,—a fine Solarium from the coast of Kerry, and many other things. As I am only writing in the interval of scaling the boiler, with no opportunity of going over the collections, you must accept this sketch. I trust to your contributing the Crustacea, which will be sent to you as soon as possible. I will write again from Lerwick.—Ever truly yours,

WYVILLE THOMSON."

Professor Huxley hoped that the meeting would not go away with the idea that scientific men had coincided with the views of the late Mr. Forbes as to the depth at which life could not exist in the ocean. These views had never been accepted by scientific men, and for the real conclusions of science they must not be content with consulting "text books," which the Professor styled a sort of literary *chiffonier*. The results obtained by deep sea dredging were of the greatest moment to science. They showed that the cretaceous formation was continued till the present day. The history of chalk extended back to millions of years beyond the recorded history of man. That was established in science, and could not be upset. Suppose that in Central Africa we found a colony of the ancient Egyptians still living, with their physique, dress, and appearance exactly as they were of old—that would not be one-tenth so marvellous and important as the facts which showed that the creatures that lived in the old chalk age had their posterity and exact counterparts still living. The Professor observed that the discoveries made showed that there was a gigantic network of a jelly-like life encircling the globe.

Dr. Hooker also stated that Professor Forbes's hypothesis had never been accepted by scientific men. Dr. Percival Wright made some observations on soundings. Mr. Norman wished to guard the Association against supposing that deep sea soundings were recent. It was the dredging only which was recent.

ON THE LAW OF DEVELOPEMENT OF CEREALS: BY MR. F. F. HALLET, OF BRIGHTON.

Mr. Hallet's experience showed him several years ago that corn, and especially wheat, was injured by being planted too closely. He found a wheat plant would increase above the ground in proportion as its roots had room to develope, and that the roots might be hindered by being in contact with the roots of another plant. Mr. Hallet continued a series of experiments, planting one grain of wheat only, and succeeded so well in improving the method of cultivation as to raise wheat, whose ears contained 123 grains, or more than 60 on each side. In the course of his investigations, Mr. Hallet made other discoveries with regard to the growth of cereals which he sums up as follows:—" 1. Every fully developed plant, whether of wheat, oats, or barley, presents an ear superior in productive power to any of the rest on that plant. 2. Every such plant contains one grain, which, upon trial, proves more productive than any other. 3. The best grain in a given plant is found in its best ear. 4. The superior vigour of this grain is transmissible in different degrees to its progeny. 5. By repeated careful 'selection' the superiority is accumulated 6. The improvement which is first raised gradually, after a long series of years is diminished in amount, and eventually so far arrested that, practically speaking, a limit to improvement in the desired quality is reached. 7. By still continuing to select, the improvement is maintained, and practically a fixed type is the result." In the discussion which ensued, Mr. Hallet was warmly complimented upon the results he had attained, and the gigantic ears of wheat which he exhibited were examined with the greatest interest by those in the room.

INAUGURATION OF THE PEABODY ACADEMY OF SCIENCES AT SALEM, MASSACHUSETTS.

"The various alterations and improvements in the East India Marine Hall at Salem, which were necessary to accommodate the large and valuable collections intrusted to the care of the Peabody Academy of Science by the Essex Institute and the East India Marine Society, having been completed, the occasion of the visit of the American Association for the Advancement of Science was taken advantage of to dedicate the Academy to the uses for which it was designed by its founder."

The inauguration took place on the morning of the 18th of August, 1869.*

It will be probably remembered that Mr. George Peabody, in the year 1867, established a trust, and liberally endowed it with the sum of $140,000, for, to use his own words, "the promotion among the inhabitants of my native county" (Essex Co., Mass.) "of the study and knowledge of the natural and physical sciences, and their application to the useful arts." The following extract from the address of Mr. W. C. Endicott at the dedication of the building will give some idea of the way in which the trustees have endeavoured to carry out the wishes of the far-seeing and enlightened founder of the institution:—

"It would be impossible, and by no means desirable, to recite what the museum contains, or the particulars of its arrangement. Three general objects were steadily kept in view.

First. The formation of a complete collection of the fauna, flora, geology and mineralogy of the county of Essex, so that all can have the means of becoming acquainted with the various objects of nature to be found on every hand. Great progress had already been made in this direction by the Essex Institution, and the western gallery is now devoted to all the specimens now in possession of the academy founded in the county of Essex.

Second. To complete, as far as practicable, the noble beginning already made by the East India Marine Society, of a collection illustrative of the habits and customs of the various

---

* The greater part of this article is taken from the columns of the *Boston Daily Advertiser*.

tribes and natives living beyond the Cape of Good Hope and Cape Horn, with whom the founders of that society carried on so large a trade, and also to preserve as far as possible the remembrance of that trade, and of the society itself, by models of the vessels employed and by a collection of portraits of those who, either as owners or navigators, were its pioneers. To these collections the eastern side of the hall is devoted, and large additions have also been made to them by the Academy, relating to the Indians of North America, especially those who lived in the neighbourhood.

Third. The arrangement of the general collection npon the simplest possible plan, that of bringing together the different divisions according to their structural affinities. This arrangement is intended to be limited, for the present certainly, to the wants of the public and the general student, in other words to be such a display of typical specimens, that every intelligent visitor may find the means of investigating the more general laws which govern the natural affinities of animals, plants and minerals. In the accomplishment of this purpose it was thought proper to suppress all useless details. Information in regard to the minor points of structure, which can only be conveyed by a large number of closely allied forms, is of no value to the general observer. On the contrary, it tends to confuse and distract attention from general principles, and concentrate it on questions of limited application, of no practical importance, except to the special student. We are aware that the difficulties in the way of this arrangement are by no means confined to the selection of suitable specimens or their disposal in regular order. When placed in their most perfect condition, classified and labelled according to their different relations to each other, or to the circumstances of their geographical or geological distribution, they still are but dumb illustrations of the laws of nature. They are indeed the best possible illustrations, and rank next to the living facts in exactitude and truthfulness, but still they are only the illustrations of the book of nature, of which the text book is still unwritten. To complete the plan therefore, and make the museum all that it should be, catalogues are needed, which shall be to some extent abbreviated text-books. And it is believed by the gentlemen in charge of the museum that they can be so made, that any desirous of information in regard to any of the groups of the three kingdoms, may find not only a statement of the laws of their classification, but objects so prepared and arranged that he can readily obtain the information desired. Such is the plan upon which the museum has been arranged. We cannot say it is yet fully completed, but we trust it may in some degree meet the requirements for which it is intended. While the completion of the museum has been the main object thus far, the trustees were of opinion it would be wise to begin at once upon a small scale what at some time we hope to do on a large and extended scale. Provision was therefore made in our by-laws for lectures and also for the publication of papers strictly scientific, to be called the "*Memoirs of the Peabody Academy of Science*." One paper has already been published, which we trust will be the first of a continuous series. One course of lectures has been given by Messrs. Putnam, Morse, and Hyatt, and it is hoped that we may commence another season with a course of lectures to be delivered by the above named gentlemen, assisted by some of the trustees from various portions of the county. These may be regarded as the commencement of a series of lectures, regular and systematic, which will be one of the chief instrumentalities for the diffusion of that knowledge which Mr. Peabody intended to afford to the county of Essex.

The lectures must be given chiefly in the rooms and the halls of the academy, when finished, but at stated periods they should be delivered in the several cities and towns of the county, and before various local societies, schools, and classes.

And here it may be remarked that lectures affording solid instruction in an agreeable and interesting way, are much needed in this community. The persons who for the most part supply the popular lecture platforms are either professional lecturers, given to sensational declamatory fine writing, gentlemen of some general reputation obtained in other fields, or the advocates of some particular hobby or reform. Lectures are given and attended, not for instruction and improvement, but to gratify curiosity, or to afford amusement or excitement to audience.

The results is that the lecture now seldom instructs. Aiming at other ends, the modest rewards of the scholar and man of science are no longer the measure of payment, and the prices have risen to an exorbitant rate. Lecturers swell their incomes by a winter's tour at one or two hundred dollars a night. They are paid as opera singers are paid. The lecture platform is thus forced to pay a heavy tribute, and in the smaller towns and communities the performance is beyond the reach of the people. It would be idle, even if it were desirable, to attempt a change in this condition of things, or to enter into a crusade against the present system, but it would seem that much might be done in this county by an institution like this coöperating with local societies, to furnish that which Lyceums no longer supply.

But the formation of a museum, which is the first and most definite object named in the instrument of trust, yet constitutes but a part of Mr. Peabody's scheme. After it is finished and such buildings as may be required are completed, the income is to be devoted in certain proportions to the departments of the physical and natural sciences. In what way this shall be done the instrument of trust does not state. This is left in the fullest manner to the discretion of the trustees.

In the early stages of an institution, it is somewhat difficult to lay down a definite plan of operations; certainly it would be unwise to encumber ourselves with any inflexible formula of action or management. Circumstances may change, or our means may be insufficient. In stating, therefore, the purposes of the trustees, I state that which now seems to them most desirable, and the best method, in connnection with the museum, of promoting, to use the precise words of the trust, "among the inhabitants of the county of Essex, the study and knowledge of the natural and physical sciences, and their application to the useful arts.

These words clearly define three distinct objects. The aid to be afforded to the student of the sciences. The aid to all in the pursuit of a knowledge of the sciences. The advancement of the material prosperity of the county by the application of science to practical purposes. Having these objects in view, the following plan is proposed:—

1. "To promote the study of the natural and physical sciences," it is proposed to offer inducements to teachers and scholars to enter upon the special study of the sciences.

The practical execution of this would be as follows:—To give courses of lectures to the Normal School as often as practicable; to give courses of lectures of a strictly educational character to teachers, persons interested in science, and select classes of students combined in different parts of the county; to distribute collections properly named, labelled and mounted, to the schools, suitable for the practical illustration of text books and lectures, provided the school committee or others receiving them will agree to preserve and use the same for the benefit of students, or return them without unnecessary delay to the academy: to afford to all special students who manifest an earnest desire to study science, the opportunity of doing so free of charge for tuition.

2. "To promote a knowledge of the sciences among the people," it is proposed to give courses of lectures to public audiences; to give practical discourses of a conversational and informal character, at certain hours, in the halls of the academy, illustrating them with the collections; to print catalogues of the collections, which shall be abbreviated text-books of the different departments, and convey to the visitor lessons upon the principles which have governed their arrangement: to print one general catalogue on the same plan, which shall be compiled from the others, but illustrated by a separate collection in the museum; to sell these catalogues at as low a price as possible: to encourage the formation of scientific associations for the promotion of knowledge, by giving collections, properly labelled and arranged, provided the recipients agree to furnish proper cases, make them the nuclei of local collections, and use them for the benefit of the public, or return them without unnecessary delay to the academy; to provide inexpensive means of communication for investigators in distant parts of this country, and in Europe, for the transportation, exchange, and purchase of books and instruments of a scientific character: to encourage any worthy publication of a scientific character which may be issued within the limits of the county.

3. To promote the "application of the natural and physical sciences to the useful arts," it is proposed to organize a systematic survey of the county, and that the means of accomplishing it may be provided, it is recommended that every salaried officer and special student of the academy be required to study some scientific subject of local application, and contribute his knowledge in a written communication for the use of the survey, that these communications be published, whenever practicable, by the academy, under the general title of "The Annals of the Scientific Survey of Essex County;" that all explorations and investigations upon local subjects of a worthy character be encouraged, and, if of sufficient importance, published in the "Annals."

In addition it is proposed to obtain a full set of works which would facilitate the arrangement and use of the collections, by exchange with other societies and institutions issuing works of a scientific character; to purchase, when the funds justify the expenditure, such books and pamphlets as may be from time to time needed by the officers of the museum in the arrangement of the collections. The geographical position of the academy and its natural advantages, impose upon its officers certain duties to science. These are, to supply institutions and individuals situated in the interior with typical collections of native products, especially the marine animals and plants, properly named and labelled, to regard these collections as exchanges, and a means of completing and increasing the museum, but to give them freely as donations, whenever it may be for the benefit of science to make the exception.

Such is the museum we to-day dedicate, such the general plans and views of those intrusted with its management. That such a plan is practicable, and would result in promoting in this vicinity the study and knowledge of the sciences, and their application to the useful arts, we have no question. How far we shall be able to carry it out, and whether we can with our present means accomplish more than a part (of that there is no doubt), the future must determine."

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Eighteenth Meeting, held at Salem, Mass.

From among the numerous papers of interest read at the above meeting, we give abstracts of the following: *

ON TWO NEW GENERA OF EXTINCT CETACEA.

By Prof. Cope.

In this paper a description was given of the characters of a very large representative of the Dugong of the modern East Indian seas, which was found in a bed, either Miocene, or Eocene, in New Jersey. It was double the size of the existing Dugong, and was interesting as adding to the series of Asiatic and African forms characteristic of American Miocenes. Another type was

* These extracts are selected and adapted from the columns of the *Boston Daily Advertiser*.

regarded as remotely allied to Squalodon, but it was edentulous, and furnished with a broad shallow alveolus, either that left after shedding a tooth, or that adapted to a broad obtuse tooth. It constituted a remarkable new genus which was called *Anopolonassa forcipata.* It was found in postpliocene beds near Savannah. He also exhibited teeth of two gigantic species of Chinchilla which had been discovered in the small West India island of Anguilla, which has an area of but about thirty square miles. The specimens were taken from caves, and were thought to indicate postpliocene age. With them was discovered an implement of human manufacture, a chisel made from the lips of the shell *Strombus gigas.* The contemporaneity of the fossils and human implements was supposed, but not ascertained. Its interest and connection with human migrations was mentioned; also the supposition of Pomel, that the submergence of the West India islands took place since the postpliocene period.

ON THE EARLY STAGES OF BRACHIOPODS.

By Prof. E. S. Morse.

Mr. Morse said he made a visit to Eastport, Maine, early in the summer, for the purpose of discovering the early stages of a species of Brachiopod (*Terebratulina septentrionalis*, Couth), so abundant in those waters. As little had been known regarding the early stages of this class of animals, the facts presented were of interest, as settling, beyond a doubt, their intimate relations with the Polyzoa. We can only give a few of the more important features mentioned. In a few individuals the ovaries were found partially filled with eggs. The eggs were kidney-shaped, and resembled the statoblasts of Fredericella. No intermediate stages were seen between the eggs and the form represented, which he proved on the blackboard. This stage recalled in the general proportions Megerlia or Argiope, in being transversely oval, in having the hinge-margin wide and straight, and in the large foramen. Between this stage and the next the shell elongates until we have a form remarkably like Lingula, having, like Lingula, a peduncle longer than the shell, by which it holds fast to the rock. It suggests also in its movements the nervously acting Pedicellina.

In this and the several succeeding stages, the mouth points directly backward (forward of authors), or, away from the penduncular end, is surrounded by a few ciliated cirri, which forcibly recall certain Polyzoa. The stomach and intestine form a simple chamber, alternating in their contractions, and forcing the particles of food from one portion to the other. At this time, also, the brownish appearance of the walls of the stomach resembles the hepatic folds of the Polyzoa. In another figure he showed a more advanced stage, where a fold was seen on each side of the stomach; from this fold the complicated liver of the adult is developed, first, by a few diverticular appendages.

When the animal is about one-eighth of an inch in length, the lophophore begins to assume the horseshoe-shaped form of Pectinatella and other high Polyzoa. The mouth at another stage begins to turn towards the dorsal valve (ventral of authors), and as the central lobes of the lophophore begin to develope, the lateral arms are deflected. In these stages an epistome is very marked, and it was noticed that the end of the intestine was held to the mantle by attachment, as in the adult, reminding one of the *funiculus* in the *Phylactolæmata*.

Prof. AGASSIZ rose at the termination of the reading of Mr. Morse's paper, and said that it had been many a year since he had listened to a paper more important to the progess of science. That now, after many years and many failures, they had at length a foundation for the homologies of the Brachiopods. He also recommended that this paper should be published, not with the usual meagre illustrations, but with a fullness worthy of the subject. He regretted that Mr. Morse had not given them more of the details of his investigations.

VERTEBRATE REMAINS IN NEBRASKA.

By Prof. O. C. Marsh.

The locality described by Prof. MARSH was the Antelope Station, on the Pacific Railroad, in south-western Nebraska. While engaged in sinking a well at that place, in June, 1868, a layer of bones was found by the workmen at a depth of sixty-eight feet below the surface, which were at first pronounced to be human, but during a trip to the Rocky Mountains, Professor Marsh examined the locality and bones, and found that the latter were remains of tertiary animals, some of which were of great interest. The well was subsequently sunk about ten feet deeper, and the bones obtained were secured by the professor. An examination proved that there were four kinds of fossil-horses, one of which he described in November last as *Equus Parvulus*. Although it was a full grown animal, it was not more than two and one-half feet high. It was by far the smallest horse ever discovered. Of the other kind of fossil horses one was a three-toed horse of the Hipparion type. Including the above the number of species of fossil horses discovered in this country was seventeen, although the horse was supposed to be a native only of the old world, and was first introduced here by the Spaniards. Of the other remains there were two carnivorous animals, one about the size of a lynx and the other considerably larger than a lion—the last twice as large as any extinct carnivore yet discovered in this country. Among the ruminants found in this locality was one with a double metatarsal bone, a peculiar type, only seen in the living aquatic musk deer and in the extinct Anoplotherium. There were also the remains of an animal like the hog, a large rhinoceros, and two kinds of turtles. These, together forming fifteen species of animals, and representing eleven genera, were all found in a space ten feet in diameter and six or eight feet in depth. It is supposed that the locality was once the margin of a great lake, and that the animals sunk in the mire when they went down to the water to drink.

At the close of Professor Marsh's address, Professor AGASSIZ made a few interesting remarks on the possibility of determining genuine affinities from fragmentary fossil remains, after which he read a paper on the Homologies of the Palæchinidæ, partially prepared by his son, ALEXANDER E. R. AGASSIZ.

ON THE GEOLOGY OF THE COAST OF MAINE.

By Prof. S. W. Johnson.

In this paper an account was given of the geology of that part of the coast of the State of Maine between the mouths of the Kennebec and Penobscot rivers. The coast of Maine, the author stated, may be called a coast of denudation, and takes its present conformation from the rocks underlying the soil, the waves of the Atlantic having long since removed everything that is movable. The rocks of this region are metamorphic, and lie in immense folds, nearly parallel with each of the rivers, Kennebec, Sheepscot, and others further east, occupying the synclinal axes between the folds. Most of the islands lying off this coast are only continuations of the promontories constituting these folds. Monhegan is an exception to this, being, as the professor believes, a part of an immense trap uplift of the same age as the trap dike at White Head Island, and other places further north.

He spoke also of the markings on a rock on Monomah Island, which lies by the side of Monhegan. These markings, he was disposed to consider not artificial characters, but as produced by the action of the atmosphere upon the partially crystalline rock.

Prof. AGASSIZ made a few remarks at the close of Prof. Johnson's paper, after which an essay "on Norite or Labradorite Rocks," was read by Dr. T. STERRY HUNT, F.R.S.

SOME NOTES ON THE CHEMISTRY OF COPPER.

By T. STERRY HUNT, L.L.D., F.R.S.

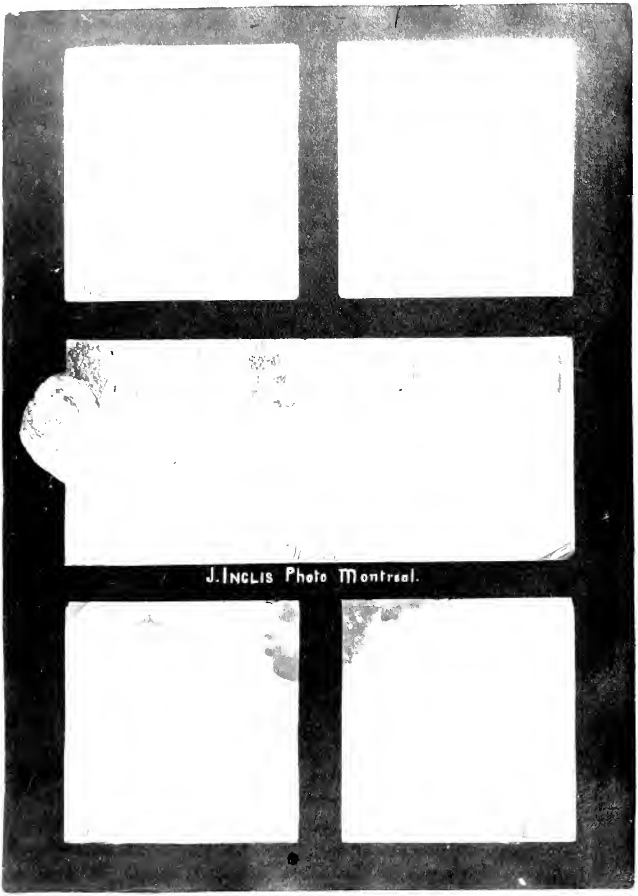
Copper in its cupreous form presents some relations to silver which were pointed out. Cupreous oxyd, like oxyd of silver, decomposes many protochlorids, as those of magnesium, zinc, manganese, cobalt, and iron, forming cupreous chlorid. This, though insoluble in water, is readily soluble in solutions of chlorids, as of sodium and magnesium, especially if hot and concentrated, but is in large part separated by cooling, and by dilution. From solutions of chlorids of zinc and manganese the red oxyd of copper precipitates insoluble oxychlorids of these metals. From chlorid of magnesium pure hydrated magnesia separates. With ferrous chlorid the reaction is more complex, since ferrous oxyd reduces cupreous chlorid, giving metallic copper, so that the iron separates as ferric oxyd, together with one-third of the copper in the metallic state. In presence of an excess of ferrous oxyd the whole of the copper is reduced to the metallic state. Cupric oxyd, in like manner, decomposes ferrous chlorid with production of ferric oxyd, while two-thirds of the copper are obtained as cupreous, and one-third as cupric chlorid. These results are best obtained in presence of strong hot solutions of chlorid of sodium, which dissolve the cupreous chlorid. The relations, both geological and economical, of these reactions, were then alluded to.

TRICHINA SPIRALIS.

Dr. J. BAKER EDWARDS read a paper with the above title, which appeared in the last number of this journal.

MICRO-PHOTOGRAPHS OF TRICHINA,

TAKEN FROM PORK AND FROM HUMAN MUSCLE.



One—Free Trichina, from Pork.—100 diameters.

Two—Single Trichina, from Human Muscle.—150 diameters.

Three—Trichina embedded in Human Muscle.—150 diameters.

Four—Trichina encysting; from Pork.—50 diameters.

Five—Trichina fully encysted but not calcareous; from Pork.—50 diameters.

COAL AND IRON IN CHINA.

By Prof. A. S. Bickmore.

The object of the paper was to show that, although China is and has been for many ages the most densely peopled area on the suface of our earth, yet her natural resources remain to be developed, and that these resources are so ample that there is a bright future for China now that the enterprise of Europe and America is to join hands with the untiring industry of her people. Professor Bickmore, who has travelled very extensively in China, gave a full list of the localities where all the above minerals are found, and some statements tending to indicate a great yield in all these mines. Coal was used for fuel ages before its properties were known to Europeans. Marco Polo, the great Venetian traveller, who visited Pekin more than six hundred years ago, found it in common use. The only mode of transporting this mineral in the northern parts of China is on the backs of camels, mules and donkeys. Professor B. described a mine near Pekin, which he descended for a mile, being obliged to crawl on his hands and knees, as the height of the adit or tube was only four or five feet. The coal is drawn up in baskets on sleds, each basket holding from a peck to half a bushel. The only covering of those who drag it up is a thick layer of coal dust. This slow and laborious mode of taking the coal to the surface was the only one seen in all mines visited; neither are there any adits or tunnels for the admission of pure air. Accidents from the explosion of fire-damp rarely or never occur, however, probably because the Chinese are unable to dig lower than the water level for want of proper pumping apparatus. For the same reason the best coal in China remains as yet undisturbed, and awaits the enterprise and improved apparatus of western nations. Coal appears from place to place over the whole empire. It is overlaid with a red sandstone, and the Chinese commence their operations when the strata chance to outcrop, and follow them down at whatever angle they chance to lead.

Prof. Bickmore showed by extracts from ancient works that petroleum was not only known but used for lamps more than one hundred and sixty years ago. The Chinese name for it is "Oil of Stone," which is identical with our name petroleum.

Iron, the next most important mineral to coal, is found in the immediate vicinity of coal over most of the northern part of

China. The best ore, from which is made the steel used in manufacture of razors and other cutlery, is found in the province of Shursi.

The abundance and wide distribution of these invaluable minerals offer the best facilities for the construction of machinery of all kinds, and render railroads practicable as soon as there is a government stable and strong enough to protect such property.

Copper is found in many places in the north of China, and large quantities have undoubtedly been taken out, and it is probable that larger quantities yet remain.

Tin is said to be found among most of the mountains of China, though Prof. Bickmore had not seen a specimen *in situ*. If this metal should prove to be as abundant as it is asserted on what may be regarded as good authority, then Prof. B. thinks it will be found that China, on account of the early age of her civilization, has been the chief source whence came the tin that was used by the Lake Dwellers in Switzerland in manufacturing their bronze implements. Silver exists in the province of Shansi, probably in great quantities. Gold is found in the beds of nearly all the rivers in China, so long as they flow through the mountainous regions. Prof. B. concluded his paper with these words:—"In review, we see that China is well supplied with coal and iron, the two minerals especially necessary for her future development; that these minerals are widely distributed over almost her whole area, and that she has thus the requisite materials for manufacturing her own cotton without being dependent on the looms of England. Again, China possesses her share of the precious metals, and yet nearly all her ample material resources remain to be developed, though she has been the most civilized nation in all the east, and the most populous empire the world has ever seen."

THE METAMORPHIC ROCKS OF NEW BRUNSWICK AND MAINE.

Prof. L. W. Bailey read a paper written by himself and Mr. G. F. Matthew "On the Age and Relations of the Metamorphic Rocks of New Brunswick and Maine."

The sediments to which the paper referred related chiefly to those embraced in the most southerly of three spurs projecting to the northeast from that extensive tract of altered and often highly crystalline rocks which occupy the greater part of New

England, and lie between the unaltered Silurian of New York on the one hand and the New Brunswick coal-field on the other.

Dr. GESNER, who made a geological survey between 1838 and 1842, recognized granitic ridges on two of these spurs, and spoke of the slates in the central part of the province as Cambrian, and described others near the bay of Fundy as Silurian. Dr. James Robb adopted substantially these views. The classification was based upon the highly altered character of the rocks and the paucity or entire absence of organic remains. About the year 1858, Mr. G. F. Matthew, from certain further examinations, pronounced some of the deposits near the city of St. John to be of Upper Devonian age.

At the beginning of the present decade, a geological survey of the State of Maine, under Prof. C. H. Hitchcock, was undertaken, by which a knowledge of some of the metamorphic rocks adjoining New Brunswick was obtained. In the following year the characters of the metamorphic belt eastward of St. John, by a reconnoissance made for the government of New Brunswick by the authors of this paper, in connection with Prof. C. F. Hartt, were discovered.

The paper described in some details the formations recognized in New Brunswick, and showed how the same formations extended into the State of Maine, which tended to throw much light on the geology of eastern New England, so long involved in obscurity.

The formations thus recognized are the Lower and Upper Laurentian, the Huronian, the Primordial, the Upper Silurian, the Upper Devonian, the Lower Carboniferous, Carboniferous, and New Red Sandstone, all except the first two and the last containing characteristic fossils. Most of these formations may be looked for in New England, especially the Laurentian (now known in the Laurentides of Canada, the Adirondacks of New York, and the Highlands of the Hudson), which probably form portions of the coast in the vicinity of Portland, and the Silurian and Devonian, altered beds of which may constitute much of the crystalline rocks of New England. In connection with this subject, one of the principal points of this paper was to show the intimate relation in New Brunswick between certain of the granites of that region and fossiliferous strata, probably of Upper Silurian age, the former passing by regular gradation into the latter. If such highly altered strata, which have long been regarded as eruptive, are thus shown to be of comparatively recent origin, many of the similar rocks now so abundant in Maine and Massachussetts, and of which the White Mountains are composed, may prove to be of similar age—a conclusion long since suspected by some geologists.

Prof. HITCHCOCK said he had examined the rocks on the Maine border, and it appeared to him that the results agreed generally with the conclusions arrived at by Prof. Bailey. Some of the generalizations, however, as yet made, must be received with some reservation until confirmed by more minute examination. He regarded the paper as a valuable contribution.

ON THE GEOLOGY OF NORTH EASTERN AMERICA.

Prof. T. STERRY HUNT, the eminent Canadian geologist, next made some remarks on the above subject, illustrating his observations by means of a splendidly colored geological map of Canada, New England, and of the northern and western portions of the United States.

He complimented the authors of the previous paper on the fidelity with which they had discharged their task, and entered into some detail in regard to the geological history and composition of many of the rocks of northeastern America.

ON SURFACE CHANGES IN MAINE.

BY DR. N. T. TRUE.

The paper began by stating that the almost infinity of time since the earth was brought into existence was now generally accepted, not only by geologists, but by non-scientific men. This had led some writers to give loose reins to their imagination and to attribute an immense period of time since the close of the last great geological changes on the surface of the earth without duly examining the condition of things within their reach which, by their accumulating evidence might lead to different results. The paper then specified the various geological, surface, and other changes that were now going on in New England, and from observations within the range of human experience and record attempted to show how materially a few thousand years might alter the character of a country. From these data the paper inferred that there was no necessity for throwing back the history of the present geological era to a period much if any before the time when man was in the infancy of his race,—not very long before the historic period. Geology had suffered too much from loose conclusions, and the present state of science demanded the most rigid investigation of facts. In conclusion, it was pretty evident that if the present epoch had claims to a very high antiquity, the evidence had not yet been seen in New England, especially in the State of Maine, and that the present results might more logically be traced back to a period from five thousand to ten thousand years ago than fifty thousand.

A somewhat animated discussion ensued, in which Prof. Agassiz and other gentlemen took part.

EVIDENCES OF HIGH ANTIQUITY IN THE KJŒKKENMŒDDEN DEPOSITS OF NEW ENGLAND.

Prof. E. S. Morse made some remarks on this subject. He said that all along our shore we have a deposit of clam shells, sometimes forming large piles, which were probably thrown out by ancient inhabitants who fed on their meat. The traces of stone fire-places are found near these deposits in Denmark, as well as in this region; also, arrow-heads and other implements; though stone implements are remarkably scarce in our shell heaps. Bone instruments, however, are remarkably plentiful, with sharp cutting edges, made from the antlers of deer. The age of these heaps is a matter for consideration, and possibly those of New England belong to an earlier period than those of North Carolina, where stone implements are found similar to those of Denmark. They are of varied thickness, from two to three feet, and the shore end is abruptly cut off by the wash of the sea. There are evidences of a great change in vegetation since the deposits were made. Quahogs and oysters, which are comparatively rare on the New England coast now, evidently existed at that period in great abundance. The bones of the elk and the great auk (now extinct) are frequently found under the heaps, and are suggestive of their high antiquity. The want of the stone implements Mr. Morse considered as additional evidence of his view of their age.

ON THE ROCKY MOUNTAIN ALPINE REGION.

By Prof. C. C. Parry.

The lecturer began by stating that the Rocky Mountain Alpine Region was of special interest on account of its extensiveness as compared with anything which they had in the east. Hitherto it had been mostly inaccessible, but now that railways were making it accessible, further exploration would reveal its flora and thus it could be compared with the Alpine flora of Europe. The woody belt of coniferous trees began at an average elevation of six thousand feet. Its densest growth was at between seven and nine thousand feet elevation, and its termination was at an average height of eleven thousand three hundred feet. The growth was most dense and varied where there was the greatest and most regular amount of aqueous precipitation. At still higher elevations the actual limit of tree growth was determined by conditions of temperature which satisfactorily explained the peculiar features of vegetation there met with. This belt of trees terminated with singular abruptness. The probable explanation was that this timber line marked the extreme point of minimum winter temperature below which no phœnogamous vegetation could exist. After alluding to the meteorological conditions of the region, the paper went on to point out the peculiar dwarfed tree growth scattered occasionally above the timber line. It was on the most open exposures above that the Alpine flora was most diversified and attractive, presenting from June to September a succession of colors most attractive to the eye of the naturalist. Out of one hundred and forty-two species, fifty-six were exclusively confined to these Alpine exposures. The usual characteristics of Alpine plants were a dwarfed habit of growth, late period of flowering, and early seeding, the forms being exclusively perennial. Of the thirty-four natural orders in the Alpine flora, thirty-one belong to the Phœnogamous plants, the remaining three were of the higher order of Cryptogams. Of the latter, ferns were represented by a single species not exclusively Alpine (*Cryptogramma acrostichoides*). Mosses were more numerously represented, but were still comparatively rare. Lichens were most abundant and afforded the greatest number of species. The superficial extent of these bare Alpine exposures in Colorado Territory had been roughly estimated at from twelve hundred to fifteen hundred square miles. After a brief allusion to the fauna of the region, the paper stated that, when accessible, it would doubtless afford a good site for summer pasturage, and eventually yield choice dairy products, equalling those of the Swiss Alps, and produce delicate fibrous tissues rivalling those of the looms of Cashmere. As a summer resort it was unexcelled in the purity of its atmosphere, the clearness of its streams, and its picturesque and extended views. The paper concluded with some topographical details and with a list of Alpine plants.

ON SOME NEW MOSOSAUROID REPTILES FROM THE GREENSAND OF NEW JERSEY.

By Prof. O. C. Marsh.

The striking difference between the reptilian fauna of the cretaceous period of Europe and the same period in America was that in the former there were great numbers of remains of ichthyosauri and plesiosauri, while hardly a tooth or vertebra of the mososauroids was to be found. In America the two former kinds of reptiles appeared to be almost entirely wanting. One or two specimens found here had been alleged to be icthyosauri or plesiosauri, but further examination threw strong doubts on the matter. To replace these forms, however, the mososauroids were found in abundance. The affinities of the mososauroids were chiefly with the serpents rather than with other reptiles, although they had certain other affinities with swarming reptiles. Prof. Marsh produced some fossil remains of different specimens of Mososauroids, showing the peculiar formation of the skull. These reptiles appeared to have no hind limbs, although Cuvier thought he had detected them. The specimens found in this country, however, afforded no evidence of this. He called attention to two new forms of the family—the *Macrosaurus platyspondylus* and the *Mosasaurus Copeanus*—in which the articulation of the lower jaw was one of the most interesting features. The larger specimens of these animals showed that they must have been the monarchs of the seas of those periods, and in appearance and size not unlike the popular notion of the sea serpent, being sometimes seventy-five feet long.

Prof. Agassiz said that the examination of the Mososauroid remains revealed much that was new to descriptive palæontology. He was not quite satisfied that the remains showed real serpent-like affinities. The resemblances of the Mososauroids to serpents, he thought, were rather of the synthetic type than of affinity. The articulation of the lower jaw, he thought, in no way corresponded to that of serpents.

REVIEWS AND NOTICES OF BOOKS.

The Entomological Correspondence of Thaddeus W. Harris, M.D. Edited by Samuel H. Scudder.

The volume before us contains and shadows forth part of the life works of an indefatigable and conscientious naturalist. The review of such a volume becomes a pleasure to any lover of natural history—particularly to the entomologist—illustrating as it does the studies of such men as Hentz, Doubleday, Le Conte, Melsheimer, and others.

The book contains 437 pages, together with an excellent portrait on steel of Dr. Harris. It has four steel plates of beetles and their larvæ, also of moths and their caterpillars (coloured) while numerous woodcuts appear in the text.

The volume commences with a memoir of Dr. Harris, by Col. T. W. Higginson, which treats of his early life and collegiate careers. It also introduces to the reader the naturalists forming the circle of his acquaintance and correspondence, including such men as Curtis, Newman, Doubleday, Hentz, Herrick, Say, Kirby, Melsheimer, Le Conte, and others well known to entomologists.

Col. Higginson, speaking of Dr. Harris as a Professor at Harvard College in 1842, says: "I was fortunate to be among his pupils. There were exercises twice a week, which included recitations in "Smellie's Philosophy of Natural History," with occasional elucidations and lectures by Dr. Harris. There were also special lectures on Botany. Dr. Harris formed in addition a private class in Entomology, to which I also belonged. It included about a dozen young men from different college classes, who met one evening of every week at the room where our teacher kept his Cabinet in Massachusetts Hall. These were very delightful exercises according to my recollection, though we never got beyond the *Coleoptera*. Dr. Harris was so simple and eager; his tall, spare form and thin face took on such a glow and freshness as he dwelt so lovingly on Antennæ and Tarsi, and he handled so fondly his little insect martyrs that it was enough to make us love the study for life beyond all branches of natural science, and I am sure that it had that effect on me."

Dr. Harris, in speaking of his Entomological Cabinet, says: "My object in making a collection, and for this purpose asking the aid of friends, has not been merely personal gratification,—it has been my desire to add something to the cause of science in this country. Even should death surprise me before the results of my labours are before the public, I shall leave an extensive, well arranged, and named collection, which from the care bestowed on it, will be in a condition of good preservation, and will remain as a standard of comparison when I am gone."

"Dr. Harris is principally known to the people of America by his 'Report on Insects injurious to Vegetation' first published for the State in 1841, in his capacity as one of the Scientific commissioners of a Geological and Botanical Survey.

This was reprinted by himself under the name of 'Treatise' instead of Report, in 1842—and it was again revised in 1852. After his death it was reprinted by the State in an admirable form, with engravings, and it is upon this that his scientific reputation will mainly rest.

It is admitted by all who read this treatise that it is a model combination of the strictly scientific spirit with the clearest popular statement.

Dr. Harris also combined the use of the pencil with the study of entomology—an accomplishment of great importance and benefit. After learning to classify butterflies by studying the nervures of the wings, he fixed by copying each successive stage of their developement."

His excursions too, though rare, were effectual; he had the quick step, the observant eye, and the prompt fingers of a born naturalist; he could convert his umbrella into a net and his hat into a collecting box; he prolonged his quest into the night with a lantern, and into November by searching beneath the bark of trees.

Col. Higginson in speaking of the correspondence of Dr. Harris, says—

"In this destitution of books and cabinets there was another compensation which gave to Dr. Harris a more practical satisfaction.

The conditions of a new country implying these drawbacks, imply also a great wealth of material. In older countries it is rare to discover a new species; it is something even to detect a new habitat. But these lonely American entomologists seem, as one reads their correspondence, like so many scientific Robinson Crusoes, each with the insect-wealth of a new island at his disposal, they are monarchs of all they survey. With what affluence they exhibit their dozen undescribed species; with what autocratic power they divide and re-combine genera! How ardently writes Hentz to Harris, 'Oh! why must we live at such a distance from each other? What pleasures we might enjoy together; or, mourn no longer for the singleness or solitude of your *Amphicoma Vulpina!* I have found another.' Yet they were richer for their loneliness, and perhaps it was better that Massachussetts and Carolina even in scientific jurisdiction should remain at a reasonable distance. Had these students shared one entomological region they would have had less wealth of material for exchange."

Col. Higginson concludes the memoir thus: "The steady growth of Dr. Harris' reputation is not due alone to his position as one of the pioneers in American Science during its barest period. It has grown because he proves to have united qualities that are rare at any period. He combined a fidelity that never shrank from the most laborious details, with an intellectual activity that always looked beyond details to principles. No series of observations made by him needed revision or verification by another; and yet his mind always looked instinctively towards classification and generalization. He had also those scientific qualities which are moral qualities as well; he had the modesty and unselfishness of science, and he had what may be called its chivalry. He would give golden days of his scanty summer vacations to arrange and label the collections of younger entomologists, and it roused all the wrath of which his soul was capable, when even a rival was wronged, as when Dejean ignored Say's descriptions, because he had not learned English enough to read them." So much for the man. We shall now look for a short time at some of his correspondence. The foregoing we have drawn altogether from the memoir by Col. Higginson, considering it the best description we could give of the man—and would earnestly recommend all interested in entomology to purchase the work and study it for themselves, believing that they will be fully compensated by its perusal.

We shall merely glance at a very few points mentioned in this correspondence, which have been corroborated by succeeding entomologists. In a letter to Hentz, dated Nov. 28th, 1825, he says:—"The unarmed *Onthophagus*, (*Copris*,) I have always taken to be the female of *Latebrosus*. Individuals of the male sex vary considerably in the size and projection of the thoracic protuberance." This has been well established since by entomologists. Processes such as antennae, mandibles, thoracic projections, clypeal developments are more prominent in the males of nearly all insects. We have also taken this particular insect *in coitu*. Again, in a letter dated Feb'y 26th, 1828, we quote what most coleopterists will agree with. "Say's genus *Harpalus* is a kind of magazine for doubtful species, several of which have the apex of the elytra *sinuato-emarginate*, as you observe in that common and very beautiful species, *H. Viridis*, Say, or as Prof. Peck more judiciously named it (from its great variation of hues)—*Proteus*. I am not sure but this species may prove to be the *viridi-æneus* of Beauvois, whose figure and description correspond very well with our insect." This species we have been puzzled with not a little on account of its variety of colours. Some in our cabinet are of a bright metallic green hue, while others have a cupreous appearance. The difference in colour we believe to be mainly a sexual distinction. In reference to Say's genus, *Feronia*, he says, "It is nevertheless a heterogeneous mixture, a complete *pot pourri*, out of which several natural genera may be rescued." We have found some of the genera of the *Carabidæ* to have been our *Pons asinorum* in Coleoptera. Species of this group closely resemble each other, and are very difficult to determine. Modern entomologists, however, have done much to clear up this difficulty; among the foremost is Le Conte.

The correspondence of this indefatigable worker (Harris) is invaluable to the entomologist, as many an idea discovered by himself is here made known for the first time. In a letter bearing date July 28th, 1829, he says, "An excellent natural character by which you may distinguish *Colymbetes* from *Dytiscus* (if you have not the males) is that there is a projection of the anterior part of the orbit over the eye in *Colymbetes*, and not in *Dytiscus*. This character had not been noticed by other entomologists. You will see it very distinctly in *C. sculptilis*." We have an acknowledgement of this discovery in a letter of Hentz, Aug. 13th, 1829, thus: "I thank you for mentioning your discovery for distinguishing between *Colymbetes* and *Dytiscus*. It is of the highest value where we must in the state of the science know the sexes to ascertain genera."

The above gives some general idea of his correspondence with Hentz, Melsheimer, Doubleday, Herrick, Say, Le Conte, and others. Through all his writings there is traceable that perseverance and clearness of decision, which marks the true naturalist. The familiar, popular, yet truly scientific style of its reasoning will recommend the "Correspondence of Thaddeus William Harris" to all lovers of Natural History.

The volume contains, also, descriptions of larvæ, their metamorphoses, habits, &c.; selected descriptions of insects; re-published papers, and contributions to entomology heretofore scattered in different works, and not easily obtained. A. S. R.

GEOLOGY AND MINERALOGY.

Fossil Bivalved Entomostraca.—No one has done more than Prof. T. Rupert Jones to illustrate these numerous and curious fossils, often microscopic, sometimes liable to be mistaken for Bivalved Mollusca, which abound in stratified rocks of all geological ages, and sometimes contribute not a little to the mass of strata of some thickness. In the following paper, from the *Quarterly Journal of Microscopical Science*, he clearly describes their characters, affinities, and geological relations:—

"On this occasion I have to explain the nature of the microscopic Bivalved Crustaceans, to allude to their ways of life, and to draw attention to some of the facts connected with their being found fossilized in clays and stones.

The common Crab and Lobster are important members of the Crustacean group of Animals; so also are Shrimps, Prawns, Sandhoppers, Woodlice, the King-crab of the Moluccas, and many others, which are only noticed by the naturalist and seen in museums.

A characteristic feature of the Crustaceans is their jointed structure (placing them among the *Articulata* or *Arthropoda*), and their being for the most part coated with a hard, tough armour—the part that covers the front of the body being usually formed of a large plate or buckler (called the Carapace or Cephalothorax), and the rest consisting of ring-like segments.

The Shell (or Test) of the Lobster well illustrates this. In the Crab, however, the body is more shrunk up, as it were, beneath the Carapace, which is widened and enlarged, whilst the jointed tail-piece is very small and folded neatly underneath. The organs in the Crab are, as it is said, concentrated; and the traces of the many ring-joints (or "somites") of which the Crustacean Animal is typically or theoretically constructed are nearly lost to sight. Indeed, if we trace the modifications of structure from one Crustacean to another—from the many-segmented Brine-shrimp to the more definitely jointed Woodlouse and Sandhopper, almost equally ringed throughout the length of their bodies—and through Squills and Shrimps with their carapace in front and their armoured tail behind, and the *Anomoura* or short-tailed members of the Lobster Tribe, until we get to the Crabs, with scarcely any tail at all, we follow, as it were, the footsteps of Nature in her advance from the lower and simpler structures, with their many times repeated parts and organs, to the higher, more concentrated, more complicated, more specialised, and, in one sense, more perfect type of animal structure.

We see the carapace flat in the Crab; in the Lobster it is folded down on either side, and so we have it in many other species; but this folding is carried a step further in some groups; the two halves being quite separate at the back, along the central line that is well marked in the Lobster, and becoming the two valves of a two-sided carapace, resembling that of a common Bivalved Mollusc.

This bivalved structure is not met with among the larger Crustacea, but only in the smaller and frequently microscopic forms. These are members of the group known by the general term "Water-fleas," or *Entomostraca* ("shelled insects)." Some live in the sea, some in ponds and rivers. They exist in countless numbers. Like the Sandhoppers, Shrimps, Lobsters, &c., they assist in the health-economy of the watery world; they are scavengers, using up all dead matters.

The Crustaceans have been termed "the Insects of the Sea," and well they may, for they not only take the place of Insects, Centipedes, and Spiders in the ocean, on every shore and at nearly every depth, but they emulate the Insect-tribe in the extremes of grace and ugliness. Though they can scarcely be said to resemble the Insects in their flight, yet in their flittings to and fro they are not unlike; and in their ceaseless, unwearying crawlings the likeness holds good;—as scavengers, too, they claim brotherhood with a world of Beetles and other Insects. In this, however, as well as in the less amount of concentration of their organs, they differ from Insects—namely, the changes which the latter undergo are from one distinct stage to another, such as caterpillar, chrysalis, butterfly; but in the Crustacea we have successive moultings of the crust, with some alteration in the body, corresponding with the growth of the individual; and though these changes are often striking (in the young state of Crabs, for instance), yet there is no break in the line of life, no dormant period, no transition from one mode of living to another, as there is in Insects.

However diversified the forms of the different kinds of Crustacea may be—however varied the number and disposition of their limbs, yet this great group have, with few exceptions, their articulated framework as a feature in common; and if that be wanting, still (according to Huxley) the uniformly similar, six-limbed, and Nauplius-like form in which so many members of the lower groups of Crustacea begin their existence, furnishes a strong connecting link among them.

The diversity of organs among the Crustacea is almost endless; what serves as jaws in one division are legs in another; the antennæ in one may be organs of sense, in another of locomotion or of prehension: then there are thoracic branchiæ in some (Decapods), sac-like branchial appendages in others (Tetradecapods); whilst the Entomostraca rarely have any true branchiæ, the surface of either some part or of the whole of the body serving for aëration.

In the Crabs, which present the condition of highest centralisation for the Crustacea, the three front segmental elements are coalesced and modified as the organs of feeling, sight, and hearing; the next six supply the mandibles, maxillæ, and palpi for the mouth; five are devoted to the organs of locomotion and prehension; and the remainder are lost in the abbreviated abdomen or tail-piece. In the other Decapoda (with ten limbs) also, such as Lobsters, &c., *nine* segments and their pairs of appendages are thus concentrated into the organs of sense and the mouth. In the Tetradecapoda (with fourteen limbs), such as the Woodlouse, &c., only *seven* segments are concentrated for these cephalic organs, In the Entomostraca, only *six* thus coalesce for the senses and mouth in the *Cyclops* group, only *five* in the *Daphnia* and *Caligus*, and only *four* in *Limulus*.

The essential points in the framework of the body of an Entomostracan of low organization, and in the arrangement of the organs, are well seen in the Brine-shrimp (*Artemia.*) Here the body has numerous articulations or segmented portions. The head-part takes up four or five coalesced somites, bearing the antennæ, eyes, and masticatory organs; eleven pairs of natatory and branchial limbs follow on eleven segments; the next two joints or rings have their own modified appendages; seven segments succeed, without appendages, except that the last ends with the caudal-flaps (post-abdomen or telson.)

Others also of these lower Crustacea, or Phyllopoda (whether bivalved or not), have more than twenty segmented parts in their body; but of the twenty theoretical typical somites or segments (twenty-one,* including the telson) characteristic of a well-developed Crustacean, several of the hindmost are absent in most of the Bivalved Entomostraca; and this curtailed form is wholly enveloped in the two more or less closely-fitting carapace-valves of the cephalothorax.

Thus in the Phyllopodous *Limnadia*, after the front part of the body, bearing the antennæ, eyes, and mandibles, succeed twenty-two pairs of branchial limbs, more or less developed, followed by the post-abdomen. Locomotion is here effected by the antennæ and post-abdomen. In the Cladocerous (Daphnioid) and Ostracodous (Cyproid) groups, however, of the Entomostraca, the antennæ, eyes, mandibles, and maxillæ, two to six pairs of feet (with branchial appendages attached to some of them), a short abdomen, and a strong hooked post-abdomen, are the chief features; so in these Bivalved forms, instead of the numerous branchial laminæ of the Phyllopods, we have a few pairs of locomotive organs with their branchial appendages.

The disposition of the organs in various orders, families, and genera, may be studied in detail in the works of Baird, Dana, Zenker, Lilljeborg, Fischer, Grube, Sars, Norman, Brady, and others. For the family and generic characters of the *Ostracodæ*,

---

* The twenty-one theoretical somites are thus allocated by some naturalists:—seven to the head or cephalon, seven to the thorax or pereion, and seven to the abdomen or pleon.

see G. S. Brady's memoir in the 'Intellectual Observer' for September, 1867; and for the specific characters of many of the *Cladocera*, see Norman and Brady's memoir on the *Bosminidæ*, &c., in the 'Nat. Hist. Trans. Northumberland and Durham,' 1867.

The Bivalved Entomostraca differ among themselves not only with respect to the arrangement and characters of the organs of sense, mastication, locomotion, and aëration, but also very markedly in the shape and structure of their carapace-valves.

In *Apus*, one of the Phyllopods, the carapace (or shell covering the cephalothorax) is nearly flat and shield-like, but ridged along the middle. In *Nebalia*, another Phyllopod, the carapace is folded down, as it were, on either side of the animal; the abdomen extends beyond it behind, the legs below, and the antennæ in front, with a small, arched, movable projection above the eyes. In the *Cladocera* (*Daphnia*, &c.) the carapace is still more flatly folded down, with a bend along the dorsal line; and the whole of the body is included within it, except that the antennæ (as swimming limbs) protrude at the head from lateral notches, which give to the front of the carapace a hood-like or quaintly beaked shape.

In other Bivalved Entomostraca the two sides of the folded carapace are quite distinct, forming separate valves, but united in life along their dorsal margins by either a simple membranous attachment (as in *Estheria*, &c.), or by a more complex system of ridge and furrow, or teeth and sockets (as in the *Cyproidea*).

In outline the carapaces of *Cladocera* range from orbicular to oblong, with varying contours. They are horny or chitinous, thin, usually transparent, and ornamented often with some reticulate pattern, having reference to the hexagonal cell-system of the typical crustacean test, or the network resolves itself into the delicate bands and furrows by the greater development of one set of mesh-lines than another. This carapace is periodically moulted and renewed; but occasionally it is retained, and one layer succeeds on the inside and at the outer edge of another until the valve is marked with several concentric boundary-lines of the periodic stages of growth. Mr. Norman points out that this feature, normal in *Menosphilus tenuirostris*, is occasional in *Lynceus elongatus*; see 'Nat. His. Trans. Northumberland and Durham,' 1867, p. 53. It is also normal in the *Limnadiadæ*, which retain their valves, whilst they cast only a chitinous skeleton or framework of the body.

Fossil carapaces of *Cladocera* have not been recognised, their extreme tenuity probably being neither favorable for their preservation nor, if preserved, to their detection in the fossil state.

The Bivalved Phyllopods, such as *Limnadia*, *Estheria*, and *Limnetis*, are larger than the *Cladocera*, and their valves are usually thicker and stronger. In shape round, oval, or oblong, they often resemble the shells of Conchifera or Bivalved Molluscs, and have been mistaken for them when living, and much more frequently in the fossil condition. The presence of a straight hinge-line, of umbones, and of concentric lines of growth, are special features in which they more or less imitate the Conchifera, such as *Avicula*, *Tellina*, *Pisidium*, &c. *Estheria donaciformis* came to the British Museum as a *Nucula;* but Dr. Baird recognised its crustacean characters, disguised as they are by the molluscan shape. *Estheria minuta* long passed as a little shell among geologists until Prof. Quekett's microscope detected the hexagonal cell-tissue of the Crustacean in fragments of the fossil: see my 'Monograph of the Fossil Estheriæ' (Palæontographical Society), 1862, pages 3, 11, &c.

Very different kinds of carapace-valves belong to the *Ostracoda*. A synopsis of the recent British forms of this great group, carefully drawn up and illustrated by Mr. G. S. Brady in the 'Intellectual Observer' for September, 1867, gives us a good general view of these very interesting Bivalved Entomonstraca, amongst which are (excepting some of the Copepoda and Cladocera) the most common of the marine and freshwater forms, both recent and fossil. Thus—

CYPRIDÆ.—*Cypris; Cypridopsis; Paracypris; Notodromas; Candona; Pontocypris; Bairdia; Macrocypris.*

CYTHERIDÆ.—*Cythere* (and *Cythereis*); *Limnocythere; Cytheridea* (and *Cyprideis*); *Cytheropsis* (to be changed to "*Eucythere*") *Hyobates; Loxoconcha* (=*Normania*); *Xestoleberis; Cytherura; Cytheropteron; Bythocythere; Pseudocythere; Cytherideis; Sclerochilus: Paradoxostoma.*

CYPRIDINIDÆ.—(*Cypridina*,) *Philomedes; Cylindoleberis; Bradycinetus.*

CONCHŒCIADÆ.—*Conchœcia.*

POLYCOPIDÆ.—*Polycope.*

CYTHERELLIDÆ.—*Cytherella.*

The valves of the *Cypridæ* (Brady) are small, usually either kidney-shaped, oblong, or boat-shaped, smooth or bearing only faint punctation and delicate setæ, and rarely thickened on the hinge-margins. The *Cytheridæ*, on the other hand, though often smooth, have frequently thick and highly ornamented valves, coarsely or neatly pitted, sculptured with fret-work (more or less reticulate), or bristling with spines and spikes. Either ovate or oblong in many shapes, they have usually thick hinge-margins, with furrows and sockets for bars and teeth. The other families mentioned have smooth valves; those of *Cypridina* are large, thick, and convex, mostly round or oval, and are marked with an antero-ventral notch. *Conchœcia* has an oblong, and *Polycope* a subspherical shell; both thin. *Cytherella* has oblong, compressed, thick valves, usually smooth, one fitting into the other, somewhat like the lid of a wooden snuff-box.

Of the *Ostracoda* very many are found fossil, such as belonged to fresh waters, to brackish waters, and to the sea, in great variety. Münster, Roemer, Reuss, De Koninck, Bosquet, Bornemann, and others, have described many species from the strata of Germany, France, Belgium, &c.; and at home McCoy, Salter, Kirby, Holl, G. S. Brady, and myself, are among those who have treated of such as have been met with in the British Isles; but a large number still remained undescribed.

Amongst the fossil specimens are several that cannot be readily co-ordinated with the groupings made out of the existing forms, as may be expected both by the naturalists who are accustomed to look on the existing races as successional representatives of older forms, and by those who may regard successive faunæ as creational replacements.

Among such fossil forms are many from the older ("Palæozoic") strata; but even for these existing representatives occasionally turn up, such as Brady's *Heterodesmus*, lately brought from the Japanese seas, which has apparently a close affinity with M'Coy's *Entomoconchus* of the Mountain-limestone. Some, indeed, of the old forms are scarcely distinguishable, as far as the valves are concerned, from their modern representatives; for instance, *Cypridina primæva* (M'Coy, sp.) of the same old limestone, and its associates *Cyprella* and *Cypridella*, present in the various valves of their multiform species gradations among themselves, and an easy passage into *Cypridina* itself. Others among the ancient faunæ possess two or more of the characteristics that are now divided amongst the several members of a group; thus the carapace of the *Leperditia* of the Silurian period has resemblances in outline to members of the Limnadiadæ, Cypridininæ, and Cypridæ; in muscle-spot to the first two; in vascular markings to the first and to the Apodidæ; in the place of the eyes to the second and fourth; and in the eye-tubercles to the third and fourth. Altogether *Leperditia*, and its palæozoic congeners *Isochilina*, *Entomis*, *Primitia*, *Beyrichia*, and *Kirkbya*, seem to be more nearly within the alliance of the *Limnadiadæ* than of the others. Nevertheless, in these, as well as in other groups of Bivalved Entomostraca, we have always to be careful in assigning special value to differences of outline, ornament, and structure, because it is not unusual, among these little Crustacea, to find that similar shells may belong to different genera, when we examine them alive, and on the other hand very closely allied species may have dissimilar valves.

As a general rule the fossil Entomostraca of freshwater, brackish, and marine strata, respectively, correspond in family and generic characters to species found in such waters at the present day; and therefore the geologist often finds his supposition as to the origin of a set of strata confirmed by the presence of this or that kind of Entomostraca; and in some instances thin intercalated bands of freshwater or of estuarine deposits, amongst marine strata, can be indicated by the presence of *Estheriæ*, which in past, as in present, times appear to have avoided sea-water, though living abundantly in salt-marshes and lagoons. See the 'Monograph of Fossil Estheria,' 1862.

Thus, also, Mr. G. S. Brady observes ('Intellectual Observer,' 1867, p. 111), in noticing the geological interest of Entomostraca, "My belief is, therefore, that those strata which exhibit such very abundant and closely packed remains of the smaller *Cypridæ* and *Cytheridæ* have most likely been formed in shallow, brackish lagoons, or at the mouths and deltas of rivers. The species of Ostracoda which I have found in these situations are *Cytheridea torosa* (Jones), *Cythere pellucida*, Baird, and *Loxoconcha elliptica*, Brady; while in water a little further from the saline influence, but still slightly partaking of it, it is not uncommon to meet with *Cypris salina*, Brady, and *Cypridopsis aculeata*, Lilljeborg, as well as Entomostraca belonging to other orders."

The Entomostraca act pre-eminently as scavengers in both salt and fresh waters. Most of the groups (as Copepods, Ostracods, and Phyllopods) comprise both marine and fresh-water species; but the *Cladocera* are confined to fresh water. The excessive swarming of the pink *Daphnia* or Water-flea has occasionally reddened pond-water so strongly as to have seemed supernatural to our ancestors, and to have produced terror, as an evil omen, among the ignorant. Amongst the British *Ostracoda*, *Cypris*, *Cypridopsis*, *Notodromas*, *Candona*, are inhabitants of lakes, ponds, ditches, streams, and rivers; and they can be readily obtained and conveniently kept and studied in the aquarium. *Paracypris*, *Pontocypris*, *Bairdia*, and *Macrocypris*, are marine members of Mr. Brady's group "Cypridæ." Excepting the fresh-water *Limnocythere*, all the *Cytheridæ* are marine, *Cytheridea* and *Loxoconcha* having also a taste for brackish water. These salt-water species of the Bivalved Entomostraca are distributed in deep and shallow seas, in pools on the beach between tides, in lagoons and back-waters, and in the brackish water of estuaries and salt-marshes. The 'Trans. Zoolog. Soc., 1867, contains a memoir, by Mr. G. S. Brady, descriptive of some new forms of Ostracoda, in which we find some "habitats" referred to as being in "shallow water," and others at 14, 17, 30, 43, 60–70, 223, 360, 470, and even 2050 fathoms.

The *Cypridæ*, having plumose "antennæ," or natatory limbs, possess a greater or less power of swimming, *Candona* being a marked exception. On the other hand, the anterior locomotive limbs of the *Cytheridæ* have usually short setæ and hook-like spines, instead of bunches of long, delicate filaments; and consequently these animals crawl about on the weeds, shells, and mud, and few among them can swim at all.

The *Cypridinidæ* are mostly free-swimming, oceanic forms. Mr. Brady observes that "some of the members of this family have very slight swimming powers, and live chiefly amongst mud; others are very agile swimmers, and are often taken in the towing-net—more especially at night—near the surface of the sea. They seem, indeed, to contribute very materially to the production of the wonderful phosphorescence of the tropical seas" ('Intellectual Observer,' 1867, p. 115.)

The removal of dead animal matter is easily accomplished by Entomostraca and other small Crustacea; and, as the Emmets and their little fellow-labourers pick bare the bones of large land animals, so these minute creatures of the water use up the dead bodies of the animals in the ocean, the lakes, and rivers, foraging for the dead zoophyte, and swarming over the lifeless mass of mollusc, annelid, and star-fish, and taking their share of the dead fish that had lived by eating their fellows, * and of the dead whale that had strained from the water myriads of their congeners for his daily food. When the sailors, in one of Parry's voyages, hung their salt beef over the ship's side in the water for a while, it soon disappeared under the combined attack of these little devourers; and if a fish be put in a perforated canister in a suitable stream or pond for a couple of days, its skeleton will be prepared by the tiny Crustaceans. Just as Mr. Charles Moore has found in the Lias of Somersetshire, the fossil reptiles overlain by a swarm of Ammonites, buried with the half-eaten carcase in the mud, so the fossil remains of the fishes (as noticed by Phillips, Binfield, myself, and others) are often and often found imbedded with innumerable carapace-valves of the Entomostracous scavengers in mud-beds of all ages, especially the Carboniferous, Wealden, and Tertiary clays); nor are Entomostraca wanting among the bones of fish and reptile in the Lias above alluded to.

Thus also we have seen a crowd of *Cyprides* and *Candonæ* cleaning out the shell of a *Paludina* or a *Limnæus* in an aquarium; and in the fossil state we know that valves of Entomostraca are sometimes associated in the shells of Molluscs. Thus Mr. J. W. Kirkby says ('Trans. Tyneside Nat. Field-Club,' vol. iv. 1859,) "The convex valve of a Conchifer appears to have been a popular place of resort with the *Bairdiæ*, for out of one I procured some dozens of individuals."

The rapid increase of some kinds of Entomostraca, and the tenacity of life possessed by the eggs, are circumstances that have attracted the attention of naturalists. The almost sudden appearance of *Apus* and of *Estheria* in great numbers in ditches, and even in cart-ruts, after heavy summer rains, in Germany and France, has been particularly noted. Here allusion need be made to these facts only to remind the reader that the dried mud of ponds will nearly always be found to contain the still vital eggs of various species of Entomostraca; and if small portions be sent home from abroad, and placed in pure water, the species belonging to the original pond may be produced under the eye of the naturalist and properly recorded. Thus, Mr. Henry Denny and Dr. Baird had the pleasure of raising in England, from dried mud sent by Dr. Atkinson from Jerusalem,

* See Dr. Baird's "Notes on the Food of some Fresh-water Fishes more particularly the Vandace and Trout." 1857.

several species of Entomostraca new to science. (See 'Ann. Nat. Hist.' for 1859 and September, 1861.)

Flourishing, then, in every water-area, fresh or salt, deep or shallow, running or still,—possessing strong powers of vitality and reproduction, and furnished with relatively hard or tough coverings, calcareous or corneo-calcareous in substance, these minute but innumerable Entomostraca have left their valves, either as the exuvia of periodical castings, or as the lasting remains of hosts of animalcules buried in the tide-shifted silt or the mud and sand of the freshet, to be fossilized in laminated clays, hardened mud-stones, and solid rocks of limestone.

In the extremely old "Silurian" strata we find abundant specimens of *Primitia*, *Beyrichia*, *Leperditia*, and *Entomis*, apparently related to the Phyllopods, and always associated with marine fossils. In the "Devonian" beds of marine origin we find *Entomis*, &c.; and in the fresh-water beds of the same period there is an *Estheria*, both in Scotland and Russia. The "Carboniferous" formations next succeed, and contain a host of Bivalved Entomostraca, many of them not yet described. *Cypridina* is well represented in these old strata with *Entomoconchus* (before alluded to); *Leperditia* lived on, with *Beyrichia*; and *Kirkbya* flourished with *Cythere* and *Bairdia*. In the fresh-water or estuarine bands *Estheria* occurs in several species, and *Cypris* or *Candona* is present also. The persistence of these genera from so old a time to the present is what is expected of such relatively low forms of life; wide geographical extension and long continuance belonging to such creatures as have not been highly specialised. In the "Permian" formations ("Magnesian Limestone" of Durham and other strata) *Bairdia*, *Cythere* and *Kirkbya* play an important part. In the "Trias" or "New Red Sandstone" we find *Estheria*, where marine conditions failed and fresh water had an influence, not only in Europe, but in India and America. (See my 'Monograph on Fossil Estheriæ,' 1862.) The Entomostraca of the "Lias" and the "Oolites" are not few, though not well known. In the "Purbeck" and "Wealden" beds they are better known. Masses of Purbeck building stone are wholly composed of the valves, and some of the Weald clays split like paper along the layers of shed valves of *Cypridea*: nor are *Estheriæ* wanting in these old fresh-water beds. The "Gault" and "Chalk" are full of *Cythere*, *Bairdia*, and other allied genera, all marine. The

"London Clay," the "Bracklesham Beds," and "Barton Clay," swarm in some places with similar forms, whilst the "Woolwich Beds" below them, and the "Hampstead" and "Osborne" formations of the Isle of Wight, above, are characterised by *Candona*, *Cytheridea*, &c., such as love estuaries, lakes and rivers. Lastly, for England, the "Crag" of Suffolk, and that of Bridlington, abound in marine forms.

If we had only these little fossils whereby to form an opinion of the probable conditions under which the clays, sandstones and limestones were formed in the long past eras of this planet, we should have, in nearly every case, ample evidence of the history of each bed of mud, silt, and shell-sand, in which these minute Entomostraca can be found.

The seas of the Silurian period had their thick-shelled *Leperditiæ* and *Beyrichiæ* very distinct from their now living congeners, but linked to them by close affinities readily discoverable by the Naturalist. When land was increased, in the Devonian period, the sea-coasts still abounded with marine Crustacea, and the lakes and rivers abounded with *Estheriæ*, like those of the present day. The coral-seas, which gave birth to the Derbyshire limestone, abounded with strange forms of Entomostraca. Land still extended, and miles and miles of swampy coasts and lowlands crowded with the dense vegetation of the Coal period, and, intersected with black, muddy lagoons, offered a home for endless tribes of Entomostraca, feeding on animal and vegetable refuse—the rotting plants and shoals of fish, poisoned by the black mud of the peaty rivers. These muds and silts, and all their buried shells, and plants, and fish, and crustaceans, sank down, and were covered up and hardened—petrified, often baked by heat, and then, pushed up again by subterranean force, re-appearing at the surface as the hard, rocky base of many a new country, and forming the bed of new seas, were eaten into by the ever-working waves, worn down by periodic rains, aided by the scorching sunbeams, the splitting frost, and the incessant agency of the atmospheric gases chemically affecting the surfaces of the rock.

The sea, now occupying fresh areas, continued its great work of destruction and reparation—wearing down the shores to make up the sea-beds; and it continued to be the abode of life in its myriad forms; but they were mostly new forms. In the new deposits laid down on the upturned edges of the old strata we find Entomostraca again, similar to those of to-day, and in the lagoons and lakes of the Triassic period *Estheriæ* abounded. The varying seas, the estuaries, bays, gulfs, and oceans of the Oolitic period, when land was rising here and sinking there—the sea ever rolling under its tidal laws, and coming and going amongst the ever-shifting land—these seas, we know, swarmed with Entomostraca, amongst the world of marine creatures, and the rivers and lakes were swarming too. The land that bore the great Iguanodon and Megalosaurus—gigantic lizards wandering on the marshy grounds, just as the amphibious Hippopotami of to-day wallow along the African swamps—had its great rivers; and their deltas like those of the Ganges and Mississippi, consisted of mud-banks and muddy lagoons full of *Uniones*, *Paludinæ*, *Cyrenæ*, and other shell-fish, and above all, with *Cypridæ* and *Estheriæ*, feeding on the dead molluscs and fish.

The Sussex marble is mainly composed of these sometimes; some beds of freestone at Swanage are wholly made up of them, and flake after flake of black clay, once mud, may easily be picked by the hand, in the Isle of Wight, in cliffs some miles in extent, from beds of shale nearly two hundred feet thick, every surface being thickly coated with the shells or carapaces of these minute creatures. What durable witnesses of a long-past age!

The "Age of Reptiles" passed away, the land and its rivers went down, the sea-bed and the estuaries were coated over with new sands and clays, derived from new cliffs and new lands, washed by the untiring, enduring sea. Some parts of what is now the European area sank several hundred feet, and was covered by a deep sea, and in this were formed successively the Greensand, Gault and Chalk. The shores were thus gradually changed, and the new land elsewhere raised up, or remaining as islands here and there, bore new plants, new trees, and new animals; the sea also brought forth new Entomostraca, which may be easily obtained by washing the Gault clay into mud, drying and sifting it, and by washing the Chalk into powder, and examining it with a glass.*

Another great change occurred over half the world, at least; the strata that had been accumulating in gradually deepening seas, and on sinking sea-beds, were hoisted up again by subterranean force, and a new era was inaugurated—recognized by geologists in the sands, clays, and limestones which they denomi-

* See some notes on the preparation of clays, sands, and chalk, for microscopical purposes, in the "Geologist" 858, vol. i., p. 249.

nate "Tertiary." The land was diversified more than before,—more islands, more bays, more rivers, more seas; hence a greater variety of life in every shape, animal and vegetable, and not least in *Entomostraca*.

From some beds of sand and clays we get *Cytheridea Muelleri*, such as now covers the estuarine muds not far from mouths of rivers; in other beds we get *Bairdia subdeltoidea*, such as is chiefly found in deep seas and warm climates: in another stratum we get the carapaces of *Cytheres*, such as we find in the shallow water of our own coasts. Here we have evidences of the existence of different conditions of sea-bottoms, contemporaneous or successive, as the case may be, in a series of deposits now converted into clay or stone.

Elsewhere we have layers of clay or stone filled and covered with the shells of *Cyprides*, as thickly strewn as in the mud of any river now running.

Tracing these river-deposits and these sea-deposits, the geologist traces out the ancient outlines of land and sea in the long past periods of the earth's history, of which we have no other record. But this is a record sufficient; and it teaches us, also, that not only to great things but to small, not only to monster beasts—Iguanodons, Elephants, Whales—but to microscopic Entomostraca, is our attention to be turned if we wish to learn aright what has passed on this earth's surface, if we wish to carefully study God's creation, and to see all the evidences of perfect design and perfect adaptation that the history of successive forms of life, with their successive modifications of structure and habits, can supply.

Boulder Clay.—Is Boulder Clay a marine or land deposit, formed by glaciers or by icebergs, or is it of both or of several origins? These questions, in so far as they relate to the Till or Boulder Clay of Scotland, are ably discussed as follows by Mr. Crosskey, in the transactions of the Glasgow Geological Society:

Under the general term, boulder clay, many deposits produced at various periods during the great glacial epoch, and by different causes have been loosely included. It is necessary to distinguish between these various 'Boulder Clays," before observers in separate localities will be able to understand each other's language, and before any satisfactory theories can be established regarding the methods of their formation.

The old motto for statesmen dealing with barbarous tribes on the frontiers of an empire was, "Divide and command;" and this must also be the motto for students of the apparently confused accumulations of glacial deposits. We must divide to command.

I. The oldest boulder clay I at present believe to be represented by that which underlies the shell clay of the West of Scotland.

It is only in the lower districts, however, that the shell clay rests upon it, while it reaches to a height in Scotland (1,500 feet or more) far beyond that at which any shells have yet been discovered. Its thickness extends from a mere covering of the rock, to the depth of even 300 feet, and is excessively variable.

It is closely compact, as though subjected to immense pressure and difficult to work even with the pick-axe.

Although occasionally containing patches of sand, of greater or less extent, it has no stratification. The included stones are in large numbers, polished and striated, and have not been broken by the process through which they have passed. Even thin and brittle pieces of shell are found finely striated.

These polished and striated surfaces are so freshly preserved that the stones could not have been rolled on a beach subsequently to their production. Any trituration would at once destroy the fineness of the glaciated surfaces.

The included stones are chiefly traceable to the heights nearest the locality in which the special bed is found, although a certain proportion have travelled from distances in the direction along which a glacier would naturally have moved, according to the general conformation of the country.

This boulder clay, we suggest, belongs to the period when the cold of the glacial epoch reached its intensest point.

It preceded the development of the arctic fauna, now fossil in our glacial clays, since the shell beds again and again most decisively rest upon it.

The highest point at which arctic shells are found in Scotland is 510 feet (Airdrie); from that point downwards at various levels to half-tide mark and beneath the sea.

The boulder clay, however, is found destitute of shells to the height of at least 1,600 feet, in every hollow and nook, on mountain flanks, through Scotland.

The only cases of fossiliferous boulder clays are those which I shall presently describe under the second type of boulder clay, and which form cliffs upon the shore, and never extend to any distance inland.

It is difficult to explain these facts in connection with the marine origin of the older boulder clay.

Upon the higher grounds it occupies frequently large hollows; these hollows might possibly have existed beneath an ice sheet and the clay have been accumulated within them, and subjected to great pressure.

At lower levels the boulder clay is largely developed, both in the plains themselves, and on the flanks of the hills bordering wide valleys, and may thus have been formed beneath the glacier near its termination at the sea.

Whatever explanation of its origin, however, may be given, there seems, so far as present investigations extend (and I admit that all present investigations are more or less tentative), to be evidence for the existence of a boulder clay. (1) Older than the fossiliferous glacial deposits. (2) Extending to greater heights than those to which the proof of any *recent* elevation in Scotland yet extends. (3) Unsubjected to any action of the tidal wave upon the shore. (4) And connected with the more remote and extreme arctic conditions.

II. There is a boulder clay very similar in physical composition to the one just described, but containing fragments of broken shells and many Entomostraca and Foraminifera.

I have examined this along the Irish coast, at the base of the Hill of Howth, and many other localities; on the Scotch coast; on the English coast near Sunderland; in Yorkshire, and along the banks of the Mersey.

The shells this boulder clay contains are essentially arctic in character; but they are very fragmentary, and even single valves are seldom found whole. This feature is in strange contrast with the state in which fossils are found in the great shell beds, resting upon the boulder clay in the Clyde districts. In these shell beds specimens are characteristically found with united valves, and in their natural position.

I have not yet observed this clay in any other situation than within easy reach of the shore, and I am inclined to regard this fossiliferous boulder clay as peculiar to the seaward terminations of the general deposit.

This fact (if as a fact it is finally established by further researches) may throw considerable light upon its origin.

This fossiliferous boulder clay may represent the *debris* accumulated on its progress downwards from the mountain by the descending glacier, and deposited by it, as it pushed itself beneath the sea on reaching the shore.

While this boulder clay possesses the general physical characteristics of the boulder clay first described—containing the usual striated and polished stones, and being compact and unworkable—these characteristics may, perhaps, fairly be described as not quite so intense in their development in many cases, although often its only distinguishing mark is the presence of shell fragments.

Its peculiar position in cliffs near the shore, the occurrence of fossils, and its general composition, seem to sustain the theory that it marks the point where the *debris* of great glaciers was pressed to the bottom of the sea at the final point of their descent.

Without reference, however, to the method of its formation, as a matter of fact there exists a boulder clay. (1) Fossiliferous—the included shells being arctic in character, but fragmentary-(2) Chiefly developed in the neighbourhood of the shore in the form of sea cliffs. (3) Physically the same as that which underlies the shell clay of the Clyde district, although sometimes distinguishable by a diminution in the intensity of its characteristics.

III. The type of a third clay, which may in its extreme form be termed a boulder clay, may be seen near Lag, Arran, overlying the older boulder clay. It is very hard and compact; the shells are better preserved than in the second boulder clay; but the embedded stones are not so well striated, and have been more or less worn since their first glaciation. Patches of sand and sandy clay are common.

This clay I am disposed to regard as the wash of the last described boulder clay upon a somewhat exposed coast. The angular blocks have been jumbled together, and their striations half obliterated, and their polish somewhat worn off, while the clay has been washed and rewashed around them, and a rude and rough habitat formed for the scanty development of some forms of molluscan life.

IV. An upper boulder clay, belonging to the period of retreating glaciers, and an ameliorated climate, is very distinguishable. (1) It is far less compact than any clay yet described.

(2) The included stones have very feeble polish, and only faint reminiscences survive of their former striations. They have evidently been much worn in many cases, and in others have not been subjected to any extreme glaciating force. (3) It is not fossiliferous.

The older boulder clay, and this younger boulder clay may sometimes be seen resting upon each other. At Chapel Hall, Airdrie, a good example of this occurs. The line of separation in a well dug by Mr. Russell in his garden, might even be detected by the eye, and it was in a deposit occurring between the two that fossils were found.

Sometimes a shell bed may been seen in sections intervening between the older and the newer boulder clay. This may be admirably studied in the beds before alluded to near Lag, Arran.*

In regular and ascending order may be seen the older boulder clay—1 of this paper; unfossiliferous and typical.

The fossiliferous clay—3 of this paper; with a scattering of striated stones; a wash from an older bed, indicating depression.

Younger boulder clay—4 of this paper; unfossiliferous, loose and sandy, with feebly striated stones; the most recent bed which can be attributed to ice action.

If there be any truth whatever in these divisions of "boulder clay," it is evident that to speak of a fossil as found in boulder clay, or under boulder clay, is a most vague and indefinite phrase.

A shell may be said to occur *in* the boulder clay, and may have been found in the second, third, or fourth, of the beds discriminated in this paper; or a shell may be said to occur *under* the boulder clay, and may have been found under the first or the fourth.

A fossil really belonging to the age of the Paisley clay may thus be ascribed to a more remote or a more recent era, to the great confusion of any attempt to understand either variations of climate or distribution of species during the glacial epoch.

The classification of boulder clays in this paper is given as a suggestion rather than in any way as an established arrangement, with the view of urging upon the members of the Society the necessity for more extended investigations.

---

* *See* a joint account of these beds by Dr. Bryce and the writer, 'Geology of Arran."—P. 166, 2nd edition.

Prehistoric Horses.—Much interest attaches to the remains of horses in the more modern deposits both in the Old World and in America; which latter Continent, though destitute of wild horses when discovered, exhibits the remains of several extinct species; but much difficulty has been felt from the time of Cuvier to that of Leidy in distinguishing one species or variety from another.

Professor Owen has recently examined some interesting specimens from a pre-historic cave at Bruniquel in France where bones of horses occur with those of rein-deer, and in such circumstances as to show that both animals afforded food to some aboriginal tribe. He has described these remains in a paper read before the Royal Society, and has in a subsequent communication compared them with equine remains from South and Central America. The following abstracts are from the Proceedings of the Royal Society.

"Referring to the want of figures of the natural size, or of any figures of the characteristic surface of the teeth of the molar series in the known species of the existing Equines, the author gives a description thereof in the Horse (*Equus caballus*), Ass (*E. asinus*), Kiang (*E. hemiconus*), Quagga (*E. quagga*), Dauw (*E. Burchelli*), and Zebra (*E. Zebra*), indicating by comparison their respective characteristics. These descriptions are accompanied with drawings (of the natural size) of the working-surface of the dentition of each species, with lettered details of such surface in the teeth of both upper and under jaws.

"The Equine fossils from the Cave of Bruniquel are then described and compared with each other, with the above-named existing species of *Equus*, and with previously defined fossil species of *Equidæ*. Two varieties in respect of size and some minor characters are pointed out in the Bruniquel series, of one of which figures (of the natural size) of the grinding-surface of the upper and lower molar series, and of the second variety, figures of the same surface of the upper molar series are given.

"The author, remarking that such evidences of mature and full-grown animals are rare from the Bruniquel Cave-deposits, selects evidence of certain phases of dentition in the Cave Equines which lend aid in determining their affinities; these phases being illustrated by four drawings of the natural size.

"Of the various fossil teeth of *Equidæ* with which those from Bruniquel have been compared, the author finds the closest resemblance, approaching to identity, in certain fossils from fresh-water sedimentary deposits of Postpliocene or "Quaternary" age in the Department of the Puy-de-Dôme, France. Of these, descriptions are given of the teeth of the upper and lower jaws from such deposits at a locality traversed by the river Allier, near the "Tour de Juvillac." A figure of the working-surface of the teeth of the lower jaw from this locality is given (of the natural size), showing the characters of the canine and proportions of the diastema. The close conformity in the characters of the upper grinders of the Puy-de-Dôme fossils of deposit with those of the Bruniquel cavern enables the author to dispense with figures of them.

"The sum of the several comparisons is to refer the above Equine fossils from sedimentary deposits and both varieties from the Bruniquel cave to one and the same species or well-marked race belonging to the true Horses, or restricted genus *Equus* of modern mammalogists; the individuals of which race, with a small range of size, probably due to sex, were less than the average-sized horse of the present period, but larger than known existing striped or unstriped species of *Asinus*, Gray.

"Interesting testimony, confirmatory of the conclusion from the palæontological comparisons, is adduced from outlines of the heads of different individuals of the Cape Equine when alive, neatly cut on the smooth surface of a rib of the same species, discovered by the Vicomte de Lastic St. Jal in 1863, in his cavern at Bruniquel, under circumstances which indisputably showed the work to have been done by one of the tribe of men inhabiting the cavern and slaying the wild horses of that locality and period for food.

"The author remarks that every bone of the Horse's skeleton (and such evidence had been obtained from about a hundred individuals that had been exhumed at the period of his second visit to Bruniquel, in February, 1864) had been split or fractured to gain access to the marrow. The dental canal and roots of the teeth had been similarly exposed in every specimen of the jaw.

"Then, referring to his previous paper on the Equine fossil remains from the cavern of Bruniquel, he finds, in the preliminary illustrations of the dental characters of existing species of the Horse-kind, the requisite and much-needed basis of comparison for the determination of other fossils of the Solidungulate group, and he devotes the present paper to the elucidation of those which have reached him from Central and South America.

"In a subsequent paper he commences by referring to the type-specimens of teeth, from two localities in South America, on which he founded the species *E. curvidens*, describing it (in 1840) 'as one co-existing with the Megatherium, Toxodon, &c., in that continent, and which had become extinct at a pre-historic period.'

"He then proceeds to describe more complete evidences of the dentition of an allied extinct Horse discovered by Don Antonio del Castillo, mining engineer, in newer Tertiary deposits of the Valley of Mexico. Besides repeating the originally described characters of the curvature of the grinder with a certain resemblance of enamel-pattern to the grinding-surface of the *E. curvidens*, they show a greater degree of curvature of the alveolar series of the upper jaw, with corresponding greater convergence of the right and left molar series toward the fore part of the palate, than in any previously described species of *Equus*.

"Deciduous teeth of the *Equus conversidens* from the same deposits of the Valley of Mexico are described. Having determined these corroborative and distinctive characters of aboriginal and now extinct American horses, the author remarks, 'It is unlikely, seeing the avidity with which the Indians of the Pampas have seized and subjugated the stray descendants of the European horses introduced by the Spanish 'Conquistadors' of South America, and the able use the nomad natives make of the multitudinous progeny of those war-horses at the present day, that any such tameable Equine should have been killed off or extirpated by the ancestors of the South-American aborigines.' If, therefore, the fossil Equine teeth do belong, as the author deems that he has proved, to a species distinct from *Equus caballus*, Linn., the circumstances of their discovery, and the fact of the extinction of such (curvident and conversident) species of Horse would point to some other cause than that of man's hostility to so useful an animal, and such doubt as to extinction by human means may then be extended to the contemporaries of the *Equus curvidens* and *E. conversidens*, viz., *Megatherium*, *Mylodon*, *Toxodon*, *Nesodon*, *Macrauchenia*, *Glyptodon*, *Mastodon*, &c.'

"The author next proceeds to describe fossil teeth from the upper and lower jaw, discovered by Don A. del Castillo in the same deposits of the Valley of Mexico, and referable to a third species of *Equus*, viz., *Equus tau*, Ow. Finally the author proceeds to the description of some fossil upper molar teeth from Pampas deposit, in the bed of a brook falling into the "Arroyo Negro' near Paysandi, Monte Video, showing characters more decisively distinct from any other known species of *Equus* than have hitherto been described.

"The degree of curvature of the upper molar teeth exceeds that in *Equus curvidens*, and equals that in *Toxodon;* and the specific name "arcidens" is accordingly proposed for this aboriginal American species of Horse. It is compared with so much of the characters as have been given by Dr. Lund of his *Equus neogæus* and *E. principalis* from Brazilian caverns; and the differences from all other Equines which these species and the *E. arcidens* agree in presenting lead the author to view them as having, like the *Hippotherium* of Kaup, formed a generic group in the *Equidæ*, for which he proposes the name *Hippidion*.

The fossil teeth of *H. arcidens* were found associated with remains of *Megatherium* and *Glyptodon* in the above-named locality; the specimens were transmitted and presented to the British Museum (in 1867) by the Hon W. G. Lettsom, Her Britannic Majesty's Minister at Monte Video.

BOTANY AND ZOOLOGY.

PLANTS NEW TO CANADA.—Mr. Macoun, of Belleville, a corresponding member of the Society, in a letter to one of the Editors, gives a list of the species which he collected, for the first time, during the summer of 1868. The following are some of the more interesting:—

Cakile Americana *Nuttall*,
Myriophyllum tenellum *Bigelow*,
Aster azureus *Lindley*,
Lobelia Dortmanna *Linn.*
Littorella lacustris *Linn.*
Utricularia cornuta *Michx.*
Physalis grandiflora *Hooker*,
Limnanthemum lacunosum *Griseb.*
Polygonum ramossissimum *Michx.*
Potamogeton natans *Linn.*
—— Oakesianus *Robbins*,
—— Claytonii *Tuckerman*,

Potamogeton Vaseyi *Robbins*,
—— spirillus *Tuckerman*,
—— rufescens *Schrader*,
—— amplifolius *Tuckerman*,
—— gramineus *Linn.* and
var.? myriophyllus *Robbins*,
—— lucens *Linn.*—the
var. minor *Nolte*,
—— perfoliatus *Linn.* and
var. lanceolatus *Robbins*,
—— compressus *Linn.* (ex *Fries*),
—— obtusifolias *Mertens* et *Koch*,
Potamogeton paciflorus *Pursh*,
—— pusillus *Linn.*—the
var. vulgaris *Fries*,
—— pectinatus *Linn.*
—— Robbinsii *Oakes*,
Saggitaria heterophylla *Pursh*,
Habenaria virescens *Sprengel*,
Juncus pelocarpus *E. Meyer*,
Scirpus subterminalis *Torrey*,
Carex adusta *Boott*,
—— livida *Willd.*
Triticum violaceum *Hornemann*.

Littorella lacustris—abundant in the north of Scotland, and widely distributed throughout Europe, chiefly among the mountainous regions and extending into the arctic circle—is now, for the first time, recorded as American. The remoteness of the locality in which it was found ('on an island in Gull Lake') gives it an undoubted claim to be a true native.

Two interesting ferns have been added to the flora of Canada during the past summer, viz.:—

Cystea montana (Lam.)

Polypodium montanum *Lamarck* Flore Francaise, vol. i. p. 23; Cyathea *Smith* Turin Memoirs, vol. v. p. 417; Aspidium *Swartz* Synopsis Filicum, p. 61; Cystopteris *of Authors*; Polypodium myrrhidifolium *Villars* Histoire des Plantes des Dauphine, vol. i. p. 262; etc., etc. (Filices Canadensis, No. 30 b.)

It is well figured by Schkuhr (table 63) and in Hooker's British Ferns (table 25). In Europe it is generally distributed from Lapland to the Apennines and Pyrenees; in Asia it is said to occur in East Siberia; of America Sir Wm. Hooker says, "We possess five specimens from the east side of the Rocky Mts. "gathered by Drummond." It was found in some abundance by Mr. Macoun on one of the most northerly bays of Lake Superior, "in low woods, July 19, 1869," and may be looked for near the same latitude throughout Canada East.

Polystichum Filix-mas (Linn.)

Polypodium filix-mas *Linnæus* Species Plantarum, p. 1551; Polystichum *Roth* Flora Germanica, vol. iii. p. 82; Nephrodium *Richard* in Desvaux's Annals, vol. vi. p. 260; Aspidium *Swartz* Synopsis Filicum, p. 55; Dryopteris *Schott* Genera Filicum; Lastrea *Presl* Tentamen Pteriodographiæ, p. 76; etc., etc. (Filices Canadensis, No. 23 b.)

Throughout Europe this is one of the commonest and most abundant of ferns; in Asia its range extends from Siberia to Asia Minor, the Himalayas and Japan; it occurs in North Africa; and one of its forms (the *Aspidium paleaceum* of Don) is common throughout America from Mexico to Peru. Its range in temperate North America is not well understood; Mr. Baker unites with it *Polystichum elongatum* (Aiton) which, he says (probably in error), occurs in the Southern States; Sir Wm. Hooker unites with it his own *Polystichum Floridanum*, which is found throughout the Gulf States, but Mr. Eaton has correctly shown that the affinity of this plant is with *P. cristatum*. Several fronds of its normal form were found among some specimens of *P. Goldieanum*, obligingly sent to me by Mrs. Roy, of Royston Park, Owen Sound, who afterwards recognized one of them as belonging to a large and stately plant which grew close to her residence. Mrs. R. hopes to collect an abundance of specimens next year. Her neighbourhood is very rich in ferns, perhaps richer than any other equally circumscribed locality in Canada. *Filix-mas* doubtless occurs throughout the continent from the Great Lakes to the Pacific, and perhaps southward to Mexico along the Rocky Mountains.

D. A. W.

MOSSES NEW TO CANADA.—Since the publication of my catalogue of Canadian Cryptogams, Mr. Macoun has detected the following species of Musci in the neighborhood of Belleville, which were not then known as Canadian :—

Sphagnum Wulfianum *Girgensohn*,
(=*S. pycnocladum* Angst.)
—— Girgensohnii *Russow*,
—— Austinii *Sull.*
—— laricinum *Spruce*,
—— recurvum *Beauv.*
—— subsecundum *Nees*,
Gymnostomum calcareum *Nees* et *Horns*.
Anodus Donianus *Bry. Eur.*
Campylopus viridis *Sull.* et *Lesq.*
Dicranum spurum *Hedw.*
—— Schreberi *Hedw.*
Fissidens minutulus *Sull.*
Barbula cæspitosa *Schwægr.*
Encalypta vulgaris *Hedw.*
Orthotrichum Lescurii *Austin*.
Bryum cernuum *Hedw.*
—— cyclophyllum *Bry. Eur.*
—— intermedium *Brid.*
Mnium spinosum *Bry. Eur.*
—— cinclidioides *Blytt*,
—— lycopodioides *Hook.*
Fontinalis novæ-Angliæ *Sull.*
—— Dalecarlica *Bry. Eur.*
Myurella Careyana *Sull.*
—— julacea *Bry. Eur.*
Pterigynandrum filiforme *Hedw.*
Hypnum lutescens *Hudson*,
—— plumosum *Swartz.*
—— rivulare *Bry. Eur.*
—— hispidulum *Brid.*
—— stellatum *Schreber*,
and var. protensum *Schim.*
—— minutissimum *Sull.* et *Lesq.*
—— cariosum *Sull.*
—— compactum *Sull.*
—— Sullivantiæ *Schim.*
—— turfaceum *Lindberg*,

Specimens of these mosses will be presented by Mr. Macoun to the Society's herbarium.

Rev. James Fowler of New Brunswick recently sent a set of his Sphagnaceæ to Mr. Austin of New Jersey, who has given me the following large list of species as forming the collection:—

Sphagnum acutifolium *Ehrh.*	Sphagnum molluscum *Bruch,*
—— Austinii *Sull.*	—— recurvum *Beauv.*
—— cuspidatum *Ehrh.*	—— rigidum *Schimper,*
—— cymbifolium *Ehrh.*	—— rubellum *Wilson,*
—— fimbriatum *Wilson,*	—— squarrosum *Persoon,*
—— Girgensohnii *Russow,*	—— subsecundum *Nees,*
—— laricinum *Spruce,*	—— Wulfianum *Girg.*

D. A. W.

Dr. Rabenhorst, of Dresden, has for many years been engaged in the publication of European Cryptogams, a priced list of which he has recently sent to me, as follows:—

1.	Herbarium Mycologicum, Centuries i.—viii., at 6	48	Thalers
2.	Fungi Europæi exsiccati, Centuries i.—xiii., at 6	78	do.
3.	Lichenes Europæi exsiccati, Fasc. i.—xxxi., (Nos. 1 to 850) at 2½	78	do.
4.	Cladoniæ Europææ	30	do.
5a.	Desmidiaceæ, Century i	12	do.
5b.	Diatomaceæ, Century i	15	do.
6.	Algen Europa's, Decades 1 to 12, (Nos. 1 to 2120) at 20 s. g.	141	do.
7.	Characeæ Europææ exsiccatæ, Fasc. i. to iii. (Nos. 1 to 75) at 3	9	do.
8.	Hepaticæ Europææ, Decades 1 to 44, at 20 s. g.	29	do.
9.	Bryotheca Europæa, Fasc. i. to xxi. (Nos. 1 to 1050) at 3	63	do.
10.	Cryptogamæ Vasculares Europææ, Fasc. i. to iv. (Nos. 1 to 100) at 3	12	do.
11.	Cryptogamia—"a collection for school and home, containing examples of all Orders and Tribes, and in the Fungi the diseases of cultivated plants;"—500 species in folio	12	do.

(The Thaler is equal to about seventy-five cents, being exactly three shillings sterling).

I have lately had an opportunity of examining the collection of the vascular cryptogamia (no. 10 above), and of comparing his specimens with our Canadian forms, and append a few notes on some of the species which are common to both continents. I copy Dr. R's nomenclature exactly; it is near enough to that of Gray's Manual to enable any one to recognise the plants. As a rule the specimens are well preserved and mounted, and are amply sufficient to illustrate the species. The four fasciculi contain in all about one hundred species, many of which are illustrated by several examples from various localities.

No. 8. Botrychium simplex *Hitchc.* The specimens are small, but they agree exactly with ours.

No. 9. Botrychium Lunaria (*Linn.*) *Kaulf.*
No. 14. Cystopteris fragilis (*Linn.*) *Bernh.* } We have forms similar to these; both species are very variable.

No. 15. Woodsia ilvensis (*Swartz*) *R. Brown.* A small specimen, but identical with ours.

No. 16. Aspidium Thelypteris *Swartz.* Exactly our plant.

No. 17. Aspidium cristatum *Swartz.* We have forms agreeing with these, but this species is much more variable in America than it is in Europe,—verging with us as well towards *Filix-mas* and *Goldieanum* as towards *spinulosum.*

No. 18. Aspidium spinulosum *Swartz.* The broadly-ovate frond and dark-centered scales of this specimen are usually considered to be characteristic of the var. *dilatatum* (Hook. Br. Ferns, t, 19) rather than of the normal *spinulosum;* we have this form, but that named var. *intermedium* by Eaton, is much more common with us.

No. 19. Aspidium spinulosum-cristatum *Lasch in litt.* This is exactly the *A. Boottii* of Tuckerman, whose name has undoubted priority. Gray and Eaton consider it to be a form of *spinulosum* ; my specimens are more *cristatum*-like ; Milde considers it a hybrid of these two species. Its proper name, according to my views, would have been *A. cristatum* var. *Boottii.*

No. 20. Aspidium Braunii *Spenner.* This is exactly our North American plant, my specimens from Tadousac, Temiscouata, the Green Mountains and the White Mountains being all identical with it. Dr. Gray should have written it as *A. aculeatum* var. *Braunii* Doll's Rheinische Flora (1843) p. 21.

No. 23. Aspidium Filix-mas (*Linn.*) *Swartz.* Agrees well enough with Mrs. Roy's specimens to be considered identical. Prof. Eaton has it from the Rocky Mountains of Colorado, from Lake Superior, and from Greenland ; Sir Wm. Hooker has it ("the normal form,") from California ; and Kunze says he has "seen it from Newfoundland."

No. 25. Asplenium Trichomanes *Hudson.* Exactly ours.

No. 29. Botrychium matricariæfolium *Al. Braun.* Identical with our forms. I have this species from Temiscouata (Dr. Thomas), Belleville and Lake Superior (Mr. Macoun), White Mountains (Horace Mann), and Pennsylvania (per Prof. Porter as *B. neglectum* A. Wood, leg. A. P. Garber).

No. 30. Botrychium rutæfolium *Al. Braun.* Evidently conspecific with our *B. lunarioides;* and Dr. Milde has very properly united both with the older *B. ternatum* of Thunberg and Swartz.

No. 31. Scolopendrium officinarum *Sw.* NewYork plants are nearer to these specimens than ours, but the species is a variable one.

No. 34. Asplenium viride *Huds.*
No. 37. Asplenium Ruta muraria *L.* } Are all identical with our North American plants.
No. 38. Aspidium Lonchitis *Sw.*

No. 40. Aspidium spinulosum *var.* dilatatum (*Sm.*) I have specimens like this from the Saguenay, but our usual form is a much larger and more compound plant ; *dilatatum* is with us less variable and nearer to a type-plant than is *spinulosum*, and should therefore, I think, be taken as our species.

No. 55. Polypodium vulgare (*C. Brauh.*) *Linn.*
No. 56. Phegopteris polypodioides *Fee.* } Are our forms exactly.
No. 57. Phegopteris Dryopteris *Fee.*

No. 58. Phegopteris calcarea (*Sm.*) *Fee.* Not certainly known as North American, but hardly more than a variety of No. 57.

No. 59. Struthiopteris germanica *Willd.*
No. 61. Acropteris septentrionalis (*Linn.*)*Link.* } Are identical with our North American forms.
No. 62. Cystopteris montana (*Roth*) *Bernh.*

No. 82. Woodsia hyperborea *R. Brown.* Clearly identical with our plant, but the specimen is very small (less than two inches high) and *ilvensis*-looking. Scarcely distinct as a species from No. 15.

No. 83. Woodsia glabella *R. Brown.* Having seen numerous European specimens of this species, chiefly from Scandinavia, which were invariably named *W. hyperborea,* I had formed the opinion that the *Acrostichum hyperboreum* of Liljeblad (Stockholm Transactions, 1793, p. 201), must be different from the *W. hyperborea* of R. Brown (Linn. Trans., vol. xi. p. 173); be that as it may, it is now manifest that European botanists have long time had *W. glabella* without recognizing it. The specimen here is from the Alps of the Tyrol, and is contributed by Dr. Milde, who appends a note, stating that the species had been collected in that district as long ago as 1848, but had been called *W. hyperborea*, until in 1855, when it first came under his notice, he found it to be the true *W. glabella.* He says the present specimen grew on a dolomite block, in company with *Potentilla nitida, Phyteuma Sieberi, Euphrasia minima, Silene quadrifida, Asplenium viride, Cystea fragilis,* etc., etc., and adds that in Tyrol, "this plant, like *Asplenium Seelosii,* is confined to the dolomite."

No. 84. Asplenium alpestre (*Hoppe*) *Metten.* Identical with some Californian specimens in my herbarium.

No. 92 *a*. Allosurus crispus (*L.*) *Bernh.* These specimens appear sufficiently distinct from our *Cryptogramme acrostichoides* to give the latter the rank of a variety, though I have in my herbarium a specimen from California which is identical with one from Scotland. It is singular that some European botanists should insist on the identity of our *Pellæa gracilis* with this species.

The Lycopodiaceæ and Equisetaceæ of Europe are also very fully illustrated, there being seven species of Lycopodium (including *L. inundatum*, *L. alpinum*, *L. selaginoides* and *L. Helveticum*), seven of Isoëtes, and no less than twenty-two species and varieties of Equisetum. Any of Dr. Rabenhorst's works can be obtained through the publishers of this journal.

D. A. W.

The Acrogens of Lake Superior.—Mr. Macoun, of Belleville, has lately returned from a somewhat extended botanical tour around the north shore of Lake Superior, which occupied him during July and part of August. By dint of excessive work he has made a large collection, many of his specimens being of great rarity and interest. A catalogue of all the plants noticed and collected by him is in progress, and will probably be published by instalments in this journal. The Acrogens, being worked up, are here given as a beginning; and the opportunity to include the species obtained by other collectors, in the same locality, is availed of. I am indebted to Prof. T. C. Porter for a list of the species collected by a party, consisting of himself, Dr. Robbins, and Mr. Smith of Philadelphia, who botanized around the south shore in 1865—these are marked Port.; also to Prof. Eaton, for such as are authentically known to him as occurring on the shores and islands of the Lake—his being marked Eat. The mark Gr. is for Dr. Gray, referring to his Manual; and Ag. is for Prof. Agassiz's work, 'Lake Superior,' (Boston, 1850). Mr. Macoun's own species are marked Mac. His most interesting ferns are *Cystea montana*, *Woodsia hyperborea*, *W. glabella*, *Botrychium matricariæfolium* and *B. simplex*; while it is remarkable that he did not find *Cryptogramme crispa*, *Polystichum Filix-mas* or *Woodsia Oregana*, which occur on the south shores of the Lake, the first-named being also abundant on Ile Royale. The personal-name attached to each species (and variety) is that of the author who first gave the specific name here adopted; when it is placed within brackets, that author put the plant in a different genus (or in the same genus differently named) from that to which it is here assigned.

ACROGENÆ LACUS SUPERIORIS.

FILICES.

1. POLYPODIUM Linn.

1. P. vulgare *Linn.*
Port. Mac.

2. CRYPTOGRAMME R. Br.

2. C. acrostichoides *R. Br.*
Port. Eat. (not distinct from *C. crispa*).

3. PELLÆA Link:

3. P. gracilis (*Michx.*)
Ag. Mac.
4. P. atropurpurea (*Linn.*)
Mr. Barnston.

4. PTERIS Linn.

5. P. aquilina *Linn.*
Ag. Port. Mac.
6. —— var. lanuginosa *Hook.*
Eaton.

5. ADIANTUM Linn.

7. A. pedatum *Linn.*
Macoun.

6. ASPLENIUM Linn.

8. A. Trichomanes *Linn.*
Port. Mac.

7. ATHYRIUM (Roth) Milde:

9. A. thelypteroides (*Michx.*)
Port. Mac.
10. A. Filix-fœmina (*Linn.*)
Eat. Port. Mac.

8. PHEGOPTERIS Fee:

11. P. connectile (*Michx.*)
(=*Polyp. Phegopteris* Linn.)
Port. Eat. Mac.
12. P. Dryopteris (*Linn.*)
Ag. Port. Eat. Mac.

9. POLYSTICHUM Roth,
Tentamen vol. iii. p. 69:

13. P. Lonchitis (*Linn.*)
Gray, Eat.
14. P. acrostichoides (*Michx.*)
Macoun.
15. P. aculeatum var. Braunii (*Doll*)
(=*Aspidium Braunii* Spenner).
W. D. Whitney fide Eaton.
16. P. Thelypteris (*Linn.*)
Macoun.
17. P. Noveboracense (*Linn.*)
Porter.
18. P. fragrans (*Linn.*)
Port. Eat. Mac.
19. P. Multiflorum (*Roth*),
Port. Mac.
20. —— var. spinosum (*Roth*),
Eaton, Mac. (the var. *intermedium* of Eaton).
21. P. cristatum (*Linn.*)
Eat. Mac.
22. P. Filix-mas (*Linn.*)
Port. Eat.
23. P. marginale (*Linn.*)
Macoun.

10. ONOCLEA (Linn.) Swartz,

24. O. Struthiopteris (*Linn.*)
Ag. Port. Eat. Mac.
25. O. sensibilis (*Linn.*)
Port. Mac.

11. CYSTEA J. E. Smith,
Eng. Flora vol. iv. p. 284:

26. C. fragilis (*Linn.*)
Port. Mac.
27. C. bulbifera (*Linn.*)
Agassiz (?)
28. C. montana (*Lamarck*)
Macoun—"near Current River."

12. WOODSIA R. Brown:

29. W. Ilvensis *R. Br.*
Ag. Port. Mac.
30. W. hyperborea *R. Br.*
Macoun—"near Fort William."
31. W. glabella *R. Br.*
Macoun — Michipicoten and elsewhere.
I follow Robert Brown's nomenclature, though I consider 30 to be a variety of 29; some of Mr. Macoun's specimens of 31 are, however, remarkably near 30.
32. W. Oregana *Eaton*,
Dr. Robbins fide Port.

13. Osmunda Linn.

33. O. regalis *Linn.*
Port. Mac.
34. O. Claytoniana *Linn.*
Port. Mac.

14. Botrychium Swartz:

I follow Dr. Milde (Monographia Botrychiorum) both as to species and nomenclature.

35. B. Lunaria (*Linn.*)
Ag. Macoun—"near Pic River."
36. B. matricariæfolium *A. Braun*,
(=*B. rutaceum* Schkuhr t. 155, fig. b; Rabenhorst, No. 29).
Macoun—"near Neepegon."
37. B. simplex *Hitchc.*
Macoun—"near Fort William."
38. B. ternatum var. Americanum *Milde*,
(=*Botrypus lunarioides* Michx.)
Macoun—"near Fort William" some curious forms.
39. B. Virginianum (*Linn.*)
Ag. Port. Eat. Mac.

EQUISETACEÆ.

1. Equisetum Linn.

1. E. arvense *Linn.*
Ag. Port. Eat. Mac. — Eu. As. Af.
2. E. Telmateia *Ehrh.*
"Shore of Upper Great Lakes"— Gray. —Eu. As. Af.
3. E. pratense *Ehrh.*
Macoun. —Eu. As.
4. E. sylvaticum *Linn.*
Ag. Port. Mac. —Eu. As.
5. E. palustre *Linn.*
Porter. —Eu. As.
6. E. limosum *Linn.*
Ag. Port. Mac. —Eu.As.
7. E. litorale *Kuhlew.?*
I refer some of Macoun's specimens to this species. —Eu.
8. E. lævigatum *A. Braun*,
Dr. Robbins fide Eat.—N. Am. only.
9. E. hiemale *Linn.*
Port. Mac. —Eu. As.
10. E. variegatum *Schleicher*,
Eat. Mac. —Eu. As.
11. E. scirpoides *Michx.*
Port. Mac. —Eu. As.

LYCOPODIACEÆ.

1. Lycopodium Linn.

1. L. lucidulum *Michx.*
Ag. Port. —Asia.
2. L. Selago *Linn.*
Gr. Eat. Mac.
—Eu. As. Af. Aus. S.Am.
3. L. annotinum *Linn.*
Ag. Port. Mac. —Eu. As.
4. L. dendroideum. *Michx.*
Ag. Port. Mac. —Asia.
5. L. clavatum. *Linn.*
Ag. Port. Mac. —Eu. As. Af.
6. L. inundatum *Linn.*
Agassiz. —Europe.
7. L. complanatum *Linn.*
Ag Port. Mac. —Eu. As.
8. L. alpinum *Linn.*
Newfoundland, Canada, Hudson Bay Territories, and Rocky Mountains, *vide* Hook. Br. Ferns. —Eu. As.

2. Selaginella (Beauv.) Spring:

9. S. selaginoides (*Linn.*)
Link, Fil. Hort. Berol. p. 158; *S. spinosa* Beauv. Prodr. 112, Spring Monogr. ii. p. 59; *S. spinulosa* A. Braun in Doll's Rheinische Flora, p. 38.
Ag. Port. Mac. Europe.
10. S. rupestris (*Linn.*)
Spring l. c. p. 55; *Stachygynandrum* Beauv.
Ag. Port. Mac.
—Eu. As. Af. S.Am.

3. Isoetes Linn.

11. I. lacustris *Linn.*
Porter. —Eu.
12. I. echinospora *Durieu?*
Macoun—Michipicoten; his specimens are too immature for accurate determination, but they are not 11.

The following species are not, so far as I am aware, recorded as occuring in this region, but are more or less likely to be found:—

Cheilanthes gracilis (*Fee*) *Mett.*
(=*Ch. lanuginosa* Nuttall),
Blechnum Spicant,
Scolopendrium vulgare,
——— rhizophyllum,
Asplenium ebeneum,

Asplenium viride,	Dicksonia punctilobula,
——— Ruta-muraria,	Osmunda cinnamomea,
——— septentrionale,	Botrychium boreale,
Athyrium rhæticum,	——— lanceolatum,
(=*Asplenium alpestre* Mett.)	Ophioglossum vulgatum,
Polystichum Goldieanum,	Selaginella apus.

Two species of North Europe may also possibly occur there, or in some other part of northern North America, viz. *Athyrium crenatum* and *Cystea sudetica*, the latter of which, a somewhat recent discovery, is closely allied to *C. montana*.

The northern shores of the lake would appear to be more prolific in Filices than the southern, inasmuch as Mr. Macoun has thirteen species which are absent from Prof. Porter's list, while the latter has but four species not collected by the former: these four are—

2. Cryptogramme crispa (not Canadian as yet),
19. Polystichum Noveboracense,
22. ——— Filix-mas,
32. Woodsia Oregana (not Canadian as yet).

Other collectors have contributed only four species, viz :—

4. Pellæa atropurpurea,	15. Polystichum aculeatum,
13. Polystichum Lonchitis,	27. Cystea bulbifera.

The last named is inserted on the authority of Prof Agassiz's catalogue, and may be a mistake for *C. fragilis*, which, though abundant on the north shore, where his party botanized, is not noted by him; should the species not occur, its absence would however be remarkable.

Of the thirty-nine numbers enumerated, two (6 and 20) are deemed varieties, leaving thirty-seven species; of these

29 species are also Asiatic;
25 do. are also European;
12 do. are common to Europe and Asia;
11 do. are common to Europe, Asia and Africa;
6 do. are common to Asia only;
6 do. are peculiarly American; and
2 do. are (apparently) common to Europe only.

The two lasted noted species (*Botrychium simplex* and *B. matricariæfolium*) are probably also Asiatic, while the six non-European species are not likely to be found there; these six (common to Asia) are—

3. Pellæa gracilis,	18. Polystichum fragrans,
7. Adiantum pedatum,	25. Onoclea sensibilis, and
9. Athyrium thelypteroides,	34. Osmunda Claytoniana.

The affinity is thus nearer to the fern flora of Asia than to that of Europe, which will probably become more apparent when the former continent is more thoroughly explored.

The six peculiarly American species are :—

2. Pellæa atropurpurea (throughout N.A. from south Mexico northward).
14. Polystichum acrostichoides (Louisiana eastward and northward).
17. —— Noveboracense (North Carolina eastward and northward).
23. —— marginale (same range as 17).
27 Cystea bulbifera (same range as 12).
32. Woodsia Oregana (Lake Superior to British Columbia, and southward, along the mountains, to California).

As regards their distribution throughout the world,—

18	species	enter the Arctic circle;
13	do.	extend into the Tropics; and
11	do.	into the Southern Hemisphere.
8	do.	are common to the Arctic circle, Tropics, and S. H.;
3	do.	are common to the Tropics and S. H.; and
2	do.	are common to the Tropics only.

The eight widely spread species are :—

1. Polypodium vulgare,
5. Pteris aquilina,
10. Athyrium Filix-fœmina,
15. Polystichum aculeatum (the most ubiquitous of all the ferns),
19. —— multiflorum,
22. —— Filix-mas,
26. Cystea fragilis (perhaps next to no. 15 in ubiquity), and
38. Botrychium ternatum.

The other five tropical species are :—

Tropics and S. H.	Tropics only;
8. Asplenium Trichomanes,	4. Pellæa atropurpurea,
16. Polystichum Thelypteris,	39. Botrychium virginianum.
33. Osmunda regalis.	

In addition to the eight above noted, the following ten species enter the Arctic circle :—

2. Cryptogramma crispa,	28. Cystea montana,
11. Phegopteris connectile,	29. Woodsia Ilvensis,
12. —— Dryopteris,	30. —— hyperborea,
13. Polystichum Lonchitis,	31. —— glabella,
18. —— fragrans,	35. Botrychium Lunaria;

and probably also the two species of Pellæa, *P. gracilis* being known from Siberia, and *P. atropurpurea* being said to be in Dr. Richardson's collections from "the wooded country, latitude 54° to 64° north" of British America, and more definitely localized by Sir Wm. Hooker as "Bear Lake."

The indications of geographical distributions which are appended to the species of Equisetaceæ and Lycopodiaceæ have been omitted from the Ferns, it being the writer's intention to treat them separately.

D. A. WATT.

NOTE ON THE NAME ASPIDIUM SPINULOSUM VAR. DILATATUM.—Botanists are at variance as to the personal name which ought to be attached to the scientific name of a plant. The British Association rule is that the author of a species is entitled to have his name always attached to it, no matter in what genus it may thereafter be placed, than which nothing could be fairer or more correct. Linné named a Siberian plant *Polypodium fragrans*. Roth, finding the Linnean genus Polypodium to be susceptible of division, separated from it a number of species under the name Polystichum, but, inasmuch as he treated of the plants of Germany only, *P. fragrans* is not named in his work. Swartz followed Roth; naming the genus Aspidium, he included the plant in question, calling it *Aspidium fragrans*. Still later Richard named the same genus Nephrodium, without having occasion to include *P. fragrans*, it being unknown to him as an American plant when he wrote "Michaux's Flora." We thus have what is practically one genus under three different names, and one well understood species, in defining which, by either generic name, we must, under this rule, if we adopt Roth's genus, write thus—*Polystichum fragrans* (Linn.); or, if we desire to be more precise, Polystichum *Roth* Tentamen Fl. Germ. vol. iii. p. 69—*P. fragrans* (Linn. Sp. Pl. p. 1550).

Many botanists, however, prefer to attach the name of the author by means of whose works the plants referred to have been by them determined, or whose works are generally accessible. Thus Robert Brown, in contributing to "Richardson's Appendix to Franklin's Journal," refers almost exclusively to the Species Plantarum of Willdenow, and writes the names of common and well-known Linnean plants thus,—"*Polypodium vulgare* Willd;" "*Lycopodium Selago* Willd."—He even goes so far as to write "*Woodsia Ilvensis* Pursh," though he himself established the genus Woodsia, and correctly defined by the old Linnean name of Ilvensis, what had hitherto been a doubtful species. By this rule it would be equally correct for us, when determining our plants by means of Dr. Gray's excellent Manual, to write "*Woodsia Ilvensis* Gray, Manl. ed. 2nd. p. 596."

Either of these modes is simple and easily understood, and neither of them involves much confusion in nomenclature. But of late years many botanists have adopted a rule different from both, and have attempted to give to it the force of law, whereby any author who first removes a well described species of another author into a different and previously described genus, or even into the same genus under a different name, is thereby entitled to connect his own name with it to the exclusion of that of the original author both of the genus and of the species. Thus Robert Brown, in the catalogue cited above, having occasion to include *P. fragrans*, wrote one line thus, "440. *Nephrodium fragrans*, Aspidium fragrans *Willd.*, v., p. 253," and thereby became entitled to have his name associated with this plant when any subsequent writer called it a Nephrodium, to the exclusion of both Linné and Richard.* A more absurd instance is furnished by another well-known North American fern, the *Nephrodium punctilobulum* of Michaux (anno 1803). In 1788 L'Heritier founded the well-characterized genus Dicksonia before Michaux's species was known; about 1809 Schkuhr figured and described the plant, under its proper genus, as *Dicksonia pubescens*, a characteristic name; in 1846 Sir Wm. Hooker re-described it in Species Filicum as "*D. punctiloba* Hook." restoring but mis-spelling Michaux's name; in 1848 Prof. Kunzé contributed to *Silliman's Journal*, a paper "on some Ferns of the United States," in which he says, in correction, "I refer, with Hooker, this plant again to Dicksonia, and name it *D. punctilobula*,"—in reward for which intellectual effort most United States botanists now write D. punctilobula *Kunzé !*

Nor is it always easy to find out who was the first author to do such signal service to botanical science as to move a plant from one established genus to another, to restore an older specific name, or to correct a lapsus pennæ. Even the careful Gray makes slips, and writes his own name after some species in violation of his own "law." A remarkable instance of this occurs in the case of Aspidium spinulosum var. dilatatum *Gray*, the

---

* It is true that several years before this author wrote some able papers on Fern Genera, but that circumstance does not affect the case as now put. It is somewhat singular too that this credit is generally denied to Brown; Sir Wm. Hooker, Mr. Baker, and other authors, always write Nephrodium fragrans *Richardson*, although the latter gave full credit to Brown for his share of their joint work.

synonymy of which I had occasion lately to investigate, with the following result:

Anno.	Author.	Work.	Spinulosum.	Dilatatum.
1767	Muller	Flora Friedrichsdalina, Nos. 841, 884	Polypodium spinulosum, t. 707	Polypodium Dryopteris, t. 759.
1770	do	Flora Danica, tt. 707 et 759		
1770	Weiss	Plantæ Cryptogamicæ, pp. 316-7	Polyp. Filix-fœmina var. spinosa	P. Filix-fœmina var. cristata.
1795	Hoffman	Deutchlands Flora, vol. ii. pp. 7-8	Polypodium cristatum	P. dilatatum et P. tanacetifolium.
1797	Roth	Catalecta Botanica, pp. 135-7	Polyp multiflorum var. spinosum	Polypodium multiflorum.
1800	do	Flora Germanica, vol. iii. pp. 87-91	Polystichum spinosum	Polystichum multiflorum.
1801	Swartz	in Schrader's Journal (for 1800), p. 38	Aspidium spinulosum	Aspidium spinulosum.
1804	Smith	Flora Britannica, pp. 1124-25	do do	Aspidium dilatatum.
1805	De Candolle	Flore Francaise, vol. ii. pp. 561-2	Polystichum spinulosum	Polystichum tanacetifolium.
1806	Swartz	Synopsis Filicum in add., p. 420	Aspidium spinulosum	Aspidium dilatatum.
1812	Wahlenberg	Flora Lapponica, No. 503	A dilatatum var spinulosum	do do
'20?	Hartmann	Handbok i Skandinaviens Flora, p. 398	Polystichum spinulosum	P. spinulosum var. dilatatum.
1827	Desvaux	"Mèm. Soc. Linn. vol. vi. p. 261"	Nephrod. spinulosum et N. intermedium	Nephrodium dilatatum.
1827	Hornemann	Nomenclatura Floræ Danicæ, p. 33. [editions)	Aspidium spinulosum	A. spinulosum var. dilatatum.
1830	Hooker	British Flora, ed. 1st, p. 444 (and subsequent	do do	do do
1836	Presl	Tentamen Pteridographiæ, pp. 26-27	Lastrea spinulosa	Lastrea dilatata.
1840	Hooker	Flora Boreali-Americana, vol. ii. p. 261	Aspidium spinulosum	A. spinulosum var. dilatatum.
1841	Link	Filices Horto Berolinensi, pp. 105-6	do do	do do
1843	Döll	Rheinische Flora, p. 17-18	A. spinulosum var. elevatum	do do
1844	Koch	Synopsis Flora Germanica, p. 979	Polystichum spinulosum var. vulgare	Polystichum spinulosum var. dilatatum.
1848	Asa Gray	Manual of Botany, ed. 1st. pp. 630-1	Dryopteris intermedia	Dryopteris dilatata.
1850	Fée	Genera Filicum, p. 291	Aspidium spinulosum et A. intermedium.	Aspidium dilatatum.
1851	Lange	Haandbok i den Danske Flora, p. 682	Lastræa spinulosa	L. spinulosa var. dilatata.
1856	Asa Gray	Manual of Botany, ed. 2nd. p. 597	Aspidium spinulosum	A. spinulosum var. dilatatum.
1858	Mettenius	uber einige Frangattungen, iv. Nos. 136-7	do do	Aspidium dilatatum.
1862	Hooker	Species Filicum, vol. iv. p. 127	N. (Lastrea) spinulosum var. bipinnatum	N. (Lastrea) spinulosum var. dilatatum.
1864	Moore, Thomas	British Ferns, pp. 48-49, (and elsewhere)	Lastrea cristata var. spinulosa	Lastrea dilatata.

Linnè probably included both forms in his *Polypodium cristatum*. Spinulosum appears to have been the first which was separated thus giving the name priority, but Müller's views of the allied forms was somewhat confused; he makes no mention of the Linnean cristatum and misunderstands *P. Dryopteris*. Hoffman was the first to characterize the form dilatatum, but he made two species out of it and applied the Linnean name cristatum to Müller's spinulosum. Then comes Roth, who is the first to make one species of the two forms, his name is multiflorum and spinulorum is reduced to a variety under Weiss's name spinosa; somewhat later, when Roth founded his genus Polystichum, he changed his mind and made a species of each form, without altering his names. Swartz copied Roth throughout, borrowed his genus, calling it Aspidium, and copied him in making the plants in question first one species and then two. Botanists do wrong to ignore Roth; his genus has undoubted priority, and his correct views of the plants in question give his names good claims to be continued. His view of the identity of the two forms has been followed by most modern authors; many able botanists (Mettenius, etc.), however, hold them to be distinct. The changes have been so often rung that the question of priority of name has become somewhat complicated; there is, however, no doubt whatever that Gray's name was applied by Hornemann to the *A. dilatatum* of Swartz and Wildenow as long ago as 1829; that Hooker applied it to the British form in 1830, and to the American form in 1840; while Dr Gray's publication is 1856. The literature to which I have access is of course limited, else the list of synonyms would have been very much longer; and the matter, in itself trifling, is alluded to, only because of its connection with the important subject of correct botanical nommalcture, which is presently being discussed.

D. A. W.

Botany of the West Coast of North America.—The following general account of the botany of the region west of the Cascade Mountains, from Puget Sound southward as far as Tillamook Bay, given by Prof. I. W. Marsh, of Pacific College, Forest Grove, Oregon, in a letter to a friend in this city, has been furnished to us for publication:

"The trees which are most conspicuous, and which cover far the larger part of the country, are conifers. The Douglas spruce

(*Abies Douglasii*) is, perhaps, the most common, and grows sometimes to the height of three hundred feet. It does not, however, attain the diameter of some others, nine to twelve feet being as large as I have seen it.

"Menzies's spruce (*Abies Menziesii*) is the giant in respect to diameter. I have seen one of fifteen feet, and they are said, as are also the cedars, sometimes to reach twenty-five feet. This latter spruce is only found near the coast. The Cedar here is *Thuja gigantea*, the great Arbor Vitæ, and is a very handsome tree. I think, however, the handsomest of them all is the Noble Fir (*Picea nobilis*). It is not quite so large as some of the others, but is more graceful. It usually grows in thick forests, and has a straight, slender stem, from two to three feet in diameter and one hundred and fifty feet without branches, with a graceful bend perhaps fifty feet in height above. A species of hemlock is common, especially near the coast, which bears a general resemblance to that of Canada, yet is not, I think, the same. It grows to two hundred or two hundred and fifty feet, and seven to nine feet in diameter. There is also a pine, but I do not know the species; it is not as common as the others I have mentioned.

"An Oak (*Quercus Garryana*) is the most common deciduous tree. It is found all through the Willamette Valley, and, in the northern part of it is the only oak, as far as I know. An Ash is also common near water. Along streams, Alder, Vine, Maple, Large-leaved Maple, Wild Cherry, a kind of Crab Apple, and some other trees form a margin of green.

"The flowers of the fields and woods are most of them different from their Eastern congeners, and where the same kinds are found they have probably been introduced. Dandelion, Sorrel, Oxeye Daisy, and others have come to plague the farmer,—Sorrel, especially, being very widely spread and troublesome, while Wild Oats, Cheat, and Fern (mostly *Pteris aquilina*), of indigenous growth, are obstinate possessors of the soil.

"In the Ranunculus family, a kind of Coptis is common in the deep woods, also, a pretty Anemone, an Actæa, and a Thalictrum, besides one that I cannot find described, while in the open ground several kinds of Ranunculus and Delphinium are common. Two species belonging to the Barberry family, differing chiefly in size, go by the name of Oregon Grape, and another (*Achlys triphylla*) has odd triangular and three pointed radical leaves, which, when dry, are used to scent clothes, etc. The Yellow

Water Lily is found here, but not the white. The Escholtzia is here, but, I think, escaped from cultivation. We have the pretty Dielytra which is cultivated in Canada, and several other species of the Fumariaceæ. A number of Crucifers are native, and the Shepherd's Purse and Mustard, introduced here, have spread considerably. The Blue Violet (*V. cucullata*) is the same, I think, as the eastern, and is native, probably. A St. John's wort is common, and a Claytonia, representing the Portulaca tribe, is one of our earliest visitors. Several kinds of Geranium and Malvaceæ are abundant. Of the other families, the Leguminosæ and Liliaceæ are most fully represented. There are, also, a great number of Orchids. The most curious of these is one I take to be a Calypso, perfectly white all over, like the Indian Pipe. Among the Leguminosæ we have several species of Lupine, some of them very handsome. The Saxifrages are very delicate and pretty, though rather obscure. One of the Ericaceæ (*Gaultheria Shallon*), called here sal-lal, in leaf and fruit resembles your Winter-Green, though it grows up into quite a bush. There are several kinds of Vaccinium, none of them to my taste quite as good as your blueberries. The 'big-root,' with a flower and leaf like your running cucumber and an intensely bitter root, as big as a person's head, represents the Cucumber tribe. Two or three kinds of Mimulus, one of the Musk Plant and a pretty blue Collinsia are the most common of the Schrophulariceæ. The Nemophila covers the prairies in April and May, and several kinds of flowers soon follow it.

"Several kinds of Willow are common, and an ugly thing, neither an herb nor a bush, a thorny stick with a spreading top of immense prickly leaves and disagreeable scent, represents your sarsaparilla. It is called Elk-Brush, or the Devil's Walking-stick, and is a pretty sure sign of water on the mountains.

"The Grasses are various and interesting, but I have not yet done much with them. I hope by another year to examine them and the Cryptogams somewhat. Much of the botany of the country remains undescribed, and what has been described is scattered in so many books, I am afraid that I shall never get hold of them all."

SPECTROSCOPIC EXAMINATION OF THE DIATOMACEÆ: BY H. L. SMITH.—"The vegetable nature of the Diatomaceæ is now generally admitted, but if any further proof is needed we have it in marked results from the application of the spectroscope. I have been enabled to prove the absolute identity of *chlorophyl* or the green endochrome of plants with *diatomin* or the olive yellow endochrome of the Diatomaceæ. The spectrum-microscope is now too well known to need any description here. The one I have used was made by Browning of London. It is not at all difficult to obtain a characteristic spectrum from a living diatom, and to compare it directly with that of a desmid, or other plants.

I need not here give the results in detail. Suffice it that from about fifty comparisons of spectra, I can unhesitatingly assert that the spectrum of chlorophyl is identical with that of diatomin."—*Silliman's Journal.*

MISCELLANEOUS.

How to Furnish a Freshwater Aquarium.—It is useless, even were it possible, to give the exact amount of plants that are necessary to keep an aquarium in order. A very few pieces will be sufficient to purify the water, but as some water plants are very beautiful, it may be desirable to have the maximum rather than the minimum amount of them in the aquarium. The fishes should have space enough to move around freely, and at the same time to be seen to advantage. Bearing this in mind my own taste would be to have as many plants as the tank would allow. As the water in the tank is changed from time to time the plants can be thinned out and the decaying stalks cut off.

The live stock of the aquarium is generally selected from fishes, lizards, snails, and mussels. One word as to the propriety of having many kinds of fish together in one tank. Some fish, such as sticklebacks or pickerel, are so voracious that either the other fish are wholly eaten up by them, or else their fins or tails are so maimed that they become objects of pity instead of amusement.—Again, in selecting a stock of fish we should try to have them of a size proportioned to the tank they are to be put in. It is a great mistake to have in the tank a fish so large that it can hardly turn about; as a general rule, in our common sized tanks, the smaller the fish the better. At the same time we thus have a chance of having more specimens without diminishing too much the supply of oxygen. It is often very difficult to get small specimens of some kind of fish, such as perch or eels. At certain seasons of the year it is the custom, in some places in the country, to draw off the water in the mill-pond and make repairs; if such a time presents then is the time for the lover of the aquarium to enjoy himself, for as the water is left in small, shallow holes, here and there, we shall find in these places multitudes of specimens only waiting to be preserved,—small perch in great numbers and many rare larvæ among the plants. At such a time too, we can make a choice of mussels, selecting for their beauty those whose shells are rayed with the darker shades of green. Very young bream are easy to catch in the net. Not so with those an inch or more long, and now is the chance offered to get as many as we wish. Perch and bream both need a good deal of care to make them live the year round in the tank, but they will repay a little trouble, as they become so tame if properly cared for. Speaking of the tameness of fishes, it seems to be more a question of food than anything else; if fishes are fed at certain times, and are compelled to come to the top for the food, they soon get into the way of coming up whenever one is near by, and will even jump out of the water at the bare finger. There is a little fish, found mostly in slowly running streams, called the roach; it is a very interesting fish for the aquarium on account of its peculiar shape and habits; it has two large side fins just behind the head, which it always keeps fully extended, looking as if it had an old fashioned collar on. It remains motionless for the most part of the time on the bottom of the stream, occasionally starting off, perhaps in search of food, only to sink down again to its former quiet position in the aquarium. Young pickerel are desirable fish to have in the tanks if one can afford to keep only that kind of fish; placed with larger fish they do very well and constantly recommend themselves for their elegant movements, but with small fish, such as minnows, they live in constant war. In one of my tanks twenty-four minnows were killed within a week by a pickerel about an inch and a half long, and this while giving the pickerel a regular course of feeding on beef. Minnows have always held a high rank among the fishes to be selected for the aquarium; collecting together in schools, tame, hardy, and lively, they have qualities which few aquarial specimens possess. The stickleback

(*Gasterosteus*), of which there are several varieties, is hardly a fish for the general collection; although of exquisite form, it is so fierce, especially in the breeding season, that it incessantly attacks the other fishes in the aquarium, and in a short time deprives them of more or less of their tails. making the unfortunate victims literally top-heavy, swimming with their tails, or rather what were once tails, much higher than their heads,

Sticklebacks should have a tank devoted exclusely to them, and this especially if we wish them to build a nest, one of their peculiar accomplishments. Early in the spring the sticklebacks may be found in great numbers in the small ditches which drain the salt-water marshes. The male is easily distinguished from the female by its deep red color around the gills and its blue eyes, while the female has only the silvery scales. A pair taken at random usually live peaceably together; if it is in the right season they will soon look about for materials for a nest, taking bits of water-plants, and even coming to the surface for small pieces of straw and sticks; with such materials they build a round nest about as large as a small English walnut, hollow in the centre, and having two holes large enough to admit the fish on either side; the nest is built upon the branches of some of the water-plants. While the female is laying the eggs, the male acts as guard, fiercely driving away anything coming within a certain radius of the nets. When the eggs are laid they resemble small globules of wet sago more than anything else. The female will be seen to fan these eggs quite often with her fins; this is probably to give them fresh water and to prevent any sediment collecting upon them. After a fortnight or so, instead of eggs, we see in different parts of the tank what at first look like very minute gold spangles as large as the head of a small pin. On closer examination we find that they are the eyes of a very small fish. Their growth is so slow that in order to preserve them it will be well to remove them to a small tank by themselves, where they can be fed by placing a piece of raw beef on the end of a string, and hanging it over the edge of the tank into the water until it is turned white, when another piece can be introduced.—The stickleback, as also the minnow, is easily accustomed to fresh water by freshening the salt water gradually until it is quite fresh and then introducing the fish into the tank. The stickleback is not the only fresh-water nest-building fish. Wood mentions a curious fish, found in tropical America, called by the natives the hassar; a fish which builds a nest as carefully as the stickleback, though one "not placed in the water but in a muddy hole just above the surface." Whether we have gold fish or not in the aquarium, is a matter of taste, some persons thinking that they give the aquarium a common fish-globe look. It seems to me if we can get some small ones of a brilliant colour, and of good proportions, we should be glad to receive them into the tank. The great trouble with gold fish is that they are so apt to be deformed, some with the gaunt look of a starved fish, others with a hump on the back or a larger or smaller number of fins than usual. Gold fish would be worth keeping in the aquarium for their remarkable colour alone, if for nothing more.

Small eels and horned pouts add to the variety of fishes in the aquarium, but both are so uneasy and so very voracious that they are not pleasing inmates of the tank; wandering up and down the sides of the tank, they seem discontented and ill at ease.—Young alewives are so beautiful that one is tempted to try them in the aquarium; rarely do they flourish in it.

One of the most interesting animals for the aquarium is the triton, or water-newt; these tritons are often found in what are called, in the country, pond-holes, seldom in brooks or ponds; they are perfectly harmless and will remain on the warm hand as long as one has patience to hold them; they come up to the surface to breathe, and therefore do not consume much oxygen; they are perfectly hardy and easy to keep alive, eating small pieces of beef eagerly; they occasionally change their skins, bringing the old skin over their heads, and then swallowing it just as the toads do. Their odd motions in the water, often poising themselves on the end of the tail or on one toe, are very amusing. They lay their eggs in the early spring either on or between the leaves of water-plants. By the middle of August the young are nearly two inches long; they breathe at first with gills, but by September they come to the surface for air, as the older ones do. These tritons outlive all the other specimens in the tank, and they live so peaceably with their companions that they are invaluable as aquarial specimens.—*C. B. Brigham, in American Naturalist.*

THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

THE INTRODUCED AND THE SPREADING PLANTS OF ONTARIO AND QUEBEC.

By A. T. DRUMMOND, B.A., LL.B.

Those members of our flora which have been introduced, or which have the habits of naturalized species, we may refer to one or other of five groups:—

I. Incidental escapes.
II. Adventive plants.
III. Naturalized foreign plants.
IV. Species which are both indigenous and naturalized.
V. Native species which have the habits of introduced plants.

The first, second, and third groups are well known, and only require a passing notice.

The first group embraces species which have escaped from cultivated grounds, have propagated themselves in neglected gardens, or have been casually introduced with grain or grass-seed, or in other ways, and which are not in the least permanent. Stray plants of wheat, oats, corn, and other grains growing upon our country roadsides, and upon the tracks of the railways, are familiar to us. The little heartsease, the ragged robin, and morning glory are some of our garden plants, which, unaided by continued cultivation, have occasionally, for a brief period, struggled to retain their places in the neglected flower plots.

The term adventive has been applied to foreign plants which have permanently located themselves in the country, and yet are so dependent upon some of the accompaniments of civilization that were the country to resume its preadamite condition they would probably soon disappear. Adventive plants form a numerous class, embracing most of those weeds which confine themselves to the vicinity of dwellings and barns, and to cultivated grounds. The mustards and the corncockle, familiar pests on many eastern farms, and the flax, carrot, parsnip, and artichoke, illustrate the group.

Those introduced species, which have freely spread themselves throughout the settled parts of the country, and which, though domesticated through the agency of man, are probably quite independent of him for existence, come under the category of naturalized plants. The buttercup, clover, Canada thistle and sheep sorrel, strikingly exemplify this extensive group.

The remaining groups require a more attentive consideration. All of the species referred to them are indigenous to this country; some to the settled, others to the remote districts. With many individual plants of some of the species it forms a question whether their introduced habit indicates a foreign origin or results from a tendency of the indigenous plant to abnormally spread. In certain instances the known limited distribution of the species, in its indigenous form, dispels any doubt. For example, around Lake Superior. Agassiz chronicles as native, or probably so, species whose habits, in the settled parts of the country, evince a decidedly exotic origin. Where, however, the range of both forms is extensive, indicating the limits of each is impracticable. It is indeed *possible* that not only have the rambles of the native species frequently placed them side by side with the domesticated plants, and probably quite undistinguishable from them, but that in some instances the species, though common to Europe and America, have no introduced representatives here; and that individuals of these species, which have the habits of exotics, are in reality indigenes which have wandered beyond their natural homes.

A question, replete with interest, arises in connection with these naturalized plants. Have changes of climate and of other conditions in the long lapse of years impressed new specific characters on the individuals of any species, or, if not, have they produced any permanent varieties? If even the latter were the case, it seems probable that not only might varieties be different on different continents, but the migration of these varieties might also lead to specific changes. Let the imagination trace the wanderings of one of these little plants under such circumstances.

Probably of a spreading habit in its native country, it emigrates, through one of the innumerable channels constantly open, to a foreign clime, where it becomes established, and where, in consequence of a change of conditions, some slight but permanent alteration is effected in its characters. The plant thrives, and in the lapse of years becomes a widely distributed weed. Another emigration takes place thence to a country where climatal and other conditions are different from those of either its native country or last adopted home. A more marked variety results. In the course of long time this variety appears on another continent, to be subjected to farther changes, which so destroy the identity of the plant that a botanist only acquainted with the species in its native clime, on seeing its wandering individuals here, hails the discovery of an allied plant requiring a place in specific nomenclature. It is, however, a suggestive enquiry whether if this new species or the variety were to find a footing in the country whence its progenitors came, it would retain its identity as a species or variety. The whole subject merits some investigation as to how far, in any respect, climatic or other differences produce permanent change. I cannot, however, help here recalling some analogous cases. The inland maritime plants, growing on the shores of the Great Lakes and elsewhere, have been subjected to a great change in their conditions of growth without any corresponding alteration in the distinctive characters of the species. Similar instances are recorded in the insect fauna of Lake Superior, and our attention has lately been drawn to *Pieris rapæ*, an intruding butterfly from Europe, extensively naturalized in the Province of Quebec, which here even feeds on a plant different from that which constitutes its food on the other side of the Atlantic, and yet retains its specific features unchanged.

In enumerating, in the catalogue below, species which have both indigenous and introduced representatives in the country, I briefly indicate the provincial range and habits of each plant as far as known. Our knowledge of the habits and distribution of the grasses in Ontario and Quebec is, however, so limited that I enumerate, without any accompanying notes, such species as are probably referable to this catalogue. Indeed, with respect to both this and the other catalogues, I shall be glad to have the aid of botanical friends in rendering our knowledge of the habits and range of all of the spreading and naturalized plants more complete.

Ranunculus sceleratus, L. This plant is frequent in railway and roadside ditches, and in wet places in old pastures and neglected grounds. In range it is common from the Detroit River and the southern shores of the Georgian Bay to the Lower St. Lawerence, and is native in the Hudson Bay Territory. In the two Provinces it probably chiefly occurs in the introduced state.

Barbarea vulgaris, R. Br., is often met with in gardens. Mr. Barnston (Canad. Nat. 1859) speaks of it as introduced or not according to locality. The varieties are indigenous from Lake Superior northward and westward. The plant is well known in Ontario in its introduced form, but is apparently less familiar in Quebec.

Erysimum cheiranthoides, L., is a weed in gardens at Belleville (Mr. J. Macoun), but elsewhere I know it only as a native. In the Lake Erie districts and in Eastern Ontario it is frequent, and no doubt occurs in the Eastern Townships.

Draba verna, L. This plant is little known here, and is only provisionally placed in this catalogue. Provancher cites Cap Tourmente as a station, and, according to Prof. Gray, it is not found north of the Province of Quebec. In the Southern United States and in Massachusetts it is introduced.

Turritis glabra, L. Mr. Macoun regards this as introduced around Belleville, where it occurs in newly seeded meadows. In the indigenous form its known range is from Lake Superior to Montreal and southward. In the Hudson's Bay Territory it is well diffused.

Sisymbrium Sophia, L., is occasionally met with from Prescott, in Ontario, eastwards. Whether it occurs in the indigenous state or not is open to doubt. In the Northern States it is still less known.

Cerastium viscosum, L. Torrey and Gray, in their flora, when referring to this species, as well as *C. vulgatum*, add an interrogation after "introduced." Macoun thinks it occurs in both the native and naturalized states at Belleville. It ranges from the northern shores of Lake Huron to those of the Lower St. Lawrence. Seeman notes its occurrence within the Arctic zone.

Arenaria serpyllifolia, L. Prof. Brunet says of this plant, "*Elle est certainement spontanée au Labrador.*" I have only seen it in the introduced state, but Macoun, whilst observing its occurrence in waste ground, thinks it may be indigenous at

Belleville. Although distributed from the islands of Lake Huron (Dr. Bell) to Labrador, and southward to Lakes Erie and Ontario, it does not appear to be very common.

Trifolium repens, L. Most of the individuals of this widely-diffused species met with in these Provinces are probably introduced. Agassiz seems to question whether the Lake Superior plant may not be native. My esteemed correspondent, Mr. Macoun, in a note on it, says, "*T. repens* is certainly a native, but it is also an introduced plant. I have observed it in all my wandering, and noticed that it always makes its appearance in new clearings along with *Erigeron Canadense*."

Vicia cracca, L. From Belleville eastwards this species is not uncommon. Dr. Bell considers it introduced in Gaspé; in Ontario it is certainly indigenous. It appears among the introduced plants of Agassiz and Lowell—(Agassiz's Lake Superior.)

Potentilla Norvegica, L., forms one of those species which are frequently found on roadsides and in fields, and yet may not be introduced. In its undoubtedly native state it is common from the northern coast of Lake Superior to Labrador and Newfoundland.

Potentilla Argentea, L., is found abundantly in old sandy fields at Toronto, Port Colborne, Picton and Gaspé. At Swampscott, near Boston, I obtained it on the roadside in sandy soil. It is questionably native.

Agrimonia Eupatoria, L., is frequently met with on roadsides. In Southern Africa it is a naturalized plant (D'Urban.) The indigenous form is well distributed over both Ontario and Quebec.

Galium Aparine, L. This plant, if it has not been overlooked, has a limited distribution. It occurs in the Erie district, and ranges thence to Montreal. I have only met with it in gardens, and Dr. Lawson, of Halifax, who has an extensive acquaintance with the flora of these Provinces, informs me that his experience is that the introduced form is not common except in gardens.

Taraxacum dens-leonis Desf. This is a plant of wide diffusion, extending northward to the Arctic zone. Wherever met with in the settled parts of Ontario and Quebec, its habit is that of an introduced plant.

Achillea millefolium, L., is another extensively-diffused species, which also ranges to the Arctic zone. It largely frequents roadsides and waste fields.

Xanthium strumarium, L., occurs in the Erie district, and thence eastward. Some forms of this species are indigenous in the United States—(Gray's Manual.)

Gnaphalium uliginosum, L. Most of the species of the genus Gnaphalium have a more or less introduced-like habit. Individuals of this species are frequently met with on roadsides and in fields. The range of the plant extends over the two Provinces, except in the extreme West, where, however, it is to be looked for.

Artemisia vulgaris, L., is a common roadside plant in eastern Ontario and Quebec. Torrey and Gray (Flora N. Amer.) refer to it as indigenous in British North America. It occurs within the Arctic zone.

Cirsium arvense, Scop. In the settled districts *C. arvense* is decidedly naturalized, but some authors regard it as probably indigenous in the Hudson's Bay Territory. It is well diffused throughout Ontario and Quebec.

Plantago major, L., is very common everywhere amongst grass in fields and on roadsides. Agassiz thinks it indigenous on the north shore of Lake Superior, and Macoun has informed me of its occurrence, in the native state, on rocks along rivers in the northern part of the County of Peterborough, Ontario.

Veronica serpyllifolia, L., is a familiar field and wayside plant from the Detroit River to Gaspé and Newfoundland. Its habits are those of an introduced plant, but some observers have met with it in the native state.

Brunella vulgaris, L., is well distributed over the two Provinces. The naturalized state occurs abundantly in lawns and in pastures, and sometimes on roadsides.

Calamintha clinopodium, Benth., is well known throughout Ontario, but in Quebec does not seem to have been observed. At Kingston I think it is indigenous, and Macoun similarly regards the Belleville plant. The Lake Superior form Agassiz also considers native rather than naturalized.

Polygonum aviculare, L. This, the most common of weeds, almost everywhere meets the eye. I have only seen the introduced form, and have doubts whether it is, at any locality, indigenous. The variety *erectum* (*P. erectum*, L.) is an aboriginal, as also is var. *littorale* (*P. maritimum*, Ray.)

Humulus Lupulus, L., has escaped from cultivation, and somewhat permanently settled in some places. I have seen it around

Montreal and at Lennoxville. It is indigenous on the north shore of Lake Superior, and during the past summer I found it entwining itself among the shrubs which border Salmon Creek, in the Township of Melbourne, Province of Quebec. It can no longer be regarded as a plant of purely Western range.

Festuca ovina, Gray, var *duriuscula*, Gray.

Poa compressa, L.

P. pratensis, L.

Agrostis vulgaris, With.

Panicum glabrum, Gaudin.

P. crusgalli, L.

Triticum repens, L.

T. caninum, L.

So intimately connected in their range and habits with the exotic plants of our fields and roadsides, are our native species in their abnormally diffused states that there seems a propriety in referring to them here. Their habits are instructive as they furnish an explanation of the circumstances which have led to the introduction of foreign plants into the country in our times. Native species, when they assume these rambling habits — as most, if perhaps not all, of our domesticated exotics to a greater or less extent have in the countries from which they have come —frequently stray into grain-fields, to roadsides, wharves, and other localities, whence their seeds are readily conveyed to foreign lands, along with grain, wool, packing, personal effects of emigrants, ballast, and other means of transmission, so amply afforded. Thousands of the seeds thus yearly brought to foreign shores probably never germinate, and of those which do, perhaps but a small proportion, representing some of these hardy species, and a few others, which find a congenial climate and soil, mature and perpetuate their existence. The recurring immigration, year after year, of the same as well as occasional other species, soon, however, gives a feature to the vegetation there. The spreading habits of any of the plants, in the countries from which they have come, will have hardened their natures, and nerved them for not only enduring the vicissitudes of, perhaps, dissimilar soils, and a more trying climate, but also of encroaching upon the domains of the native vegetation. In this manner has, I conceive, arisen in a large measure the distribution of the exotic flora of our roadsides and fields. And it further seems unquestionable that those members of our indigenous flora which have this spreading habit will not only be the most likely to migrate to and become naturalized in foreign lands, but of all species which may happen to be so naturalized from here will be the most hardy, and probably have, eventually, the widest range. *Erigeron Canadense* and *E. annuum* are familiar illustrations. With an extensive range in this country, they have migrated to Europe, where, in the naturalized state, they now have a wide distribution. *Œnothera biennis* affords an example of the same feature.

Illustrative of this last group there are some well-known plants. *Ranunculus abortivus*, L., is very common on roadsides in different parts of the country. The range of the plant is from the Detroit River to the Lower St. Lawrence and Newfoundland. The variety *micranthus* occurs on the north shore of Lake Superior, and thence westward and south-westward.

Corydalis aurea, Willd. At Ottawa, I found this plant among the rocky debris on the banks of the river, along with introduced plants. Dr. Bell has observed a similar spreading tendency on the Manitoulin Islands. This habit is, as yet, but little developed, as elsewhere the species is only known in its normal state. It is well distributed over the two Provinces, except in the Erie district.

Oxalis stricta, L. At Kingston, this is common in gardens. Excepting on the north shore of Lake Superior, it is well diffused over Ontario and Quebec.

Œnothera biennis, L., is now a garden plant. It is sometimes found growing in rubbish and on road-sides. The distribution of the plant over the two Provinces is very general.

Sambucus Canadensis, L. This is exceedingly common in fence rows. It is a well-known species from the southern shores of the Georgian Bay and from the Detroit River to the Lower St. Lawrence. Its abnormal habits have been observed in the United States, and the question has been raised whether it is a native there or not.

Erigeron Canadensis, L., is a plant of wide distribution, both on this and other continents. Here it ranges over the greater portion of the two Provinces, and often occurs in neglected fields. Two other species of this genus *E. annuum*, Pers. and *E. strigosum*, Muhl. have also a tendency to become intruders.

Rudbeckia hirta, L., is a southern plant, indigenous in the Ontario peninsula, and eastwards as far as Belleville, but also frequent in grain fields around London and on St. Joseph's Island, Lake Huron, and spreading in the County of Northumberland.

Antennaria plantaginifolia, Hook. This plant is found everywhere throughout the Provinces, and beyond them extends to Hudson's Bay and the Rocky Mountains. Farm yards and the road-sides are favourite resorts of it. Among its near allies, the Gnaphaliums, there is also a tendency to spread.

Bidens frondosa, L. This, and perhaps one or two other species of the same genus, frequently stray into railway and roadside ditches. The known range of *B. frondosa* is from Lake Erie to the Lower St. Lawrence.

Lobelia inflata, L., a well distributed plant of both Provinces, occurs in grain fields in the Province of Quebec, and is thought to be the cause of some cases which have lately occurred of poisoning among cattle.

Hedeoma pulegioides, Pers. and *H. hispida*, Pursh—neither of which seems to range into the districts north of Lakes Huron and Superior and into the Province of Quebec—both have, Mr. Macoun informs me, spreading habits at Belleville.

Verbena hastata, L. is a frequent intruder on road-sides and in neglected fields. In the indigenous state it is common from the Manitoulin Islands to the neighbourhood of Quebec.

V. urticifolia, L. This species occurs in similar situations to *V. hastata*, and has a nearly analogous range.

Veronica peregrina, L. This is a well-known grass plant, occurring on lawns, in parks and elsewhere. Its recorded range is from Lake Erie to the vicinity of Quebec.

Urtica gracilis, Ait, Macoun remarks, has an introduced habit at Belleville. From Lake Superior to Anticosti this plant has been everywhere met with.

Polygonum Pennsylvanicum, L. In wet fields, road-sides, and railway ditches, this, and perhaps one or two more Polygonums are often found. *P. Pennsylvanicum* is known to range from the Manitoulin Islands to below Montreal.

Acalypha Virginica, L., is a familiar weed in some places. The species is distributed from the Erie district to about the City of Quebec.

Euphorbia maculata, L., is a known road-side plant, and is possibly an introduction from the United States. It ranges over a considerable portion of Ontario.

E. commutata, Engel., has been noticed at Shannonville, Ont., by Macoun, who remarks its introduced-like appearance.

Salix lucida, Muhl., is very common in the ditches and moist grounds on the sides of railway tracks. It is abundant throughout the two Provinces.

Panicum capillare, L.

When the Provinces were originally settled by the ancestors of the present French population, we can believe that many of the weeds of France found a home here. Immigration during succeeding years from the same country, and from Great Britain and Germany, not only repeated the introduction of many of these weeds, but largely swelled the number of introduced species. At the present day, our close commercial relations with Great Britain and the United States are producing a yearly influx of these unwelcome visitors, and scattering them broadcast over the country. Though new forms only now and then make their appearance, there is an incursion—renewed every summer to a greater or less extent—of those familiar, self-made friends of ours. At the same time, not only are these very species—along with some members of our indigenous flora — migrating from here and obtaining a footing in other foreign lands with which we are in commercial intercourse, but they must frequently reappear among their native brethren, in the countries from which they originally came. Amongst those countries between which trade relations are intimate, there must be a constant interchange in this way.

Illustrative of this immigration from different countries, there may be cited: from tropical America, *Senebiera didyma*, Pers., which occurs at Gaspé, and Montreal, and which has, probably, been directly introduced, *Chenopodium ambrosioides*, L., species of *Amaranthus*, of which there is presumption that they have come by way of the United States, and *Nicotiana rustica*, L., which Dr. Gray considers a relic of cultivation by the Indians; from the United States, *Martynia proboscidea*, Glos., probably *Acalypha Virginica*, L., and some of the Euphorbias, and from Europe, in addition to many well-known plants, *Potentilla argentea*, L., *Leontodon autumnale*, L., *Plantago lanceolata*, L., *Rumex patientia*, L., and *Cynodon Dactylon*, Pers.

The large yearly influx of population from different parts of Europe aids materially in establishing species throughout the Provinces, and the facilities afforded for the subsequent distribution of these species are especially great in consequence of the long continuous lines of railway and water communication between the seaboard and all sections of the interior. Many introduced plants are thus of wide range. *Capsella bursa pastoris*, Mœnch, *Achillea millefolium*, L., *Maruta cotula*, D. C., *Cynoglossum officinale*, L., and *Polygonum persicaria*, L., for example, extend from Lake Superior to the Lower St. Lawrence. Others, again, are quite restricted in range. *Leontodon autumnale*, L., and *Senebiera didyma*, Pers., are limited to the seaports, and *S. coronopus*, D. C., is only known from Gaspé; *Veronica chamædrys* has not been observed elsewhere than at Quebec; *Sisymbrium sophia*, L., is uncommon in the Province of Quebec and quite unknown west of Prescott, and *Plantago media*, L., has, as yet, only been observed at Toronto.

Currents may play a more important part in the introduction of exotic plants than is generally supposed. Our Canadian lake coasts supply illustrations of this agency at work. Coral islands are, it is well known, mantled with a vegetation largely resulting from the seeds carried to their shores through the medium of winds and currents. In the United Kingdom, the influence of the Gulf Stream is observable in the occurrence of *Eriocaulon septangulare*, With., *Sisyrinchium anceps*, Car., and *Naias flexilis*, Rostk, upon the western coasts. It seems, indeed, possible that the part played by this great current in the phenomena of distribution has not been brought into sufficient prominence. The evidence, though limited, suggests the enquiry whether, in addition to some local plants, others, common to the two continents, and fairly diffused, at the present day, in Europe, may not have had their starting points on its west shores, whither their seeds have been carried, by the Gulf Stream, from America, at stray times, during passing centuries, without destroying their vitality.

VOLCANOES AND EARTHQUAKES.

ABSTRACT OF A LECTURE

By T. STERRY HUNT, LL.D., F.R.S.*

It is proposed, in the present lecture, to discuss the nature and causes of volcanoes and earthquakes, with their related pheno-

* Delivered April 22, 1869, before the American Geographical and Statistical Society, and reprinted from its proceedings.

mena, and to consider the reason of their peculiar geographical distribution. Violent movements of the earth's crust are confined to certain regions of the globe, which are at the same time characterized by volcanic activity; from which it is reasonably inferred that the phenomena of earthquakes and volcanoes have a common origin. The discharge through openings in the earth's crust of ignited stony matter, generally in a fused condition, and the disengagement of various gases and vapors, accompanied by movements of elevation or subsidence of considerable areas of the earth's surface, sometimes rapid and paroxysmal, and attended with great vibratory movements, are evidences of a yielding crust of solid rock resting upon an igneous and fluid mass below. To the same conditions are also to be ascribed the slow movements of portions of the earth's surface shown in the rise and fall of continents in regions remote from centres of volcanic activity. The unequal tension of the yielding crust and the sudden giving way of the overstrained portions are probably the immediate cause of earthquake phenomena; the seat of these, according to the deductions of Mallet, is to be found at depths of from seven to thirty miles from the surface.

A brief description of the phenomena of volcanoes will be necessary as a preliminary to the inquiry which constitutes the object of our lecture. Volcanoes are openings in the earth's crust through which are discharged solid, liquid, and gaseous matter, generally in an intensely heated condition. Sometimes the ejected material is solid, and consists of broken comminuted rock, or the so-called volcanic ashes. Oftener, however, it is discharged in a more or less completely fused condition, constituting lava, which is sometimes fluid and glassy, but more frequently pasty and viscid, so that it flows slowly and with difficulty. The ejected materials, whether liquid, or solid, build up volcanic cones by successive layers—a fact which has been established by modern observers in opposition to the notion come down from antiquity, that volcanic hills are produced by an uprising or tumefaction of previously horizontal layers of rock by the action of a force from beneath. First among the gaseous products of volcanoes is watery vapor; water appears not only to be involved in all volcanic eruptions, but to be intimately combined with the lavas, to which, as Scrope has shown, it helps to give liquidity. The water at this high temperature is retained in combination under great pressure, but as this pressure is removed passes into the state of vapor, a process which explains the swelling up of lavas and their rise in the craters of the volcanoes. Besides watery vapor, carbonic, and hydrochloric acid gases, and hydrogen, both free and combined with sulphur and with carbon, are products of volcanoes. The combustion of the inflammable gases in contact with air sometimes gives rise to true burning mountains—a name which does not properly belong to such as give out only acid gases, steam, and incandescent rocky matters, which are incombustible. The escape of elastic fluids from lavas gives to them a cellular structure, but when slowly cooled under pressure, as seen in the dykes traversing the flanks of volcanoes, the stoney materials assume a more solid and crystalline condition, and resemble the older eruptive rocks found in regions not now volcanic. These include granites, trachytes, dolerites, basalts, etc., and are masses of rock which, though extravasated after the manner of lavas, became consolidated in the midst of surrounding rocks, and consequently under considerable pressure. Their presence marks either the lower portions of volcanoes whose cones have been removed by denudation, or outbursts of liquefied rock which never reached the surface. The escape of such matters, and the formation of volcanic vents, are but accidents in the history of the igneous action going on beneath the earth's surface. We shall, therefore, regard the extravasation of igneous matter, whether as lava or ashes at the surface, or as plutonic rock in the midst of strata, as, in its wider sense, a manifestation of vulcanicity, and, for the elucidation of our subject consider both those regions characterized by great outbursts of plutonic rock in former geologic periods, and those now the seats of volcanic activity, which, in these cases, can generally be traced back some distance into the tertiary epoch. To begin with the latter, the first and most important is the great continental region which may be described as including the Mediterranean and Aralo-Caspian basins, extending from the Iberian peninsula east-ward to the Thian-Chan Mountains of central Asia. In this great belt, extending over about 90° of longitude, are included all the historic volcanoes of the ancient world, to which we must add the extinct volcanoes of Murcia, Catalonia, Auvergne, the Vivarais, the Eifel, Hungary, etc., some of which have probably been active during the human period.

It is a most significant fact that this region is nearly coextensive with that occupied for ages with the great civilizing races of the world. From the plateau of central Asia, throughout their westward migration to the pillars of Hercules, the Indo-European nations were familiar with the volcano and the earthquake; and that the Semitic race were not strangers to the same phenomena, the whole poetic imagery of the Hebrew Scriptures bears ample evidence. In the language of their writers, the mountains are molten, they quake and fall down at the presence of the Deity, when the melting fire burneth. The fury of his wrath is poured forth like fire; he toucheth the hills, and they smoke, while fire and sulphur come down to destroy the doomed cities of the plain, whose foundation is a molten flood. Not less does the poetry and the mythology of Greece and of Rome bear the impress of the nether realm of fire in which the volcano and the earthquake have their seat, and their influence is conspicuous throughout the imaginative literature and the religious systems of the Indo-European nations, whose contact with these terrible manifestations of unseen forces beyond their foresight or control, could not fail to act strongly on their moral and intellectual development, which would have doubtless presented very different phases had the early home of these races been the Australian or the eastern side of the American continent, where volcanoes are unknown, and the earthquake is scarcely felt.*

Besides the great region just indicated, must be mentioned that of our own Pacific slope, from Fuegia to Aliaska, from whence along the eastern shore of Asia, a line of volcanic activity extends to the terrible burning mountains of the Indian archipelago. Volcanic islands are widely scattered over the Pacific basin, and volcanoes burn amidst the thick-ribbed ice of the Antartic continent. The Atlantic area is in like manner marked by volcanic islands from Jan Mayen and Iceland, to the Canaries, the Azores, and the Caribbean islands,and southward to Ascension, St. Helena, and Tristan d'Acunha.

---

*Compare the fine lines of Pope, in the Essay on Man, where, of superstition, the poet says:

" She, 'mid the lightning's glare, the thunder's sound,
While rocked the earthquake, and while rolled the ground,
She taught the proud to bend, the weak to pray—
To Powers unseen and mightier far than they,
She, 'mid the rending earth and bursting skies,
Saw gods descend and fiends infernal rise;
Here fixed the baleful, there the blest abodes—
Fear made her devils and weak hope her gods."

The continents, with the exception of the two areas already defined, present no evidences of modern volcanic action, and the regions of ancient volcanic activity, as shown by the presence of great outbursts of eruptive rocks, are not less limited and circumscribed. In northern Europe, the chain of the Urals, an area in central Germany, and one in the British islands are apparent, and in North America there appear to have been but two volcanic regions in the paleozoic period—one in the basin of Lake Superior, and another, which may be described as occurring along either side of the Apallachian chain to the north-east, including the valleys of the lower St. Lawrence, Lake Champlain, the Hudson and Connecticut rivers, and extending still farther southward. The study of the various eruptive rocks of this region shows that volcanic activity in different parts of it was prolonged from the beginning of the paleozoic period till after its close.

Having thus before us the principal facts in the history of volcanoes, we may proceed to notice the various theories from time to time put forward to account for them. The first and most obvious notion is that of combustion, and we find early writers supposing that volcanoes might be due to the burning of coal, bitumen, or sulphur. As juster ideas were acquired of the nature of combustion, and the necessity of a supply of air for its maintenance, other chemical agencies were invoked as the probable source of internal fire. Lemery suggested the oxidation of sulphurets in the presence of water, and the brilliant discovery by Davy, in the earths and alkalies, of metallic bases which decompose water with great violence, and even with the phenomena of combustion, gave rise to the so-called chemical theory of volcanoes, which has found its defenders down to our own time. This theory supposes that the interior of the globe consists of the metallic bases of earths and alkalies, which are oxidized by the gradual access of the ocean's water, with the production of intense heat, causing the fusion of the resulting oxides, which constitute lavas and eruptive rocks. The chemical objections which may be urged against this theory are numerous, and to my mind insuperable; in addition to which it may be added that it fails to explain the facts connected with the past and present distribution of volcanoes, and is in disaccord with those views of the early condition of the globe most in harmony with the deductions of modern astronomy, physics, and chemistry.

I need not here repeat the arguments in favor of the theory which supposes our earth to be a cooling globe, which has passed through various stages, from an uncondensed nebulous mass to a liquid, and finally to its present solid condition, with a cold exterior; nor to the evidences of a regularly increasing temperature as we descend into its crust, from which it is concluded that at a depth of a few miles a heat of ignition would be attained. If we suppose the solidification of the once liquid globe to have begun at the surface, which became thus covered with a feebly conducting crust, it would not be difficult to admit, as some imagine, a still liquid centre, surrounded by a shell of congealed matter upon which are spread the sedimentary strata. Various and independent arguments from the phenomena of precession, from the theory of the tides, and from the crushing weight of mountain masses like the Himmalaya, have, however, been brought against this hypothesis of a thin crust resting upon a liquid centre, and in addition to these another important one of a different order. Judging from the known properties of the rocks with which we are acquainted, solidification should commence not at the surface, but at the centre of the liquid globe, a process which would moreover be favored by the influence of pressure. This augments the melting temperature of matters which, like the rocks and most other solids, become less dense when melted, while on the other hand it reduces the melting point of those which, like ice, become more dense by fusion. Pressure, moreover, it may be mentioned in this connection, increases the solvent power of water for most bodies, whose solution may be described as a kind of melting down with water into a compound whose density is greater than that of the mean of its constituents; the importance of this point will appear farther on. The theory deduced from the above considerations, and adopted by Hopkins and by Scrope, is briefly as follows: the earth's centre is solid, though still retaining nearly the high temperature at which it became solid. At an advanced stage in the solidifying process the remaining envelope of fused matter became viscid, so that the descent from the surface of the heavier particles, cooled by radiation, was prevented, and a crust formed, through which cooling has since gone on very slowly. There were thus left between this crust and the solid nucleus, portions of yet unsolidified matter (or even perhaps, as suggested by Scrope, a continuous sheet), and it is in the existence of this stratum, or of lakes of uncongealed matter, that we are to find an explanation of all the phenomena of volcanoes and earthquakes, of elevation and subsidence, and of the movements which result in the formation of mountain chains, as ingeniously set forth by Mr. Shaler. The slow contraction of the gradually cooling globe, a most important agency in the latter phenomena, is evidently not excluded by this hypothesis. It may be added that a similar structure of the globe, viz., a solid nucleus and a solid crust separated from each other by a liquid stratum, was long ago suggested by Halley in order to explain the phe-enomena of terrestrial magnetism. Scrope has completed this hypothesis by the suggestion that variations in tension or pressure may cause portions of matter beneath the surface to pass from solid to liquid, or from a liquid to a solid state, and in this way help us to explain the local and the temporary nature of volcanic activity.

This theory of Hopkins and Scrope, apparently so complete in itself, is an approximation to the one which I adopt, though differing from it in some most important particulars. While admitting with them the existence of a solid nucleus and a solid crust, with an interposed stratum of semi-liquid matter, I consider this last to be, not a portion of the yet unsolidified igneous matter, but a layer of material which was once solid, but is now rendered liquid by the intervention of water under the influence of heat and pressure. When, in the process of refrigeration, the globe had reached the point imagined by Hopkins, where a solid crust was formed over the shallow molten layer which covered the solid nucleus, the farther cooling and contraction of this crust would result in irregular movements, breaking it up, and causing the extravasation of the yet liquid portions confined beneath. When at length the reduction of temperature permitted the precipitation of water from the dense primeval atmosphere, the whole cooling and disintegrating mass of broken-up crust and poured-out igneous rock would become exposed to the action of air and water. In this way the solid nucleus of igneous rock became surrounded with a deep layer of disintegrated and water-impreg-nated material, the ruins of its former envelope, and the chaotic mass from which, under the influence of heat from below and of air and water from above, the world of geologic and of human history was to be evolved.

As we descend in the sedimentary crust of the earth, we observe a regular increase of temperature, due, as is supposed, to the slow upward passage of the central heat. In the present state of refrigeration this process is so slow that the increase of temperature in descending is only about one degree centigrade for each hundred feet; but if we admit the hypothesis of a cooling globe, it can be shown that in early geologic ages this increase must have been tenfold, or even twenty-fold greater than at present. As this augmentation of temperature in depth obeys the same law alike in the newest and the oldest formations, it follows that the accumulation of sediment at any time and place will result in a slow rise in temperature of the portion covered thereby, so that a deposit of a few miles in thickness in comparatively recent ages, and probably one of as many thousands of feet in the Laurentian or even the paleozoic period, would, after a lapse of time, so elevate the temperature of the buried portions as to produce new chemical and mechanical arrangements of the sediments. The expansive action of heat upon these porous materials, which generally include several hundredths of water, would soon be counteracted by the great contraction following chemical combination, resulting in the formation of new and denser compounds, which constitute the crystalline and metamorphic rocks. The action of silicious matters in the presence of water, aided by heat, upon the various carbonates, chlorides, sulphates, and organic matters which abound in most sedimentary formations, would generate the acid gases which are so often evolved in volcanic eruptions. It must be borne in mind that water under pressure, and at high temperatures, develops extraordinary solvent powers; while from what has already been said of the influence of pressure in favoring solution, it will be seen that the weight of the overlying mass becomes an efficient cause of the liquefaction of the lower portions of the sedimentary material. Time is wanting to discuss the great forces which from early geologic periods have been active in transferring sediments, alternately wasting and building up continents. By the depression of the yielding crust beneath regions of great accumulation there follows a softening of the lower and of the more fusible strata, while the great mass of more silicious rocks becomes cemented into comparative rigidity, and finally, as the result of the earth's contraction, rises a hardened and corrugated mass, from whose irregular erosion results a mountainous region.

Those strata, which from their composition yield under these conditions the most liquid products, are, it is conceived, the source of all plutonic and volcanic rocks. Accompanied by water, and by difficultly coercible gases, they are either extravasated among the fissures which form in the overlying strata, or find their way to the surface. The variations in the composition of lavas and their accompanying gases in different regions, and even from the same vent at different times, are strong confirmations of the truth of this view, to which may be added the fact that all the various types of lava are represented among aqueous sedimentary rocks, which are capable of yielding these lavas by the process of fusion.

The intervention of water in all lavas, of which it appears to form an integral part, was first insisted upon by Scrope, and is a fact hardly explicable upon any other hypothesis than the one just set forth. Considering the conditions of its formation, water would seem to be necessarily absent from the originally fused globe, in which the older school of geologists conceive volcanic rocks to have their source. Scheerer supplemented Scrope's view, by showing that the presence of a few hundredths of water, maintained under pressure at a temperature approaching ignition would probably suffice to produce a quasi-solution or an igneo-aqueous fusion of most crystalline rocks, and subsequent observations of Sorby have demonstrated that the softening and crystallization of many granites and trachytes must have taken place in the presence of water, and at temperatures not above a low red heat. Keeping in view these facts, we can readily understand how the sheet of water-impregnated debris, which, as we have endeavored to show, must have formed the envelope to the solid nucleus, assumed in its lower portion a semi-fluid condition, and constituted a plastic bed on which the stratified sediments repose. These, which are in part modified portions of the disintegrated primitive crust, and in part of chemical origin, by their irregular distribution over different portions of the earth, determine, after a lapse of time, in the regions of their greatest accumulation, volcanic and plutonic phenomena. It now remains to show the observed relations of these phenomena, both in earlier and later times, to great accumulations of sediment.

If we look at the North American continent, we find along its north-eastern portion evidences of great subsidence, and an accumulation of not less than 40,000 feet of sediment along the line of the Appalachians from the Gulf of St. Lawrence southwards, during the paleozoic period, and chiefly, it would appear, during its earlier and later portions. This region is precisely that characterized by considerable eruptions of plutonic rocks during this period and for some time after its close. To the westward of the Appalachians, the deposits of paleozoic sediments were much thinner, and in the Mississippi valley are probably less than 4,000 feet in thickness. Conformably with this, there are no traces of plutonic or volcanic outbursts from the north-east region just mentioned throughout this vast paleozoic basin, with the exception of the region of Lake Superior, where we find the early portion of the paleozoic age marked by a great accumulation of sediments, comparable to that occurring at the same time in the region of New England, and followed or accompanied by similar plutonic phenomena. Across the plains of northern Russia and Scandinavia, as in the Mississippi valley, the paleozoic period was represented by not more than 2,000 feet of sediments, which still lie undisturbed, while in the British islands 50,000 feet of paleozoic strata, contorted and accompanied by igneous rocks, attest the connection between great accumulation and plutonic phenomena.

Coming now to modern volcanoes, we find them in their greatest activity in oceanic regions, where subsidence and accumulation are still going on. Of the two continental regions already pointed out, that along the Mediterranean basin is marked by an accumulation of mesozoic and tertiary sediments, 20,000 feet or more in thickness. It is evident that the great mountain zone, which includes the Pyrenees, the Alps, the Caucasus and the Himmalaya, was, during the later secondary and tertiary periods, a basin in which vast accumulations of sediments were taking place, as in the Appalachian belt during the paleozoic times. Turning now to the other continental region, the American Pacific slope, similar evidences of great accumulations during the same periods are found throughout its whole extent, showing that the great Pacific mountain belt of North and South America, with its attendant volcanoes, is, in the main, the geological equivalent or counterpart of the great east and west belt of the eastern world.

It is to be remarked that the volcanic vents are seldom immediately along the lines of greatest accumulation, but appear around and at certain distances therefrom. The question of the duration of volcanic activity in a given region is one of great interest, which cannot, for want of time, be considered here. It appears probable that the great manifestations of volcanic force belong to the period of depression of the area of sedimentation, if we may judge from the energy and copiousness of the eruptions of island volcanoes, although the activity is still prolonged after the period of elevation.

As regards the geological importance of volcanic and earthquake phenomena, their significance is but local and accidental. Volcanoes and earthquakes are and always have been confined to limited areas of the earth's surface, and the products of volcanic action make up but a small portion of the solid crust of the globe. Great mountains and mountain chains are not volcanic in their nature or their origin, though sometimes crowned by volcanic cones; nor are earthquakes and volcanoes to be looked upon as anything more than incidental attendants upon the great agencies which are slowly but constantly raising and depressing continents.

The theory of volcanic phenomena here set forth was first partially indicated by Keferstein in 1834, and subsequently and apparently independently by Sir John Herschel in 1837. It, however, attracted little or no attention until, in 1858 and 1859, I again brought it forward, and endeavoured to show its conformity with the facts of chemistry, physics, and geognosy. In the hasty sketch of it here given, the chemist, the geologist, and the geographer will alike discover points which require elucidation or provoke criticism, but will, I hope, find, nevertheless, a concise and intelligible statement of a theory of earthquakes and volcanoes which appears to me more in harmony with the known facts of science than any other hitherto advanced.

P. S.—In justice to myself, it should be said that at the time this lecture was delivered I had no knowledge of Prof. J. D. Whitney's excellent and suggestive paper on earthquakes, which appears in *The North American Review* for April, 1869. The relation of modern volcanic phenomena to great accumulations of newer secondary and tertiary rocks, and the connection of the foldings and contortions of sedimentary strata with great thicknesses of the same, are set forth by me in several papers, the chief of which may be found in the *Canadian Journal* for May, 1858, the *Geological Journal* for November, 1859, and the *American Journal of Science* for July, 1860 (vol. xxx., p. 133), and also for May, 1861 (vol. xxxi., pages 406-414), where the important contributions of Professor James Hall, bearing upon this question, are noticed at length.

DESCRIPTIONS OF THE CANADIAN SPECIES OF MYOSOTIS, OR "FORGET-ME-NOT," WITH NOTES ON OTHER PLANTS OF THE NATURAL ORDER BORAGINACEÆ.

By G. LAWSON, Ph.D., LL.D., Professor of Chemistry and Mineralogy in Dalhousie College and University, Halifax, N. S.

As the true relations of our palustral forms of *Myosotis* have not hitherto been explained, it may be well to call the attention of botanical students to the subject, by characterizing our plants more carefully than has been done, and endeavouring to adjust the nomenclature, I shall add a few notes on the other *Boraginaceæ*, found within the Dominion or adjoining country, with the view of promoting enquiry in regard to doubtful points of identity and distribution.

All the species in British America and the Northern States are herbaceous plants, and several of them biennials or annuals. In the Southern States, however, there are five plants of the order which assume the character of small trees or erect or twining shrubs.

In our Flora this order is chiefly remarkable for the large proportion of species of exotic origin. The nutlets are, in some species, furnished with barbed prickles, which cause them to adhere to the coats of animals, but this is of itself not sufficient to explain the large number of introduced species, and the rapidity with which they seem to have spread. The total number of Canadian *Boraginaceæ* (excluding those of the North-West) is a little over 20 species, of which one-half are introduced; in the Northern States, Gray enumerates 29 species, of which 11 are introduced; and in the Southern States, Chapman describes 22, of which 3 are introduced. There is a manifest increase of introduced species northwardly

Myosotis, Linn. In Professor Gray's "Manual of Botany of the Northern States," 2nd edition, (1856,) *Myosotis palustris* is described, with the specific name, in the broad-faced type of indigenous species, and as a perennial, but the remark is added, "Cultivated occasionally;" then it is said that the plant "varies into smaller forms, among which high authorities rank *M.*

cæspitosa, and (with yet more reason) the intermediate var. *laxa* (*M. laxa* Lehm.) Wet places common, especially northward." In the fifth edition (1868) *M. palustris* is still kept in the broad-faced type, but its distribution is thus noted:—" Naturalized from Europe, near Boston, escaping from gardens." This is followed by var. *laxa*, (*M. laxa* Lehm.,) briefly described and ranged thus:—" Wet places, northward." In short, Prof. Gray is of opinion that the normal *M. palustris* is a European plant, but that we have a variety of it here (*M. laxa*) which is indigenous.

In Wood's " Class Book or Flora of the United States and Canada" (1867) the true *M. palustris* is not indicated, but merely the so-called *M. palustris* var. *laxa*, as perennial and indigenous, with the synonym *M. cæspitosa* Schultz.

Professor Torrey, in the " Flora of New York State," describes *M. palustris* Roth, adding the remark:—" Our plant differs from the European in its smaller flowers. It seems to be the var. *micrantha* of Lehmann."

In Chapman's " Flora of the Southern United States" (1862) the name *M. palustris* does not occur at all, but *M. laxa* Lehm. is described as an annual.

In the " Flora Canadienne " of the Abbé Provancher (1868) there is but one plant described under " *Myosotis des marais*," to which the names *M. palustris* Hook, *M. cæspitosa* Schultz, and *M. lingulata* Lech., are all made to apply equally.

In Dr Hooker's " Outlines of the Distribution of Arctic Plants" (Linn. Trans. xxiii., pp. 251—348) *M. palustris* is given in his columns for Arctic Europe, North Europe and Asia, and *North-East America*, while *M. cæspitosa* is confined to Europe and Asia.

These citations show an obvious tendency to confusion in the use of names, which arises partly from difference of opinion and partly from a mistake respecting the plants. The plant, which is naturalized from Europe in the United States, is undoubtedly the normal form of *M. palustris*; it appears to be more abundant in the British Provinces, and there is the possibility of its being indigenous with us.

The plant described by American authors as indigenous, and as a variety of *M. palustris*, does not belong to *M. palustris* at all, but is a form of *M. cæspitosa*, a species that has long been well known, and was found, in the time of Sir James E. Smith, to retain its characters under cultivation, (*vide* "English Flora.") Whether we have more than one form of *M. cæspitosa* cannot be determined without a larger series of specimens from different localities; but hitherto I have met with nothing like the *M. strigillosa* or *M. repens* of Europe, which may be looked upon as intermediate forms, and are regarded by some as belonging properly to *M. palustris*. The right of *M. cæspitosa* to rank as a distinct species has long been recognized by the best botanists of Europe, and a careful comparison of our plant with the European leaves no room for doubt as to their identity.

M. palustris Withering. Stem freely creeping and rooting at the base, then ascending; from 6 to 12 inches long; thick, angular, branched; rough, with spreading hairs; prominent ribs or wings run down the stem from the margins and mid-ribs of the leaves. Leaves all sessile, clasping decurrent, oblong-lanceolate, or linear-oblong or linear-lanceolate, usually ligulate, rarely spathulate, (the lower half of the lamina usually broader than the upper,) blunt at the apex; rough, with very short (mostly appressed) hairs or hair-points; foliage always of a uniform bright green color. Flowers large; corolla bright sky-blue, with a white circle surrounding a prominent raised yellow ring or eye; the horizontal limb of the corolla much longer than the tube; coralline divisions almost overlapping and slightly emarginate; calyx more than half as long as its pedicel; cleft nearly half way down into five segments, which are triangular-ovate; rough, with very short appressed bristles; peduncle and pedicels, with appressed hairs. Flowers in June and succeeding months, remaining long in blossom, partly from the continuous branching of the stem and successive production of new racemes in the axils, and partly from the production of fresh flowering shoots from the creeping base of the stem.

Myosotis palustris, Withering. "Arrangement of British Plants," vol. ii., p. 225; Smith, "English Flora;" Babington, "Manual of Botany;" Hooker & Arnott, "British Flora;" A. Gray, "Man. Bot.," 5th ed., p. 364 (exclude var. *laxa*.)—Regel & Herder.

Not *M. palustris* Torrey. "Flora of New York State"

This species grows in muddy spots by the margins of streams, usually on black mud, and in places liable to inundation; Sackville River and its tributaries, N.S.; Sydney, Cape Breton; also near Halifax, G.L.; Boyne Cottage, Studley Road; W. L.

Lindsay, sp. We require more information as to the occurrence of this plant before deciding definitely whether it is an introduced or indigenous species, for, being the common Forget-Me-Not, it is frequently cultivated in garden patches, and has obviously a great capacity for spreading in suitable situations.

M. palustris extends through Europe to the Altai, where it is noticed by Regel and Herder; it appears, however, to be more Southern in distribution than *M. cæspitosa*.

M. cæspitosa, Schultz. Stem nearly a foot high; usually simple, erect and straight from a short decumbent base, or only very slightly creeping; round, wiry, without wings or angles, but with a narrow furrow or "impressed line" running down from the margins of the leaves; smoothish-looking throughout and shining, especially in dried specimens, but the surface is beset with very short, appressed, conspicuous, bristly hairs. Lower leaves stalked; upper ones sessile; all more or less spathulate; broader above the middle, and rounded or blunt at the tips; the veins, especially towards the base, of a reddish color, with which the whole plant is frequently tinged. Flower small; pale sky-blue, (half the size of that of *M. palustris*, and paler in colour;) limb of corolla nearly horizontal, but slightly incurved, and equal in length to the tube. Calyx covered with appressed bristles. Flowers in June or July; one set of cymes is produced, and there is no prolonged succession of blossoms as in *M. palustris*.

M. cæspitosa, Schultz. Ledebour, Smith, Babington, Regel & Herder, Kar. & Kir., Trautv.

M. palustris, Torrey. "Fl. New York State," vol. ii., p. 87 (exclude synonyms.)

M. palustris, var. *laxa* Asa Gray. "Man. Bot., N. S." 5th ed. Wood, "Fl. of United States," p. 562.

M. laxa, Chapman. "Fl. S. States."

Not *M. strigillosa*, Bertel.

Not *M. laxa*, Lehmann?

"Var. *micrantha* of Lehmann?"—Torrey.

Ditches, drains and other moist places; usually in gravelly or stony soil. Quite common in Halifax County, N.S., as in railway drains between Bedford and Windsor Junction, roadsides at Sackville, Prince's Lodge, &c. Probably common throughout the Dominion. I have collected it at Kingston. Dr. P. W. Maclagan notes it at Chippewa and Thorold, Ont., and Mr. Macoun finds it very common about Belleville. It is common in

Northern Europe, extending to the Altai, and in America is not uncommon in low grounds throughout the States south to Florida.

M. arvensis, Hoffman. Kingston, Ont., a weed in gardens; not indigenous, but probably effectually naturalized as a plant cultivated by man against his will. Dr. Hooker observes:—"Watson finds this occasionally approximating to *cæspitosa*, and I find it difficult to separate northern forms of one from the other." This remark should set at rest all doubt as to the propriety of separating *cæspitosa* from *palustris*, unless, indeed, we revert to the old Linnæn idea of one species of *Myosotis*, which no modern botanist is prepared for.

M. verna, Nuttall: Chapman, "Flora of Southern United States," p. 333 (in part). *M. stricta*, Wood: "Flora United States," p. 562 (in part probably.) *M. arvensis*, Torrey: "Fl. New York State," vol. ii., p. 88 (not of other botanists.) *M. scorpoides* (*a*) Michaux.

Whether *M. stricta* Link, Ledebour, Kar. & Kir., Trautvéteer, Regel & Herder, &c., is identical with this admits of some doubt. Millcreek, Odessa, Ont., 8th July, 1861—G. L.; Malden, Ont.—Dr. Maclagan. Mr. Macoun speaks of it doubtfully as occurring at Ox Point, below Belleville; very rare.

There are two forms, viz.:—

a. Typica. Stem simple, branching above into cymes. *M. verna*, Chapman. Indian Island, Bay of Quinté—G. L.

b. Ramosa. Much branched from the very base; whole plant more robust. Odessa, near Kingston, Ont.—G. L. Chapman's var. *macrosperma* may prove to be a distinct species.

M. versicolor, Persoon. I have no information respecting this as a Canadian plant.

M. suaveolens, (*b*) *Americana.* This plant is intermediate between the *M. suaveolens* (alpestris) of the mountains of Europe, and *M. sylvatica* of the plains. Between Fort Youcon and Lapierre's House, in the Youcon Country—Governor McTavish, sp.

Eritrichium villossum, Bunge. West of Rocky Mountains, between Ft. Youcon and Lapierre's House—Governor McTavish, sp.

Eritrichium villosum, var. *aretioides*; *E. aretioides*—D. C.; *E. villosum* Hook, fil; *E. villosum*, var. *aretioides* A. Gray, in "Parry's Plants." Fort Simpson, summer of 1853—Governor McTavish, sp.

Onosmodium Virginianum, D. C. On the common, north from Railway Station, Belleville; rather rare—Mr. Macoun. This species extends south to the dry pine barrens of Florida.

O. Carolinianum, D. C. Brantford, Ont.—Dr. P. W. Maclagan. Extends to the Southern States.

Echium vulgare, Linn. Naturalized from Europe. This plant has spread considerably in rear of Brockville, Ont. Common near the Seminary at Belleville, and on Stillman's Farm, Seymour, Ont.—Mr. Macoun. Christy's Corners, on the road from Kemptville to Spencerville, Ont.

Judge Malloch informed me that this was sown as a garden plant, about the year 1850, by a farmer of the name of Christy. It soon spread, so as to form a noxious weed on his farm, and when I visited the locality in 1862 it had spread along the road side for four or five miles. In North Carolina and Virginia it is said to have become a troublesome weed.

The plant varies in form:

a. Plant large; weed-like; leaves green, with long, straight, erect bristles on the lower surface of the mid-ribs, as well as on the stem, and especially on the pedicels and calyx. Roadside, Tin Cap Schoolhouse, between Brockville and Farmersville. This is like the Southern plant.

b. Smaller; corolla larger, and rather wider in proportion; leaves whitish, with short, fur-like, scarcely spreading hairs, and without erect bristles on the mid-ribs; the bristles on the stem and flower stalks shorter than in *a*. Between Kemptville and Spencerville. This is like the Scotch plant.

Borago officinalis, Linn. Adventive from Europe. Sackville, N.S., G L. Roadside near Odessa, Ont.—Dr. Dupuis. Not noticed by any of the American botanists as having become wild in the States, and may be only a temporary colonist with us. It is not a plant that spreads in its native country. There is a specimen in my herbarium, from Rev. P. Somerville, labelled "Malta, Feb., 1839; very rare, if not now extinct."

Lycopsis arvensis, Linn. Adventive from Europe. Kingston, Ont. An abundant weed about Queen's College grounds and neighboring gardens. Montreal—Dr. P. W. Maclagan.

Symphytum officinale, Linn. A European plant, sparingly naturalized with us, as it is in the United States and in Europe beyond its original range. Waste ground about Queen's College, and on Prince's Street, Kingston. Roadsides near Hillton, Brighton—Mr. Macoun. Montreal, abundant; also, Niagara River—Dr. P. W. Maclagan. Probably we have more than one form, possibly more than one species. The Montreal and Niagara plants I have not seen.

Lithospermum arvense, Linn. Adventive from Europ An abundant weed in gardens at Kingston, Ont., 16th May, 1862, in fl., G. L. Montreal—Dr. P. W. Maclagan. In wheat fields, Brighton; also, Taylor's Hill, Belleville; common—Mr. Macoun. The plant varies somewhat, being either simple or divaricately branched from a straight red tap-root; the red root gives out a purple stain to paper in the herbarium. It extends south to Florida.

Var. *a. incanum*. Leaves linear, narrow, more or less canescent. Indian Island, (uninhabited,) Bay of Quinté, G. L. I have the same form from Malta. This appears to be the proper form of the plant.

b. robustum. Leaves linear, lanceolate, pale green, covered with very short setaceous hairs. This is the common weed form. English (Cambridgeshire) and Scotch specimens agree with this. It is larger than the plant from Indian Island.

L. officinale, Linn. Naturalized from Europe. Abundant about roadsides and waste places near Kingston, G. L. Montreal, abundant, and Niagara River—Dr. P. W. Maclagan.

L. latifolium, Michaux. Indigenous. Bois Blanc and other islands in Detroit River—Dr. P. W. Maclagan.

L. hirtum, Lehm. Grand Rapids, 13th July, 1851—Governor McTavish. Indigenous.

L. canescens Lehm. Indigenous. Grand Rapid, 13th July, 1851—Governor McTavish; Malden, Sandwich, Ont.—Dr. P. W. Maclagan; Assiniboine River, July, 1861; Lake Manitoba, June and July, 1861, in fl., and Fort Garry, July, 1861—Dr. Schultz, sp. Nos. 8, 66, 82 and 143.

" *L. linearifolium*, Goldie. Malden, Ont."—Dr. P. W. Maclagan. I have not seen the specimen.

Mertensia maritima, Don. More common on our coasts than on those of the United States. Abundant on the sandy shores at Great Bras d'Or, Cape Breton—G. L.; Gulf of St. Lawrence, on the New Brunswick Coast—Rev. J. Fowler; Bay of Fundy—Mr. J. F. Mathew; St. Augustine, Labrador, 1865—Rev. D. Sutherland, sp.; Anticosti, a form with glabrous leaves was occasionally met with—Mr. Verrill.

M. sibirica, var. *paniculata*. Shores of the great Lakes, &c.; Hudson's Bay—Gillespie, sp.; Fort Simpson, 1853; between York Factory and Norway House; Youcon River; Lake Superior; York Factory—Governor McTavish. The specimens vary very much in size, breadth of leaves, hairiness, roughness, &c.

Dr. Hooker observes that *Mertensia pilosa* D. C., which includes *Lith. corymbosum* Lehm., and *paniculatum* Don, is clearly referable to *denticulata* Don, the hairy calyx being a very inconstant character. These, he suggests, should all be united under *sibirica*; and in reference to *M. Drummondii* Don he finds no plicæ in the tube of the corolla, whence it must be associated with *Virginica*, of which it appears to be a northern form, but it has not been gathered anywhere between the Arctic Sea Coast and the United States *M. Virginica* is a southern plant extending from New York and Wisconsin to South Carolina and Tennessee.

The following remain to be identified with described forms. The first is a variety of *paniculata*; the second is very different in aspect:

1. Leaves narrow, linear-lanceolate; sepals narrow, ciliate on the margins; otherwise glabrous. West of Rocky Mountains, say from Fort Youcon to Lapierre's House, W. J. H.—Governor McTavish, sp. A small plant; leaves bright green, with very few rough points.

2. Leaves orbicular to very broadly ovate, with very short hairs, but quite rough all over with hair bulbs, and perfectly glaucous; sepals externally glabrous, except at the margins. Youcon—Governor McTavish. A robust, large-leaved plant, as glaucous as *M. maritima*, but with the flowers, &c., of the *Sibirica* group.

Echinospermum Lappula, Lehm. Naturalized from Europe. Hinchinbrook, July, 1862—G. L. So common throughout some of the settled portions of Ontario that botanists have neglected to note its distribution, or to collect many specimens; but rare or absent over a large portion of the Maritime Provinces. (According to Wood it extends to Arctic America, but probably he refers to another form.) This is a rare plant in Britain, found in only one locality in the South of England. Provancher notices it as extending to Carolina, which must be a mistake, as there is no notice of it in "Chapman's Flora." Regel & Herder, in "Plantæ Semenovianæ," 1869, p. 31, describe two varieties, viz.:

a. Typicum. Prickles in two rows on the margins of the nutlets. *E. Lappula* Lehm. "Asperif," p. 121. Ledebour, "Flora Ross.," vol. iii., p. 155

b. Consanguineum. Prickles in three rows at the base, from middle to apex two rows or one. *E. consanguineum*, Fischer & Meyer, "Index Sem. Hort. Petrop.," vol. v., p. 35. Ledebour, "Fl. Ross.," vol. iii., p. 157.

E. Redowskii, Lehm. "Asperif." p. 127; Ledeb., "Fl. Ross.," vol. 3, p. 158; A. Gray. "Man. Bot.," ed. 5, p. 365. Noticed by Prof. Gray as growing at St. Paul's, Minn., and on the plains westward, and, therefore, likely to be met with in our intercourse with the Red River country. The following species, differing in the branching and in the granulate or tuberculate, or nearly smooth back of the nutlets, and in the rugose or smooth sides, are referred by Regel as named varieties of this species, viz.: *E. strictum*, Ledeb.: *E. tenue*, Ledeb.; *E. Karelini*, Fischer; *E. oligacanthum*, Ledeb.; *E. affine*, Kar. & Kir. It is, therefore, very desirable that specimens from different localities should be examined with much care.

E. deflexum, Lehm. Differs by its recurved fruit pedicels from *E. Redowskii* and *E. Lappula*, in both of which they are erect; prickles in a single series. *E. deflexum* Lehm. "Asperif," p. 120; Ledeb., vol. iii., p. 154; Regel & Herder. "Pl. Sem., 1869," p. 30. Noticed in Hooker's "Outlines of Arctic Distribution," as occurring in N. E. America, as well as in Europe (Arctic and Southern) and Asia to N. E. I am not sure, however, whether he means this to be identical with *E. Redowskii*. Regel keeps it separate.

E. patulum, Lehm. has extremely short, erect pedicels, (flowers sub-sessile,) and is kept separate by Regel. *E. patulum* Hooker, probably different, is referred by Gray to Redowskii in "Man. Bot.," ed. 5.

Cynoglossum officinale, Linn. Naturalized from Europe. Common throughout the settled portions of Ont.—G. L.; Belœil, P. Q., 1869—Dr. J. Bell; Portland, Ont., July, 1860—Dr. Dupuis, sp. Is naturalized throughout the United States, south as far as N. Carolina.

C. Virginicum, Linn. Indigenous. Montreal—Dr. P. W. Maclagan; Belœil—Dr. Bell. Abundant in pine woods east from Castleton, Ont.—Mr. Macoun. Extends south to Florida.

C. Morisoni, D. C. Racemes numerous, slender, divaricate, bracted throughout; flowers pale-blue. Kingston, Chippewa, Malden, Ont.—Dr. P. W. Maclagan. Borders of woods and half-cleared land about Belleville—Mr. Macoun; Portland, Frontenac County, Ont.—Dr. Dupuis, August, 1860, fl. and ft.; Frankville, Kitley; also rear of Kingston; abundant along every roadside—G. L. Not noticed as occurring in Quebec Province, but probably common about Montreal.

Prof. Gray characterizes this plant as "a vile weed" in the States, and it is so, likewise, throughout a large portion of Ontario, but not in the Maritime Provinces. Notwithstanding its universal prevalence in some districts, and its complete absence in others, its distribution has not been very accurately traced. Judging from specimens in my herbarium the southern plant is more robust and more hairy than the Canadian. It extends as far south as the upper districts of South Carolina.

ON THE RANUNCULACEÆ OF THE DOMINION OF CANADA AND OF ADJACENT PARTS OF BRITISH AMERICA.

By GEORGE LAWSON, Ph.D., LL.D., &c.

At a meeting of the Nova Scotian Institute held Dec. 13, 1869, Professor Lawson, of Dalhousie College, who has been for some time engaged in investigating the Botany of the Dominion, read a *Monograph of the Ranunculaceæ of the Dominion of Canada and adjacent parts of British America.* The paper, which is a lengthy one, will be published in the Transactions of the Institute; in the meantime the following brief outline of its contents may not be unacceptable to our readers:—

The Ranunculaceæ are characterised by the perfect separation of all the parts of the flower, the calyx of separate sepals, the corolla of separate petals, the stamens numerous and free, and the fruit composed of separate carpels. All these parts arise directly from the thalamus or receptacle; there is a great development in the size of the sepals, and a tendency to suppression or malformation of petals. The Ranunculaceæ are mostly herbaceous plants, with much divided leaves having broad sheathing petioles. They are characteristic of northern countries; in the Monograph, 48 indigenous and six introduced species, making 54 in all, are described, so that in proportion to territory there are fewer species in the Northern States (61), and still fewer in the Southern States (51). The most interesting point in distribution, however, is the intimate relation of many of our British American plants to those of Eastern Europe and Asia, respecting which many details were given.

The genera of our Ranunculaceæ are 16 in number:—1. *Clematis*, with fruit consisting of feathery-tailed achenes, and valvate calyx, large and petal like. 2. *Pulsatilla*, with equally large petal like sepals and feathery-tailed achenes, but herbaceous plants with a large involucre, and imbricate æstivation. 3. *Anemone*, differing from the preceding in the absence of feathery tails. 4. *Syndesmon*, with ribbed fruit, large petaloid sepals and involucrate foliage. 5. *Thalictrum*, with usually ribbed carpels, diœcious or hermaphrodite flowers, and very compound leaves, but no involucrate verticil. 6. *Ranunculus*, with medium sized green sepals, large, usually yellow, petals, and single-seeded achenes. 7. *Myosurus*, with a great development of the receptacle into a body resembling a mouse's tail. 8. *Caltha*, with a fruit composed of separate, several-seeded carpels or pods, and entire leaves. 9. *Trollius*, with similar fructification but palmately divided leaves. 10. *Coptis*, with cucullate petals and ternate leaves. 11. *Aquilegia*, with trumpet-like or spurred petals. 12. *Delphinium*, with the upper sepal produced downwards into a spur. 13. *Aconitum*, with irregular hooded calyx enclosing small abnormal stalked petals. 14. *Cimicifuga*, with deciduous sepals and follicular fruit. 15. *Actæa*, with deciduous sepals and fruit of many-seeded berries. 16. *Hydrastis*, with a fruit of many single or two-seeded berries.

The various species belonging to these genera are fully described in the paper; their synonymy is investigated and their distribution traced in detail throughout all the Provinces, and their range in other countries is likewise given. The effects of the dry and hot inland climate of Ontario are conspicuous in the absence from that Province of many plants common to the North-West and Maritime Provinces.

Several plants that have been described as Canadian are shown to have been so recorded through mistakes, and many points still unsettled are suggested for investigation. Of Clematis, we have two species, one local and the other general in its distribution, the first of these, *C. Virginiana*, grows around the rifle range at Bedford, and at Windsor N.S.; it extends to Lake Winnipeg, Isle Verte being its last point north-eastwardly. The subgenus *Pulsatilla* is confined to the North West, whence numerous specimens have been received from Gov. McTavish. The common form of the species, named *P. Nuttalliana*, is now known to be identical with *P. Wolfgangiana* of the Russian botanists, which is itself a variety of the European *P. patens.* Two forms from the North-West are described, besides *alpina*, one of which does not accord with Regel's *Wolfgangiana*. *Anemone dichotoma* is shown to be the proper name for the plant hitherto known as *A. Pennsylvanica.* Of *A. nemorosa*, the Windflower of English forests, four varieties are described as inhabiting the Dominion, one a small northern form, and another found at Belleville by Mr. Macoun. *A. Richardsonii* has been received only from the Hudson's Bay Territories. *A. Hepatica* is shown to be essentially an Ontarian and New England plant, although found to extend into Nova Scotia, having been gathered at Windsor by Professor How. *A. acutiloba* is restricted and less southern in range. *A. narcissiflora* is not known to exist within British America, although it occurs in the United States in the Rocky Mountains. *A. parviflora* is a North-Western plant, and is found also at Gaspé by Dr. Bell, of Montreal, and on Anticosti, and has usually 5, not 6 petals, as described. *A. multifida* has not yet been collected in Canada, except on the Gulf shore and in the North-West, but will probably reward some diligent searcher in Ontario. *A. Pennsylvanica* has a wide and southern range. *A. cylindrica*, a sand-hill plant, is confined to central and western Ontario.

Syndesmon is a curious little plant, a link between the Windflowers and Meadow-rues, but has only been found in two localities, although in the adjoining States it is not rare; its Canadian habitats are St. David's, Dr. P. W. Maclagan; Hamilton, Judge Logie.

Thalictrum Cornuti is a stately plant with large masses of showy white blossoms, rendering it conspicuous along the Sackville River and on the meadows at Beaver Bank, and is of general distribution throughout the Dominion. *T. purpurascens*, differing in its sessile stem-leaves, greenish flowers and drooping anthers, is to be looked for in dry situations; its record as Lower Canadian is, however, a mistake, and possibly it does not reach so far north as the St. Lawrence. *T. dioicum* has a wide range, but there are two distinct forms about Kingston which require further investigation, one growing near Kingston Mills and the other at the Penitentiary. *T. alpinum*, an arctic European plant, is confined with us to Anticosti and Newfoundland; it is general within the Arctic circle, and runs down the Rocky Mountains to low latitudes, as Arctic plants are apt to do. *T. clavatum* is a York Factory plant remarkable for its pod-like, stipitate carpels, without furrows, but with embossed veins. Of *Ranunculus* 18 species are described and 1 excluded. *R. repens* is the most common as a weed, but rare as an indigenous plant, in which character it grows near Toronto, where it has beon observed for many years by Prof. Hincks. *R. bulbosus* has been frequently reported as Canadian, but the evidence is doubtful. *R. ovalis*, *R. brevicaulis*, and *R. cardiophyllus* are referred as mere forms of *R. rhomboideus*. *R. auricomus* does not belong to our flora, and *R. affinis*, here referred as a variety of it, is confined to the Arctic Sea and the North West Hudson Bay Territories. Of *R. abortivus* two varieties (pratensis and sylvaticus) are described. *R. nivalis* was found by Dr. Rae at Repulse Bay, and the specimens agree with *sulphureus* of Solander. *R. Cymbalaria* is a seashore plant. The numerous varieties of *R. multifidus* and *R. aquatilis* still require careful comparison in the living state with European forms. *R. digitatus*, is a Rocky Mountain plant, approaching *Ficaria* of Europe. *Trollius laxus* has not been recently found in Canada. *Aquilegia Canadensis* presents two forms, and abounds in Ontario, but becomes scarce eastward and northward; it will probably be found in Annapolis, if anywhere in Nova Scotia.

A. brevistyla is quite western, and does not come so far east as to enter the Province of Ontario. *A. vulgaris*, on the other hand, is confined to Nova Scotia, except as a mere garden escape; but even with us it is only a naturalized plant, one of the Wild Flowers of England brought long years ago by the Duke of Kent, and now widely spread through the woods and along our railway banks and roadsides. *Delphinium exaltatum* is from the Youcon and Clear Water Rivers, although in the States its distribution is decidedly southern. *D. azureum* is also from the Youcon; *D. Consolida*, an introduced European plant, is found at Prescott, and *D. Ajacis*, is an excluded species, not permanently naturalized. *Aconitum delphinifolium* is kept distinct from *Napellus*, of which

Dr. Regel describes no fewer than forty varieties and forms, all named and classified. *A. semigaleatum*, not previously noticed as American, is referred as a distinct variety of *delphinifolium*; flowers very large, sepals of thin texture, spreading, galea quite depressed with a long acuminate point. These plants are indigenous, and the specimens of both are from Governor McTavish. The true *A. Napellus* is a naturalized plant. *Cimicifuga* is confined to Cayuga, in the extreme south west of Canada, where it was found by Dr. Maclagan. *Actæa rubra* is widely spread throughout the whole Dominion, but *A. alba* is south western. *Hydrastis Canadensis* is confined to Ontario, and *Adonis* is excluded, as the specimens sent to Hooker from Labrador, 30 or 40 years ago, had no doubt sprung from seeds dropped there by accident, and the plant has not been heard of or seen since.

CANADIAN ZOOLOGY.

Messrs. Dawson have just issued a "Handbook of Zoology, with Examples from Canadian Species, Recent and Fossil," by the Principal of McGill University, one who has been engaged in teaching Natural Science and in making original observations in some of its departments. The effort is a most useful one, and must prove of the utmost service both to teachers and learners in this country. The intention of the work is to illustrate the subject by Canadian examples, and these are taken both from recent and fossil species, by which means greater completeness is secured, and the work is made useful to collectors of fossils and students of Geology. The tone and character of the work are thus explained in the preface:—

"In teaching Zoology nothing is of more importance than to have the means of directing the attention of the student to the animals of the country in which he lives. For this reason I have been in the habit of preparing a synopsis of the subject for the use of my class, with examples taken as far as possible from common native species. In preparing a new edition of this synopsis, I was advised by the publisher to give it greater extension, in the hope that it might be useful to other teachers, and to isolated students and collectors. The present manual is the result of this attempt; and the only merit which it claims is that of giving a skeleton of the subject, with illustrations taken from species which the student can collect for himself within the limits of British North America, or can readily obtain access to in public or private collections.

"Fossil animals are included as well as those which are recent, because many types not represented in our existing fauna occur as fossils in our rock formations; and because one important use of the teaching of Zoology is that it may be made subsidiary to geological research.

"I have avoided the modern doctrines of a 'physical basis of life' and of 'derivation,' because I believe them to rest on grounds very different from those of true science, and therefore to be unsuitable for the purposes of a text-book. I have also retained the Cuvierian provinces of the animal kingdom as amended by modern discoveries. I am quite aware that there are Zoologists who affirm that the Province Radiata has been 'effectually abolished' and that other provinces should be broken up; but as I cannot help perceiving that the four types of the great French naturalist exist in nature, I have not scrupled to adhere to them, as the expression of a grand and philosophical idea, essential to an accurate and enlarged conception of nature.

"In the present chaos of synonymy in Zoology, I have often been perplexed as to the generic and specific names to be given to our most common animals; but have endeavoured to take such a middle way between the older names and the later innovations as seemed likely to be least perplexing to the student."

To some of those who regard themselves as the more "advanced" naturalists the views above stated may be objectionable, but they are, no doubt, the safest in the present state of the subject.

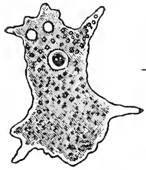
The idea of representing the various groups of animals by Canadian examples, is one which involves an immense amount of labour and research, and must necessarily, in the present state of knowledge, be more or less incomplete. Still it has been carried out to a great extent in this work, and the student and collector will find described, and often well figured, a very large proportion of our more common and important invertebrate animals. As examples, we give the following extracts, which we have selected purposely as referring to creatures not popularly much known.

They will also serve to show the profuse manner in which the work is illustrated with wood-cuts:—

RHIZOPODS.

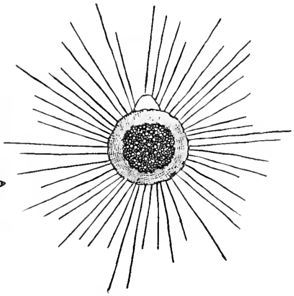
We may take, as a type of this group, the *Amoeba*, a microscopic creature frequently found in ponds containing vegetable matter. It occurs in Canada, and may readily be procured by the microscopist. Different species have been described, but they are very similar to each other. When placed under the microscope, a living specimen appears as a flattened mass of transparent jelly; the front part moving forward with a sort of flowing motion, and jutting forth into pseudopodial prolongations; the hinder part appearing to be drawn after it, and presenting fewer irregularities. In its interior are seen minute granules which flow freely within its substance, and one or more vesicles which alternately expand and become filled with a clear fluid, and contract and disappear. Often also there are certain spaces or vacuoles, in which may be seen minute one-celled plants or other particles of food which the creature has devoured, and which are in process of digestion. The outer portion of the substance of the Amoeba appears to be more transparent and dense than the central portion. So soft is the tissue that the creature seems to flow forward like a drop of some semi-fluid substance moving down an inclined surface; but as the Amoeba can move forward on a horizontal plane or up an incline, it is obvious that its movement proceeds from a force

Fig 24.



AMOEBA, (Montreal,) Magnified.

Fig. 25.



ACTINOPHRYS, (Montreal,) Magnified.

acting from within, and probably of the nature of muscular contraction. Nor are there wanting indications that these motions are voluntary and prompted by the appetites and sensations of the animal. Fig. 24 represents one of the states of a specimen from a pond on the Montreal Mountain.

Another generic form found in the same situation is *Actinophrys*, the Sun-animalcule. In this the outer coat is more distinctly marked, and the body retains a globular form, while the pseudopodia are very slender and thread-like. Fig. 25 represents a specimen found with the preceding.

Amoeba and Actinophrys belong to a family of Rhizopods, (the Amoebina,) which either have no hard covering or a thin crust or lorica covering part or the whole of the body. The remainder of the Rhizopods are protected by calcareous shells, often of several chambers and perforated by pores for the emission of pseudopodia, (*Foraminifera*,) or they are covered by a silicious shell or framework of one piece, (*Polycystina*). The whole of the Rhizopods may thus be included in the following groups, which may be regarded as sub-orders or families:

1. *Amoebina*, without hard skeletons, and mostly fresh-water.
2. *Foraminifera*, with calcareous skeletons; marine.
3. *Polycystina*, with siliceous skeletons; marine.*

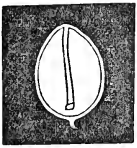
The Foraminifera are the most important of these groups, since they occur in immense abundance in the waters of the ocean, and in its deeper parts their calcareous shells accumulate in extensive beds. According to Messrs. Parker and Jones, from 80 to 90 per cent. of the matter taken up by the sounding lead in deeper parts of the Atlantic, is composed of their remains. In like manner, in the sea bottoms of former geological periods, were accumulated, by the growth and death of Foraminifera, the great beds of chalk and of Nummulitic and Miliolite limestone. In the older formations, also, these creatures are found to have attained gigantic dimensions as compared with living species. A Foraminiferous organism of dimensions unequalled in the modern seas (Eozoon Canadense, Fig. 36) occurs in the Lower Laurentian, and is the oldest form of animal life known to us. The forms figured (Figs. 26 to 35), as seen under the microscope, are some of the most numerous in the Gulf of

---

* Some naturalists form for these a separate class or order (*Radioloria*).

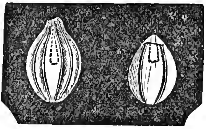
St. Lawrence; in the deeper parts of which great numbers of these creatures occur.

Fig, 26.



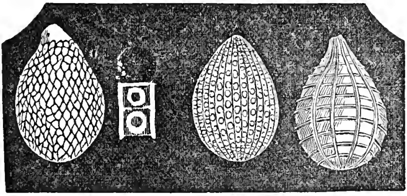
ENTOSOLENIA GLOBOSA, (Gulf St. Lawrence.)

Fig. 27.



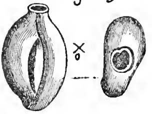
ENTOSOLENIA COSTATA, (Gulf St. Lawrence.)

Fig. 28.



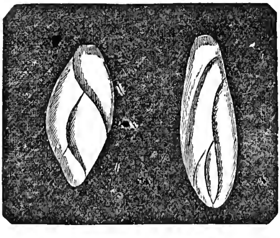
ENTOSOLENIA SQUAMOSA, three varieties, (Gulf St. Lawrence.)

Fig 29



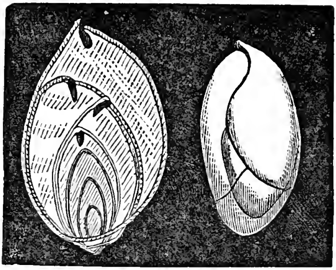
QUINQUELOCULINA SEMINULUM, (Gulf St. Lawrence.)

Fig. 30.



POLYMORPHINA LACTEA, (Gulf St. Lawrence.)

Fig. 31.

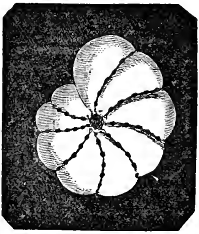


Bulimina presli, (Gulf St. Lawrence.)

Fig. 32.

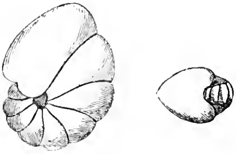
Biloculina ringens—Section, (Gulf St. Lawrence.)

Fig. 33.



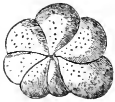
Polystomella crispa, (Gulf St. Lawrence.)

Fig. 34.



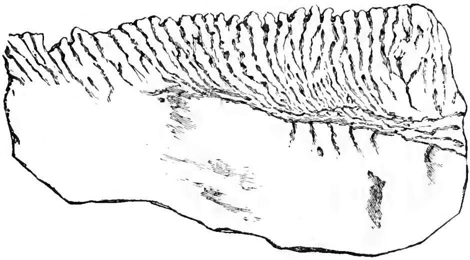
Nonionina scapha—Var. Labradorica, (Gulf St. Lawrence.)

Fig. 35.



Truncatulina lobulata, (Gulf St. Lawrence.)

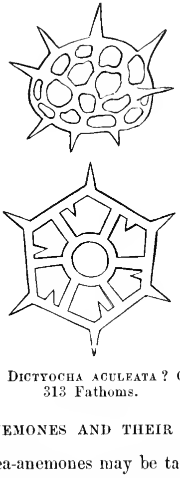
Fig. 36.



EOZOON CANADENSE—Dawson.—Laurentian system, Canada. Section of a small specimen natural size.

The Polycystina are almost equally widely diffused in the sea, though less abundant than the Foraminifera, and their silicious skeletons are often of great beauty and symmetry. Fig. 37 represents two species obtained from a depth of 313 fathoms in the Gulf of St. Lawrence, by Capt. Orlebar, R. N.

Fig. 37.



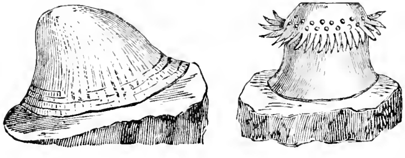
CERATOSPYRIS and DICTYOCHA ACULEATA? Gulf St. Lawrence, 313 Fathoms.

SEA ANEMONES AND THEIR ALLIES.

The Actinias or Sea-anemones may be taken as the type of the Zoantharia; and as an example of these the species named by

Agassiz *Rhodactinia Davisii*, and which is the most common species on the north shore of the Gulf and River St. Lawrence, may be noticed here. It is probably a variety of *Actinia crassicornis* of the British coast. Externally, when expanded, it presents a cylindrical body attached at the lower extremity to a rock or stone, and at the upper having a crown of thick worm-like tentacles arranged in several rows, in the centre of which is the mouth. The external surface of the body, the tentacles and disc are often gaily coloured in shades of purple, crimson, and flesh colour, though different individuals differ very much among themselves in this respect, and also in the smoothness or tuberculated character of the body. When fully expanded, the animal has the appearance of an aster or other stellate flower. When irritated or alarmed it withdraws its tentacles, contracts the body wall over the disc, and assumes the form of a flattened cone. Its food consists of such small animals as may be attracted by its gay colours, or may accidentally come within reach of its tentacles. To enable it to seize these it has in the substance of the tentacles an apparatus of extensile and retractile thread-cells, by means of which it can hold with some tenacity any object which touches the tentacles, and can also exert a benumbing influence tending to paralyze and subdue the resistance of its prey. The specimens figured (Figs. 43 and 47,) were dredged in Gaspé, and referred to a new species, *R. nitida*, but may possibly be a variety of the above.—Another variety, found in the River St. Lawrence, is permanently tuberculated, and cannot be distinguished from *A.* (*Urticinia*) *crassicornis*, as ordinarily seen in Great Britain.

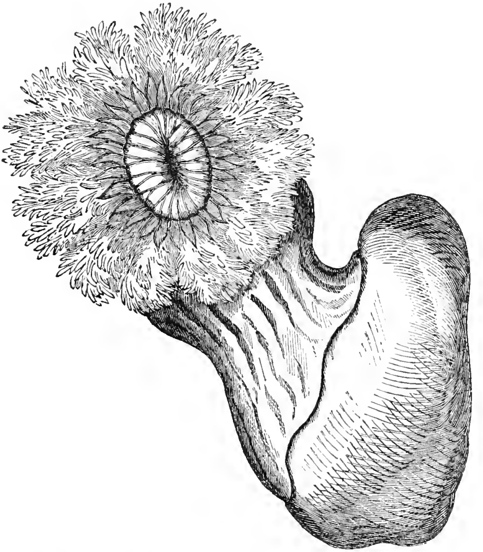
Fig. 47



ACTINIA (Urticinia) CRASSICORNIS, contracted, and smaller individual expanded.

A larger and often more beautiful representative of the Actinoids is the *Metridium marginatum*, a species closely allied to the *Actinia dianthus* of Great Britain. It is found in great perfection at the mouth of Gaspé Basin, where the specimens represented in the following figures (Figs. 48, 49) were obtained. In this species the tentacles are in two series, the outer series being very numerous, and arranged on lobes of the edge of the disc.

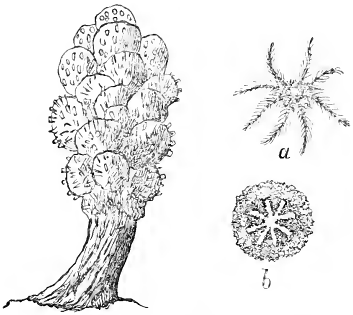
Fig. 48.



METRIDIUM MARGINATUM, Edw. & Haime, (Gaspé.)

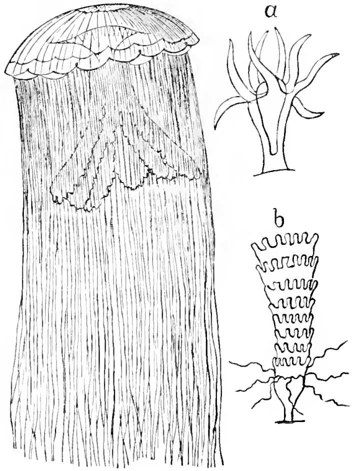
As a native example of the Alcyonoids, we may take the *Alcyonium rubiforme*, (Fig. 51,) which is sometimes cast up in storms, on the shore of the Gulf of St. Lawrence, and may be obtained alive by dredging in deep water. It presents tuberculated yellowish or pinkish masses of a club-shaped form, from an inch to three inches in length, and of a spongy or firmly gelatinous structure. The surface is studded with round or star-shaped cells of small size, from which, when the creature is alive and undisturbed, delicate semi-transparent polyps protrude themselves and extend their tentacles. These little animals can be easily distinguished from those of the last group by their pinnate tentacles, eight in

Fig. 51.



ALCYONIUM RUBIFORME, Dana, (Gaspé,) (a) Polyp expanded; (b) Polyp contracted.

Fig. 66.



CYANEA ARCTICA, Per. and Les. reduced.
(*a*) Hydroid progemy.
(*b*) Strobila.

number. The corallum or skeleton is of a corneous and fibrous nature, and the animals are connected by numerous canals traversing its substance.

THE SEA JELLIES.

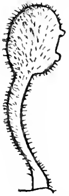
One of the best representatives of this order on our coast is the great blue Jelly-fish, *Cyanea Arctica*, (Fig. 66), which is often found in the Gulf of St. Lawrence and on the Atlantic coast of Nova Scotia, a foot or more in diameter, and is said sometimes to attain the enormous diameter of seven feet. The most conspicuous part of this creature, as it floats in the sea, is its great violet-coloured disc, the edges of which are moved slowly up and down as it swims along. In the centre of this disc below, projects the proboscis or external stomach, furnished with a profusion of filmy fringes hanging at the extremities of the four lateral processes into which its free end is divided. From the margins of the disc float backward innumerable long reddish tentacles armed with urticating thread cells, which paralyze any little animal they may touch, and enable it to be drawn into the mouth. These tentacles are often several feet in length. Between the tentacles and the base of the probocis, when the creature is mature, may be seen four great ovaries loaded with yellowish eggs. The eyes and ear-vesicles, each eight in number, are placed in notches in the margin of the disc, while circulation and respiration are provided for by a network of vessels ramifying through the disc. Though these animals are as tenuous as jelly, and contain very little solid matter, their organs are of singular complexity, and the body consists of several layers of cellular and fibrous tissues. The reproduction of the Cyanea, as described by Agassiz, forms an interesting example of the changes through which animals of this type pass in attaining to maturity. The eggs are hatched into ciliated embryos which swim freely. These attach themselves to the bottom, and are developed into little hydroids, with tentacles in fours and multiples of four (Fig. 66 a), and which have the power of increasing by gemmation. From this stage the young animal passes by a transverse fission into a sort of jointed form (the Strobila. Fig. 66 b), and this, breaking up into separate segments, produces free swimming discigerous animals, formerly known by the name of Ephyra, and which are the young of the Cyanea. Thus each animal passes through four definite stages, before attaining the perfect form, and one ovum may produce several adult Cyaneas.

Another very common species on our coasts is the white or colourless Jelly-fish, *Aurelia flavidula*. It has four white or milky spots (the ovaries) seen conspicuously through its transparent body, and has short marginal tentacles.

THE TUNICATES.

Externally these creatures are among the most uninteresting of the molluscs; their whole bodies being enclosed in a uniform sac-like coat. A species of *Boltenia*, (*B. Bolteni*, Linn.) presenting externally the appearance of a leathery sac, supported on a stalk, is not uncommon on our coasts. (Fig. 92.)

Fig. 92.



Boltenia Bolteni, Linn., Gulf of St. Lawrence—reduced.

The sac has two apertures, and when the animal is alive, the sea-water is drawn into one of these, and expelled from the other by the alternate contraction and expansion of the sac. On dissecting the outer tunic, this is found to be lined with a muscular sac, which is the true mantle, and by the contraction of which water is expelled from the interior, while it is re-admitted by the elastic expansion of the outer tunic. Within the muscular sac is a delicate membraneous ciliated organ, the respiratory sac, along the surface of which the water entering by the entrant aperture is carried by the motion of the cilia, and the nutritive matter which it contains wafted toward the mouth, which lies near the bottom of the sac. The intestine doubles round and empties at the excurrent aperture, toward which also the opening of the ovarian ducts is directed. The creature, thus constituted, remains attached at the bottom of the sea, and its actions are limited to the rhythmical contraction and expansion of the tunic, by which water is continually introduced, and brings with it microscopic organisms on which the tunicate feeds. The same action subserves the function of respiration.

In addition to the Boltenia, we have several species of *Cynthia* and *Ascidia*, one of which, *Cynthia echinata*, is remarkable for its covering of stiff branching bristles. Another species, *Didemnium roseum*, exists in compound communities, encrusting sponges and sea-weeds. Dr. Packard has dredged it at Hopedale, Labrador; and at Eastport, Maine; and Mr. Whiteaves has found it at Gaspé.

There are other species of smaller size, some of them highly coloured, and others perfectly pellucid, so that the internal organs are distinctly visible through the tunic, but all may be distinguished by the sac-like tunic and the two apertures.

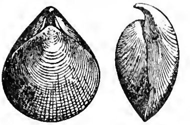
All the species found on our coast belong to the first sub-order of Tunicates, that of the *Ascidiae*, which also includes the remarkable *Pyrosomidae* of the warmer seas, freely moving forms in which the animals are grouped in radiating series in the walls of a hollow cylinder, closed at one end: these creatures are said to be impelled by the reaction of the water sent forth from the excurrent apertures.

A second sub-order, *Biphora,* includes the *Salpidæ,* also inhabitants of the warmer seas, and floating in chain-like bands of individuals, which, however, produce ova from which solitary individuals are hatched, and these in turn develope within their bodies colonies of banded Salpae. The Salpas and the Pyrosomas are gifted with that luminosity in the dark which is the property of so many marine animals.

THE BRACHIOPODS.

Of these curious and rare bivalve shell-fish, only a few species are found on our coasts. The most common is *Rhynchonella*

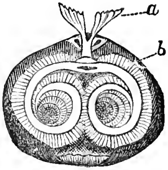
Fig. 93.



RHYNCHONELLA PSITTACEA, Linn. Gulf St. Lawrence.

psittacea, the parrot's-bill Rhynchonella. (Fig 93.) It is a little horny bivalve shell, with one valve, the dorsal, smaller than the other, the beak of which projects and has a notch (foramen) below, through which passes a stalk or pedicel for attachment. The interior of the shell is lined with the two valves of the mantle, and is occupied principally with the two-fringed and ciliated arms coiled like cork-screws. (Fig. 94.) At the base

Fig. 94.



RHYNCHONELLA PSITTACEA. Interior of dorsal valve, showing (*a*) adductor muscles, and (*b*) spiral arms; drawn from a specimen dredged at Gaspé—natural size.

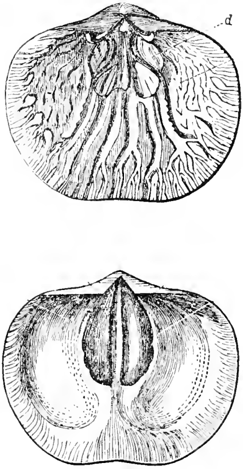
of these is the mouth, leading to a small stomach and short intestine. It has a more complicated nervous and circulating system than those of the Tunicates, and has several pairs of muscles placed near the hinge for opening and closing the shell and regulating the movements of the creature on its pedicel. The Rhynchonella is found attached to stones and dead shells in moderately deep water.

In addition to this species, we have on our coasts *Terebratulina septentrionalis*, of more elongated form than the above-named species, ribbed longitudinally, with a round perforation at the beak, instead of a notch, and with an internal shelly loop. Other species found on our coasts are *Waldheimia cranium*, and *Terebratella Spitzbergensis*, a northern form found in Labrador, and also fossil in the post-pliocene clay of Rivière du Loup. *Waldheimia cranium* has as yet been found only on the coast of Nova Scotia, by Willis. It has been ascertained that the young of some Brachiopods much resemble Polyzoa in form and structure. (Morse).

Though recent Brachiopods are few in species, vast numbers are found fossil. Mr. Billings's catalogues include nearly 100 species, from the lower Silurian alone, in Canada; and Dr. Bigsby, in his Thesaurus Siluricus, enumerates 429 species from the Silurian of America, whereas less than 100 living species are known in the whole world at present.

Many of the fossil Brachiopods differ considerably from those that are recent, and are placed in different families. We can recognise their general resemblance to the modern forms by the impressions of the mantle and muscles on the valves. Fig. 95 represents the interior of the dorsal and ventral valves of an Orthis, showing the muscular and mantle impressions, teeth and foramen.

(Fig. 95.)



ORTHIS STRIATULA, after Woodward.

(A) Dorsal valve, showing the muscular impressions at (d); also the vascular impressions of the mantle, and the notch, tooth and brachial processes in the hinge.

(B) Ventral valve, showing the impressions of the hinge and pedicel muscles.

NOTES ON THE STRUCTURE OF THE CRINOIDEA, CYSTIDEA, AND BLASTOIDEA.

By E. BILLINGS, F. G. S., Palæontologist of the Geological Survey of Canada.

(Reprinted from the American Journal of Science, II., vol. xlix, p. 51, and continued from this vol., ante p. 293.)

5. *On the Homologies of the Respiratory Organs of the Palæozoic and recent Echinoderms, and on the "Convoluted Plate" of the Crinoidea.*

In a former note I have advanced the opinion that:—"The grooves on the ventral disc of *Cyathocrinus*, and also the internal "*convoluted plate*" of the Palæozoic Crinoids, with the tubes radiating therefrom, belong to the respiratory, and perhaps in part to the circulatory systems — not to the digestive system. The convoluted plate with its thickened border seems to foreshadow the "œsophageal circular canal," with a pendant madreporic apparatus, as in the Holothuridea." (This vol. ante, p. 282.) I should have referred it to the madreporic system of the existing Echinodermata in general, instead of to that of the Holothuridea in particular. At the time the note was written I had in view the madreporic sack of *Holothuria* which, as will be shown further on, most resembles in form that of *Actinocrinus*. The figures and descriptions, which follow, are intended to show the gradual passage or conversion of the respiratory organs of the *Cystidea, Blastoidea and Palæocrinoidea* into the ambulacral canal system of the recent echinoderms, and that as the convoluted plates of the former have the same structure and connections as the madreporic sacks and tubes or sand canals of the latter, they are, most probably, all the homologues of each other.

Among the Cystideans we find several genera, such as *Cryptocrinites*, *Malocystites*, *Trochocystites*, and apparently some others, whose test is totally destitute of respiratory pores, being composed of simple, solid plates like those of the ordinary Crinoidea. In a second group of genera, among which may be enumerated *Caryocystites*, *Echinosphærites*, *Palæocystites*, and *Protocystites*,

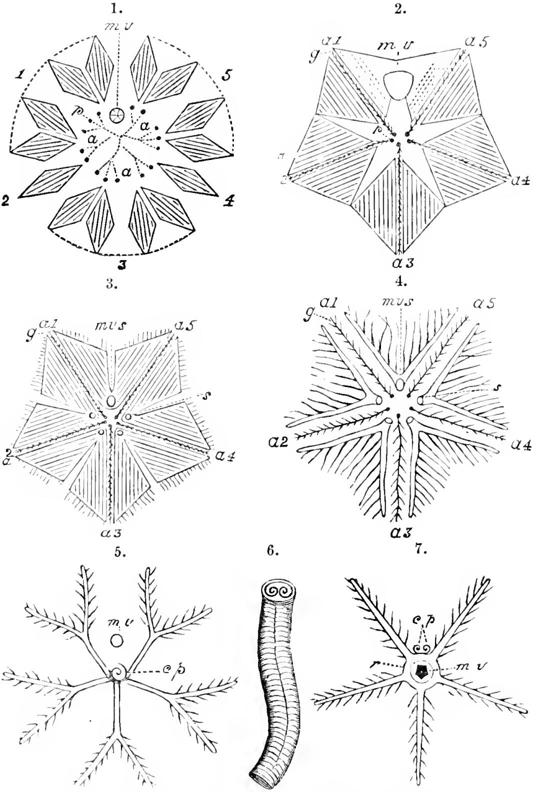


Fig. 1. The upper part of *Caryocrinus ornatus*, the test being removed in order to show the internal structure of the fourteen hydrospires that surround the summit. The parallel lines represent the flat tubes. The other figures exhibit the modifications which the hydrospires undergo in passing through :—2. *Codaster*. 3. *Pentremites* with broad ambulacra. 4. *Pentremites* with single tubes. 5. *Palæzoic Crinoids* with a convoluted plate attached to the centre of radiation. 6. Sand canal or madreporic tube of a starfish inclosing a doubly convoluted plate 7. Ambulacral canals of a starfish with the doubly convoluted plate ot the sand canal attached to the œsophageal ring. The following letters have the same reference in all the figures in which they occur: *a*, an arm or ambulacrum ; *m v*, mouth and vent combined in a single aperture ; *m v s*, mouth, vent and spiracle ; *g*, ambulacral groove ; *p*, ovarian pore ; *s*, spiracle ; *cp*, convoluted plate ; *r*, œsophageal ring.

the whole of the external integument seems to have been respiratory, as all, or nearly all, of the plates of which it is composed, are more or less occupied by variously arranged, poriferous or tubular structures. The Cystideans of these two groups hold the lowest rank of all those known. In their general structure they are mere sacks of a globular, ovate, or (as in the case of *Trochocystites*) flattened form. Their test consists of an indefinite number of plates without any radiated arrangement. They were also, according to our present knowledge, the first to make their appearance, two of the genera, *Trochocystites* and *Eocystites*, having been discovered in the primordial zone. No other echinoderms have been found in rocks of so ancient a date.

Next in order may be placed those genera whose test is composed of a definite number of plates, which have, to some extent, a quinary arrangement. Thus, *Glyptocystites*, *Echinoencrinites*, *Apiocystites*, and several others, have each four series of calycine plates, of which there are four plates in the basal and five in each of the other three series. The respiratory areas or hydrospires are reduced in number—ten to thirteen in *Glyptocystites*, and three in most of the other genera of the group. Neither in the plates nor in the hydrospires is there exhibited any tendency to a radiated arrangement. The most ancient genus of this family is *Glyptocystites*, which first appears in the Chazy limestone and seems to have become extinct in the Trenton. The other genera occur in various horizons between the Chazy and the Devonian.

In the genera *Hemicosmites* and *Caryocrinus* the hydrospires in the upper part of the test converge toward, but do not reach, the central point of the apex, thus forming the commencement of that concentration and complete radiation which is exhibited in the ambulacral canal system of the higher echinoderms. In a former note (this vol. p. 286,) it is pointed out that *Caryocrinus* has thirty hydrospires,—ten at the base with their longer diagonals vertical — a zone of six round the middle, with their diagonals horizontal, and a third band of fourteen around the upper part of the fossil. These latter are represented in fig. 1, as if spread out on a plane surface. On consulting this figure it will be seen that the flat tubes of the hydrospires, represented by the parallel lines, all converge toward the central point from which the dotted lines radiate. This point is the position of the mouth in the recent echinoderms, but in *Caryocrinus* it is occupied by a large solid imperforate plate. The hydrospires are arranged in five groups. Commencing at *m v* and going round by 1, 2, &c., there are four in the first group; one in the second; four in the third; one in the fourth and four in the fifth. These five groups represent the five ambulacral canals of the recent echinoderms. In the specimen from which this diagram was constructed there are the bases of fifteen free arms to be seen situated at the outer extremities of the dotted lines. At the base of each arm there is a small pore, *p*, which I believe to have been exclusively ovarian in its function. The hydrospires have no connection whatever with the arms and are, moreover, all of them entirely separated from each other. If, then, they represent the ambulacral system of the recent echinoderms, it is quite certain that that system was at first, (or in the undeveloped stage in which it existed in the Cystidea,) destitute of the œsophageal ring.

In *Codaster* a further concentration of the respiratory organs is exhibited. There are here only five hydrospires and they are all confined to the circle around the apex. Two of them are incomplete in order to make room for the large mouth and vent (*m v*, fig 2.) They are each divided into two halves by an arm, *a*1, *a*2, &c. They are only connected with the arms to this extent, that these latter lie back upon them. The arms are provided with pinnulæ, but it is not at all certain that they (the pinnulæ) were in any direct communication with the hydrospires. It is evident that *in all the Cystidea,* (and in none is it more obvious than in *Caryocrinus,*) there was no connection between the hydrospires and the pinnulæ. The main difference (so far as regards the evidence of the presence or absence of such a connection) between *Caryocrinus* and *Codaster,* consists in this, that in the former the arms are erect and do not touch the hydrospires, whereas in the latter they are recumbent and lie back upon them. Each of the arms of *Codaster* has a fine ambulacral groove and all of the grooves terminate in a single central aperture. But as this aperture was covered over by a thin plated integument, as in the Blastoidea, I have not shown it in the diagram, but only the five pores, *p*.

No one who compares a *Codaster* with a *Pentremites* (the internal structure of the latter being visible) can doubt that the hydrospires of the two genera are perfectly homologous organs. If we grind off the test of a species of the latter genus, selecting one for the purpose which has broad petaloid ambulacra such as those of *P. Schultzii*, the structure exposed will be that represented in the diagram, fig. 3. In *Pentremites* as in *Codaster*, the five hydrospires are divided into ten equal parts by the five rays, *a* 1, *a* 2, &c. In *Codaster* these ten parts remain entirely separate from each other, but in *Pentremites* they are re-united in pairs, the two in each interradial space, being so connected, at their inner angles, that their internal cavities open out to the exterior through a single orifice or spiracle (*s*, figs. 3 and 4). This is best shown in fig. 4, intended to represent the structure of *P. ellipticus* (Sowerby) as described by Mr. Rofe, Geol. Mag., vol. ii, p. 249. In this species the hydrospires instead of being formed of broad sacks, with a number of folds on one side, consist of ten simple cylindrical tubes connected together in five pairs. The only difference between the structure of fig. 3 and fig. 4 is in the width of the tubes and in the absence of folds in the latter. These two forms are moreover connected by intermediate grades. Species with 11, 10, 8, 6, 5, 4 and 2 folds being known, there is thus established a gradual transition from the broad petaloid form to the single cylindrical tube.

Between the *Cystidea* and the *Blastoidea* the most important changes are, that in the latter the hydrospires become connected in pairs, and also, are brought into direct communication with the pinnulæ. In the Palæozoic Crinoidea (or at least in many of them,) concentration is carried one step further forward—the five pairs of hydrospires being here all connected together at the centre, as in fig. 5. There is as yet no œsophageal ring, (as I understand it) but in its place the convoluted plate, described in the excellent papers of Messrs. Meek and Worthen. This organ, according to the authors, consists of a convoluted plate, resembling in form the shell of a *Bulla* or *Scaphander*. It is situated within the body of the Crinoid, with its longer axis vertical, and the upper end just under the centre of the ventral disc. Its lower extremity approaches but does not quite touch the bottom of the visceral cavity. Its walls are composed of minute polygonal plates, or of an extremely delicate net work of anastomosing fibres. The five ambulacral canals are attached to the upper extremity, radiate outward to the walls of the cup, and are seen to pass through the ambulacral orifices outward into the grooves of the arms.

The ambulacral canals of the Crinoidea are, for the greater part, respiratory in their function. They are, however, as most naturalists who have studied their structure will admit, truly the homologues of those of the Echinodermata in general. In the higher orders of this class the canals are usually more specialized than they are in the lower—being provided with prehensive or locomotive organs. In all of the existing orders, including the recent Crinoidea, we find an œsophageal ring.

To this organ, which is only a continuation of the canals, are attached the madreporic appendages. These consist of small sacks, or slender tubes, varying greatly in form and number in the different genera. That of the Starfish *Asteracanthion rubens* is thus described by Prof. E. Forbes:—"On the dorsal surface is seen a wart-like striated body, placed laterally between two of the rays; this is the *madreporiform tubercle or nucleus*. When the animal is cut open, there is seen a curved calcareous column running obliquely from the tubercle to the plates surrounding the meuth; Dr. Sharpey says it opens by a narrow orifice into the circular vessel. It is connected by a membrane with one side of the animal, and is itself invested with a pretty strong skin, which is covered with vibratile cilia. Its form is that of a plate rolled in at the margins till they meet. It feels gritty, as if full of sand. When we examine it with the microscope we find it to consist of minute calcareous plates, which are united into plates or joints, so that when the investing membrane is removed it has the appearance of a jointed column. Prof. Ehrenberg remarked the former structure, and Dr. Sharpey the latter: they are both right. Both structures may be seen in the column of the common cross-fish."—(Forbes, British Starfishes, p. 73.)

In Prof. Joh. Muller's work, "Uber den bau der Echinodermen," several forms of the madreporic appendages of the different groups of the recent Echinodermata are described. In general they are composed of a soft or moderately hard skin, consisting of a minute tissue of calcareous fibres, or of small polygonal plates. The walls are also, sometimes, minutely poriferous. In all the Holothurians the madreporic organ is a sack attached by one of its ends to the œsophageal canal, the other extremity hanging freely down into the perivisceral cavity, not connected with the opposite body wall as is the sand canal of the starfishes. (Op. cit., p. 84.) In its consisting of a convoluted plate the madreporic organ of *Actinocrinus*, therefore, agrees with that of the starfishes, while in its being only attached at one extremity it resembles that of the Holothurians.

The convoluted plate of the Palæozoic Crinoids and the madreporic sacks and tubes (or sand canals) of the recent Echinoderms, therefore, all agree in the following respects:—

1. They have the same general structure.

2. They are all appendages of the ambulacral system.

3. They are all attached to the same part of the system, that is to say, to the central point from which the canals radiate.

The above seems to me sufficient to make out at least a good *prima facie* case for the position I have assumed. When among the petrified remains of an extinct animal, we find an organ which has the same general form and structure, as has one that occurs in an existing species of the same zoological group, we may, with much probability of being correct in our opinion, conclude that the two are homologous, even although we may not be able positively to see how that of the fossil is connected with any other part. But when, as in this instance, we can actually see that it is an appendage of another organ, or system of organs rather, which is known to be the homologue of the part with which that of the existing species is always correlated, we have evidence of a very high order on which to ground a conclusion. By no other mode of reasoning can we prove that the column of an *Actinocrinus* is the homologue of that of *Pentacrinus caput Medusæ*.

In an important paper, entitled "Remarks on the Blastoidea, with descriptions of New Species," which Meek and Worthen have kindly sent me, the authors, in their comments upon my views, state that:—

"In regard to the internal convoluted organ seen in so many of the *Actinocridæ* belonging to the respiratory instead of the digestive system, we would remark that its large size seems to us a strong objection to such a conclusion. In many instances it so nearly fills the whole internal cavity that there would appear to be entirely inadequate space left for an organ like a digestive sack, outside of it, while the volutions within would preclude the presence of an independent digestive sack there. In additon to this, the entire absence, so far as we can ascertain, of any analogous, internal respiratory organ in the whole range of the recent *Echinodermata*, including the existing Crinoids, would appear to be against the conclusion that this is such, unless we adopt the conclusion of Dujardin and Hupé, that the Palæozoic Crinoids had no internal digestive organs, and were nourished by absorption over the whole surface. We should certainly think it far more probable that this spiral organ is the digestive sack, than a part of a respiratory apparatus."

The objection here advanced does not appear to me to be a strong one. In many of the lower animals the digestive organs are of inconsiderable size in proportion to the whole bulk. In the Brachiopoda, for instance, the spiral ciliated arms fill nearly the whole of the internal cavity, the digestive sack being very small and occupying only limited space near the hinge. These arms, although not the homologues of the convoluted plates of the Palæozoic Crinoids, have a strong resemblance to them, and are, moreover, at least to some extent, subservient to respiration. They are certainly not digestive sacks. In the recent echinoderms the intestine is usually a slender tube, with one or more curves between the mouth and the anus. It fills only a small part of the cavity of the body, the remainder being occupied mostly by the chylaqueous fluid, which is constantly in motion, and undergoing æration, through the agency of various organs, such as the respiratory tree and branchial cirrhi of the Holothuridea, the dorsal tubuli of the Asteridæ and the ambulacral systems of canals of the class generally. In no division of the animal kingdom do the respiratory organs occupy a larger proportion of the whole bulk than they do in the Echinodermata. The great size which the convoluted plate attains in some of the Crinoids is, therefore, rather more in favour of its being a respiratory then a digestive organ.

Prof. Wyville Thomson says, that inside of the cavity of the stomach of the recent Crinoid, *Antedon rosaceus*, there is a spiral series of glandular folds, which he supposes to be a rudimentary liver. (Phil. Trans. R. S., 1865, p. 525.) It is barely possible that the convoluted plate may represent this organ. At present I think it does not.

I believe that the reason why the convoluted plate attained a greater proportional size in the Palæozoic Crinoids, than do the sand canals of the recent Echinoderms, is that the function of the system of canals, (of which they are all appendages,) was at first mostly respiratory, whereas in the greater number of the existing groups, it is more or less prehensive or locomotive, or both.

(*To be continued.*)

NOTES ON SOME POINTS IN THE STRUCTURE AND HABITS OF THE PALÆOZOIC CRINOIDEA.

By F. B. MEEK and A. H. WORTHEN, of the State Geological Survey of Illinois.

Reprinted from the Proceedings of the Academy of Natural Science, Philadelphia, 1869, p. 323.*

Through the kindness of Mr. Charles Wachsmuth, of Burlington, Iowa, we have recently had an opportunity to examine some unique and exceedingly interesting specimens of Carboniferous Crinoids, showing parts of the structure of these animals, in some instances, never before observed, so far as we are at this time informed. In a few instances, these specimens show internal organs entirely free from the matrix, and although like all the other solid parts of these curious creatures, composed of numerous calcareous pieces, really surpassing in delicacy of structure the finest lace-work, and so frail that a touch, or even a breath, might almost destroy them. Some of these specimens we propose to notice here, but, before proceeding to do so, we avail ourselves of this opportunity to express our thanks to Mr. Wachsmuth for the zeal, industry, skill and intelligence he has brought to bear, in collecting and preparing for study, such an unrivalled series of the beautiful fossil Crinoidea of this wonderfully rich locality. Some idea of the extent of his collection of these precious relics may be formed, when we state that of the single family *Actinocrinidæ* alone, after making due allowance for probable synonyms, he must have specimens of near 150 species, or perhaps more, and many of them showing the body, arms and column.

It is also due to Mr. Wachsmuth, that we should state here that he is not a mere collector only, but that he understands what he collects, and knows just what to collect, as well as how to collect.

Below we give substantially some notes of observations made in his collection, followed by some remarks on other specimens at Springfield:

1. *Synbathocrinus*, Phillips. Some of Mr. Wachsmuth's speci-

* For further observations on the subject of this important paper, see the notes of Dr. Lutken and E. Billings, in this vol. pp. 267 and 427.

mens of a species of this genus show that it is provided with a long, slender, pipe-stem like ventral tube, or proboscis, apparently equalling the arms in length. Also, that a double row ot minute alternating marginal pieces extends up within the ambulacral furrows of the arms, apparently all their length. We are not aware that these characters have been hitherto noticed in any of the publications on this genus. It will be seen, however, farther on, that minute marginal pieces probably occupied the furrows along the inner side of the arms of other types of Crinoidea, as well as this.

2. *Goniasteroidocrinus*, Lyon and Casseday. Some unusually fine specimens of the typical species of this genus (*G. tuberosus*) in Mr. Wachsmuth's collection, from Crawfordsville, Ind., show the slender pendent arms much more distinctly than any we had before seen, and from these it seems evident that those arms are stouter than we had supposed, and that there are not more than five or six of them to each of the ten openings. In the specimen figured by us on page 220 of the second volume of the Illinois Reports, these arms were only imperfectly seen by working away, with great difficulty, the hard matrix between two of the produced rays of the vault, which we have termed pseudobrachial appendages, or false arms. In clearing away the matrix of this specimen, we had cut just far enough to expose the edges of the arms on each side of the deep ambulacral furrow, so that each of these edges presents the appearance of being a separate and distinct, very slender arm, composed of a single series of pieces, and without any ambulacral furrow on the outer or ventral side; whereas there is a well-defined ambulacral furrow, bearing the tentacula along its margins, on the outer side of the arms, and when the matrix is removed from these ambulacral furrows, the arms can be seen to be composed each of a double series of small alternately-arranged pieces. It is barely possible that in specimens of this species with the arms *perfectly preserved*, that the ambulacral furrows may be covered on the outer or ventral side by a double series of alternating pieces, and that the tentacula* may connect

* We use the term tentacula here in the sense it is generally used by palæontologists, with reference to the delicate pinnulæ along the arms of Crinoids, and of course not as applying to the minute fleshy organs along the ambulacral furrows, usually termed tentacles by those whe have investigated the recent Crinoids

with little openings along each side, though there certainly appear to be only open furrows in the specimens examined.

It is worthy of note, in this connection, that there certainly are species, agreeing exactly in all other known characters with this genus, that have no open furrow along the outer or ventral side of the arms, which are distinctly seen to be round on the outer side, and show there a double series of interlocking pieces along their entire length, while the tentacula connect along the inner, or under side, as the arms are seen hanging down. This is clearly seen to be the case in a beautiful specimen of *G. typus* (=*Trematocrinus typus*, Hall) in Mr. Wachsmuth's collection, and we can scarcely doubt that in this species there is an open furrow on the inner (under) or dorsal side of the arms. If not, the arms must be tubular, in consequence of having the ambulacral canal enclosed all around, excepting at the points where the the tentacula connect along each side.

3. *Cyathocrinus*, Miller. Specimens of this genus showing the vault (more properly the ventral disc) have very rarely been seen. In England a few examples have been found, and these have been supposed to show two openings, one central and another lateral; the latter, according to Prof. Phillips' and Mr. Austin's figures, being provided with a slender marginal tube, or so-called proboscis. Some of Mr. Wachsmuth's specimens, however, of *C. malcaceus* and *C. Iowensis*, Hall, showing the vault, have led us to doubt the existence of a central opening in the vault of this genus, when the specimens have this part entire. The specimen of *C. malcaceus* shows the remains of the usual narrow lateral proboscis, and also has an opening in the middle of the vault, but from the appearance of this opening, as well as from the structure of the vault of a specimen of *C. Iowensis*, in which this opening is closed, we can scarcely doubt that it was also closed in the specimen of *C. malcaceus*, when entire. The remaining parts of the vault of the *C. malcaceus* mentioned consist of only five comparatively large pieces, alternating with the upper inner edges of the first radial pieces,—the one on the anal side being larger than the others, and forming the base of the inner side of the proboscis. These five pieces connect with each other laterally and extend inward some distance, but not so far as to meet at the centre, where there is a sub-semicircular opening, nearly as large as that in the remaining base of the proboscis. Along each of the sutures between the five vault pieces mentioned,

a comparatively large furrow extends inward from each arm-base to the central opening. These we regard as continuations of the ambulacral furrows from the arms, though there is also a minute opening at each arm-base, passing directly downward into the cavity of the body, which was probably for the passage of the arm-muscles.

Looking at this specimen alone, one would naturally suppose there must have been, during the life of the animal, two distinct openings in the vault, as appears to be the case in the specimen of *C. planus*, Miller, figured by Prof. Phillips and Mr. Austin. But on examining the specimen of *C. Iowensis* mentioned above, we find that it shows the base of the small lateral proboscis with the five principal vault-pieces alternating with the first radials, the one on the anal side being larger than the others, and the same ambulacral furrows extending inwards from the arm-bases, all exactly as in the *C. malvaceus*. But here we find the central opening undoubtedly closed by several vault-pieces, while the ambulacral furrows, extending inward from the arm-bases, pass in under these central pieces, and are themselves occupied, or covered, by a double series of alternating, very minute pieces, which probably also extend on, all the way up the ambulacral furrows of the arms as marginal pieces.

From our examinations of these two specimens, which are the only examples of the genus we have seen, showing the vault-pieces, and seem to be typical forms of the genus in all other respects, we are strongly inclined to think the specimen of *C. planus*, figured by Prof. Phillips and Mr. Austin, has had these central vault-pieces removed by some accident. The fact that these pieces in the specimen examined by us, in Mr. Wachsmuth's collection, seem not to be deeply implanted between the five larger surrounding pieces mentioned, but rather rest, as it were, partly upon the narrow bevelled points of the inner ends of the latter, between the ambulacral furrows, so as to allow room for these furrows to pass under, would render them less firm, and more liable to be removed by any accident, and may possibly account for their absence in the English specimen mentioned.

In regard to the pieces covering the central part of the vault, and which, from the way they are arranged for the ambulacral furrows to pass under them, were apparently more liable to be removed than the others, we would remark that they do not present the prominent appearance, and uniformity of size and form, of the movable pieces composing what is often called the ovarian pyramid in the Cystids, but certainly have all the appearances of true fixed vault-pieces, and scarcely project above the others surrounding them. Consequently we cannot believe it at all probable that this genus had a central mouth, opening directly through the vault; though its ambulacral canals evidently converged from the arm-bases to the middle of the vault, partly above the outer vault-pieces, and under those composing the middle of the vault. That these furrows terminated at the entrance of the alimentary canal, under the middle of the vault, as those of *C matula* converge to the mouth, in the same central position, is highly probable; and, as will be seen further on, we are much inclined to believe that the minute organisms upon which we are led, from analogy, to think these animals subsisted, were conveyed to the entrance of the alimentary canal along the ambulacral furrows, without the agency of any proper mouth, opening directly through the vault. Hence we think it probable that the small tube, usually called the proboscis, situated near the posterior side of the ventral disc, rather corresponds to the tubular anal opening similarly situated in *Comatula Mediterranea*.

From our description of the vault of these species, it will be seen to present considerable similarity to that of *Crotalocrinus rugosus*, excepting that in that genus, owing to its great number of arms, the ambulacral furrows, or canals, bifurcate several times between the middle of the vault and the arm-bases, while in *Crotalocrinus* there is no lateral proboscis, nor, apparently, even any visible opening, judging by the figures we have seen, though we suspect it may have a small opening at the periphery of the ventral disc, on the posterior or anal side. In the group of depressed *Platycrini* for which Troost proposed the name *Cupellæcrinus* we observe a somewhat similar vault, at least in some of the species; also in *Coccocrinus*. In such forms there would seem to be, as it were, an intermediate gradation between the modern Crinoids and the prevailing Palæozoic types, as has been pointed out by Mr. Billings.

4. *Convoluted support of the digestive sack, in the Actinocrinidæ.* The presence of a large convoluted body, resembling in form the shell of a *Bulla* or *Scaphander*, within the body of several types of the *Actinocrinidæ*, was noticed by Prof. Hall in vol. xii, p. 261 of the Am. Journ. Sci., in 1866, though he made no suggestions there in regard to the functions it probably

performed in the internal economy of these animals. In the second volume of the Illinois Geological Reports, published soon after, we figured, on page 191, a specimen of *Strotocrinus*, with this body seen in place, and stated that we regarded it as having been connected with the digestive apparatus of the animal.

Both in Prof. Hall's and our own remarks, this organ was spoken of as a convoluted *plate*. This, however, we now know is not strictly correct, for although composed of hard calcareous matter, and in some species somewhat dense in structure, it seems to be always constructed of a great number of minute pieces, and generally has a more or less open or porous texture; while in some cases it presents the appearance of an exceedingly delicate net-work. It seems never to be attached to the bottom of the visceral cavity, though it extends down nearly to the bottom. It is open at both ends (the opening at the lower end being generally smaller than the other), and is placed with its longer axis nearly so as to coincide with that of the body of the Crinoid. In some species it is more or less dilated at the upper end, while in others it is contracted at both ends, so as to present, as above stated, the form of the shell of a *Bulla*. It has apparently no columella, but is more or less loosely convoluted, with a spiral ridge descending the interior, and sometimes another ascending the exterior. Its walls are generally of moderate thickness, but they often appear to be thicker than natural, in consequence of the presence of inorganic incrustations, of calcareous or silicious matter, which also disguise its real structure.

In *Actinocrinus Verneuilianus*, Shumard, this body is narrow below, and sub-cylindrical above to the top, which is slightly dilated. The small opening at the lower end has a thickened rim, which passes around spirally, so as to ascend the outside, as a rather stout ridge, all the way to the top, making nearly two turns and apparently also forming a rim partly around the top. The surface of the whole organ, as well as of its external spiral ridge, has the usual rough appearance, and when fragments of it are held up, so as to be examined by transmitted light, through a good pocket-glass, it is seen to be composed of a great number of very minute polygonal pieces, varying somewhat in form and size. When these pieces are examined under a magnifier, by reflected light, they show shining facets, like crystals, though they are evidently not surface incrustations, but actually compose the walls, or substance of the organ itself. No pores or meshes were observed passing through the walls of this organ in this species, in which it appears to be more than usually dense.

In another specimen in Mr Wachsmuth's collection, apparently of *Actinocrinus proboscidialis*, this organ, as seen with one or more of the outer turns removed, has an oval or sub-elliptic form, being contracted and twisted at both ends, so as to present very nearly the appearance of the shell of some species of *Ovulum*. Its walls are quite thin, and seem to form more convolutions than in any other species in which we have had an opportunity to examine it. As seen by the aid of a magnifier by transmitted light, it presents a very beautiful appearance, being composed of a great number of minute pieces, with numerous openings passing through between them. The little pieces and the openings between them, are of nearly uniform size, and arranged so that there are usually one or two of the former intervening between any two of the openings.

Another of Mr. Wachsmuth's specimens of *Actinocrinus securus*, Hall, has one side of the body removed so as to show about two-thirds of the convoluted organ, the upper part of which is broken away. The part remaining has a short wide sub-cylindrical form, with a rather broad, obliquely truncated lower end, which is not tapering, as in the other species. Under a magnifier it is seen to be composed of an extremely fine net-work, far surpassing, indeed, in delicacy of structure, the finest laces that it is perhaps within the power of human skill to fabricate; and as it is entirely free from any surrounding matrix, excepting at one side below, the specimen has to be handled with great care, as a mere touch of this delicate part would probably cause it to fall into hundreds of little minute fragments. On examining it under a magnifier, the bars of which it is composed are seen not to intersect each other at any uniform angle, but anastomose, so as to impart a kind of irregular regularity, if we may so speak, to the form and size of the meshes. Of these little bars there are two sizes, the larger forming the larger meshes, while within the latter a smaller set of processes extend partly or entirely across, so as to form more minute meshes; the whole presenting a beautiful appearance, of whiee it would be difficult to convey a correct idea by a mere description alone, without the aid of figures.

From analogy, judging from what is known of the internal structure of the recent genus *Comatula*, in which several authors have noticed a reticulated calcareous structure secreted within the tissue of the softer parts of its alimentary canal, we may infer that this convoluted organ was, as it were, a kind of frame work, secreted for the support of the digestive sack, which was probably more or less convoluted in the same way in many, if not all of the Palæzoic Crinoids, though not apparently, in all cases, endowed with the power of secreting a sufficient dense structure of this kind to leave traces of its existence in a fossil state.

So far as we are at this time informed, this organ has yet been very rarely observed in any other family than the *Actinocrinidæ*, though it was probably more or less developed in various other groups. In one instance Mr. Wachsmuth found it in a *Platycrinus*, but here it seems to be, in the specimen found, merely a spongy mass, not showing very clearly the convoluted structure. Some traces of what was supposed to be something of this kind were also observed by him in one of the Blastoids.

5. *Ambulacral canal passing under the vault in the Actinocrinidæ.* In the third and fourth Decades of descriptions and illustrations of the Canadian Organic Remains, Mr. Billings, the able palæontologist of the Geological Survey of the Canadian provinces gives some highly interesting and instructive remarks on the ambulacral and other openings of the Palæozoic Crinoids. In these remarks he noticed, at length, some striking differences between the vault, or ventral disc, of these older types, and that of the few living examples of this extensive order of animals. That is, he noticed the facts, that while in the living *Comatula* and *Pentacrinus*, the ambulacral canals are seen extending from the arm-bases across the surface of the soft skin-like ventral disc, to the central mouth, and these genera are provided with a separate anal opening, situated excentrically between the mouth and the posterior side, that in the Palæozoic Crinoids the ventral disc is very generally, if not always, covered by close-fitting, solid plates, showing no external traces whatever of ambulacral furrows extending inward from the arm-bases; and that in nearly all cases they are merely provided with a single excentric or sub-central opening, often produced into a long tube, which, like the vault, is made up of solid plates. He showed that there is no evidence whatever that the ambulacral canals, in these older types, were continued along the surface of the vault from the arm-bases to the only opening, whether sub-centrally or laterally situated, and that in cases where this opening is produced in the form of a greatly elongated proboscis, or tube, such an arrangement of the ambula-

cra would be almost a physical impossibility. Hence he concluded that the ambulacral canals must have passed directly through the walls of the body at the arm-bases; and he gave several figures of various types, showing openings at the base of the arms, through which he maintained that the ambulacra must have passed to the interior of the body from the arms.

Although these arm-openings had long been well known to all familiar with our numerous types of western Carboniferous Crinoids, in which they are very conspicuous, and we had never entertained any other opinion in regard to them, than that they are the only passages of communication that could have existed between the softer parts occupying the ambulacral furrows of the arms, and the interior of the body, Mr. Billings was the first author, so far as we are at this time aware, who called especial attention to them in this regard. We regret that we have not space to quote a portion, at least, of his remarks on this subject, and would advise the student to read attentively the whole of both of his articles alluded to.

The specimens at Mr. Billings' command enabled him to trace the courses of the ambulacral canals from the arms, through the walls of the body at the arm-bases, and to ascertain the additional fact that, after passing through the walls, they seemed to have turned upward; but beyond this he had not the means of tracing them farther.

A single specimen of *Actinocrinus proboscidialis*, however, in Mr. Wachsmuth's collection, is in a condition (thanks to the great skill of that gentleman, and the exceedingly fortunate state of preservation, by which its delicate internal parts remain almost entire, and without any surrounding matrix) to throw much additional light on this subject. By very dextrous manipulation, Mr. Wachsmuth succeeded in removing about half of its vault, so as to expose the internal parts, in place, and in an excellent state of preservation. The convoluted organ already described in other species is in this comparatively large, sub-cylindrical in the middle, apparently tapering at the lower end, and a little dilated at the upper extremity. It seems to be rather dense, and shows the usual rough appearance, but as we had no opportunity to examine any detached fragments of it by transmitted light, we did not determine whether or not it has pores passing through it, though it probably has, at least when entirely free from any inorganic incrustation. Its slightly dilated upper end seems to stand with its middle almost, but apparently not exactly, under the middle of the nearly central proboscis of the vault; while at the anterior side of its upper margin, and a little out from under the proboscis, it shows remains of a kind of thickened collar, which we found to be composed of minute calcareous pieces. From this there radiate five ambulacra, composed of the same kind of minute pieces as the collar itself, each ambulacrum consisting of two rows of these minute pieces alternately arranged. They are each also provided with a distinct furrow along their entire length above. As they radiate and descend from their connection with the top of the convoluted frame-work of the digestive sack, they all bifurcate, so as to send a branch to each arm-opening, those passing to the posterior rays curving a little at first above, so as not to pass directly under the proboscis. These ambulacra, although passing along obscure furrows in the under side of the vault, which are deepest near the arm-openings, are not *in contact* with the vault, or visibly connected with any other parts than the top of the convoluted digestive sack, and the outer walls at the arm-openings. Each of their sub-divisions can be traced into an arm-opening, and it is very probable that they continued out on the ambulacral furrows of the arms and tentacula. At one point in one of these ambulacral canals, beneath the vault, some evidences of the remains of two rows of minute pieces were observed alternating with the upper edges of those composing the under side of these canals, and thus apparently covering them over. The condition of the parts is such, however, as scarcely to warrant the assertion that this was really the case, though we are much inclined to think it was. If so, these canals must have been, at least under the vault, hollow tubes, formed of two rows of pieces below, and two above, all alternately arranged.

We are not aware that any evidences of the existence of these delicate ambulacral canals, composed of minute calcareous pieces, and passing beneath the vault from the arm-openings to the summit of the convoluted digestive sack, have ever before been observed in any Crinoid, recent or extinct; and we can but think it probable, that the extremely rare combination of circumstances that brought them to light in this instance may not again occur for centuries to come, with regard to another specimen. That they correspond to the ambulacral canal seen extending from the arm-base to the mouth, on the *outside* of the ventral disc in *Comatula*, is clearly evident.

The presence of furrows radiating from the central region of the under side of the vault to the arm-openings, in various types of Palæozoic Crinoids, must have been frequently observed by all who have had an opportunity to examine the inner surface of this part. Messrs. DeKoninck and Lehon figure a portion of the vault of *Actinocrinus stellaris* in their valuable *Recherches sur les Crinoides du Terr. Carb. de la Belgique*, pl. iii, fig. 4 f, showing these furrows, which they seem to have regarded as the impressions left by the muscles of the viscera. The inner surface of the vault of most of our western Carboniferous Crinoids is known to have these furrows more or less defined, either from specimens showing this inner surface, or from natural casts of the same. In some instances they are very strongly defined from the central region outward to the arm-bases, to each of which they send a branch. In *Actinocrinus ornatus*, Hall, for instance, they are generally so strongly defined as to raise the thin vault into strong radiating ridges, separated by deep furrows on the outer side. In *Strotocrinus*, the vault of which is greatly expanded laterally, and often flat on top, these internal furrows, in radiating outward, soon become separated by partitions, and as they go on bifurcating, to send a branch to each arm, they actually assume the character of rounded tubular canals, some distance before they reach the arm-bases.

That these furrows or passages of the inner side of the vault were actually occupied during the life of the animal by the ambulacral canals as they radiate from the top of the convoluted digestive sack to the arm-openings, we think no one will for a moment question, after examining Mr. Wachsmuth's specimen of *Actinocrinus proboscidialis*, which we have described, showing all these parts in place. It is also worthy of note, that in all the specimens of various types in which these furrows of the under side of the vault are well known, whether from detached vaults, or from casts of the interior of the same, they *never converge directly to the opening of the vault, but to a point on the anterior side of it*, whether there is a simple opening or a produced proboscis. The point to which they converge, even in types with a decidedly lateral opening of the vault, is always central or very nearly so, and even when the opening is nearly or quite central, the furrows seem to go, as it were, out of their way to avoid it, those coming from the posterior rays passing around on each side of it to the point of convergence of the others, a little in advance of the opening. That the ambulacral canals here, under this point of convergence of the furrows in the under side of the vault, always came together and connected with the upper end of the convoluted frame-work of the digestive sack, we can scarcely entertain a doubt.

Now in looking at one of these specimens, especially an internal cast of the vault, showing the furrows (or casts of them) starting from a central, or nearly central point, and radiating and bifurcating so as to send a branch to each arm-base, while the opening or proboscis of the vault (or the protuberance representing it in the cast) is seen to occupy a position somewhere on a line between this central point from which the furrows radiate, and the posterior side, one can scarcely avoid being struck with the fact, that this point of convergence of the ambulacra, under the vault, bears the same relations in position to the opening of the vault, that the *mouth* of a *Comatula* does to its *anal* opening. And when we remember that eminent authorities, who have dissected specimens of the existing genus *Comatula*, maintain that these animals subsisted on microscopic organisms floating in the sea-water, such as the *Diatomaceæ*, minute *Entomostraca*, etc.,* which were conveyed to the mouth along the ambulacral canals, perhaps by means of cilia, we are led from analogy to think that the Palæozoic Crinoids subsisted upon similar food, conveyed in the same way to the entrance of the digestive sack. If so, where would there have been any absolute *necessity* for a mouth or other opening directly *through* the vault, when, as we

---

* Bronn mentions the fact (Klassen des Thierreichs. Actinozoa, II, p. 211), that the remains of *Diatomaceæ*, of the genera *Navicula*, *Actinocyclus*, *Coscinodiscus*, and of Entomostraca, were found in the stomach of *Comatula*, and suggests that, when such objects, in floating in the sea-water, came in contact with the ambulacral furrows of the pinnulæ, they were conveyed along these furrows to those of the arms, and thence in the same way into the mouth. He ridicules the idea, sometimes suggested, that the food may have been handed by the pinnulæ or arms directly to the mouth.

Dujardin and Hupé also state (Hist. Nat. des Zoophytes Echind., p. 18), that the living *Comatula* was "nourished by microscopic *Algæ* and floating corpuscles, which the vibratile cilia of the ambulacra brought to the mouth." That they may have sometimes swallowed a larger object, that accidentally floated into the mouth, however, is not improbable, and would not, if such was the case, by any means disprove the generally accepted opinion that these animals received their food almost entirely through the agency of their ambulacral canals.

know, the ambulacral canals were so highly developed *under* it from the arm-openings to the entrance into the top of the alimentary canal? Indeed it seems at least probable, that if the soft ventral disc of *Comatula* had possessed the power of secreting solid vault-pieces, as in most types of Palaeozoic Crinoids, that these vault-pieces would not only have covered over the ambulacral furrows, as in the Palæozoic types, but that they would also have hermetically covered over the mouth, and converted the little flexible anal tube into a solid calcareous pipe, such as that we often call the proboscis in the extinct Crinoids.

From all the facts, therefore, now known on this point, we are led to make the inquiry whether or not, in all the Palæozoic Crinoids in which there is but a single opening in the vault—whether it is a simple aperture or prolonged into a proboscis, and placed posterially, sub-centrally, or at some point on a line between the middle and the posterior side—this opening was not, instead of being the mouth, or both mouth and anus as supposed by some, really the anal aperture alone; and whether in these types the mouth was not generally, if not always, hermetically closed by immovable vault-pieces, so far as regards any direct opening through the vault?

We are aware of the fact, that at least one apparently strong objection may be urged against this suggestion, and in favour of the conclusion that the single opening seen in these older Crinoids was the mouth, or at least performed the double office of both anal and oral aperture. That is, the frequent occurrence of specimens of these Palæozoic species, with the shell of a *Platyceras* in close contact by its aperture, either with the side or the vault of the Crinoid, and not unfrequently actually covering the only opening in the vau t of the latter, so as to have led to the opinion that the Crinoid was in the very act of devouring the Mollusk at the moment when it perished.

Amongst the numerous beautiful specimens of Crinoids found in the Keokuk division of the Lower Carboniferous series at Crawfordsville, Indiana, there is one species of *Platycrinus* (*P. hemisphæricus*), that is so abundant that probably not less than two hundred, and possibly more, individual specimens of it have been found there by the different collectors who have visited that noted locality; and, judging from those we have seen, apparently about one-half of these were found with a moderate sized, nearly straight, or very slightly arched and conical *Platyceras* (*P.

infundibulum), attached to one side by its aperture, between the arms of the Crinoid, and often so as to cover the single lateral opening in the vault of the same.* From the direction of the slight curve of the apex of the *Platyceras*, it is also evident that it is always placed in such a manner, with relation to the Crinoid, that the anterior side of the Mollusc was directed upward, when the vault of the Crinoid was turned in that direction.† A species of *Goniasteroidocrinus* (*G tuberosus*, Lyon and Casseday), found at the same locality, also has frequently a *Platyceras* attached to the top of its nearly flat vault, so as to cover the only opening in the same. It is worthy of note, however, that it is always another, sub-spiral, *Platyceras* (very similar to *P. æquilaterum*), that we find attached to this Crinoid, so that here at least, it would seem that each of these two Crinoids has its own particular species of *Platyceras*.

---

* We at one time thought these shells attached to the side of this *Platycrinus*, to be out of reach of the opening, or supposed mouth, because we had not seen specimens showing the position of the opening in this species, and had supposed, from its similarity to *Platycrinus granulatus*, Miller, and other species without a lateral opening, that such was also the case with this. We have since seen specimens, however, showing that is has a lateral opening, and therefore belongs to the group *Pleurocrinus*, to that it is probable these shells often cover this opening.

† Prof. Richard Owen has noticed, in his Report on the Geological Survey of Indiana, p. 364 (1862), the frequent occurence of a *Platyceras* attached to this same *Platycrinus*, at this locality, and proposed to name the *Platyceras*, *P. pabulocrinus*, from the supposition that it formed the chief food of these Crinoids. It is probable that the *Platyceras* for which he proposed this name, is the same we named *P. infundibulum*, but as he gave no description of the species, and but an imperfect figure, we cannot speak *positively* as to its identity. Prof. Hall has also proposed the name of *P. subrectum* for this Crawfordsville *Platyceras*, but he had previously used the same name for a very different, New York, Devonian species of this genus.

Prof. Yandell and Dr. Shumard have also figured in their paper entitled "Contributions to the Geology of Kentucky," a specimen of *Acrocrinus*, with a very similar *Platyceras* apparently attached to its vault.

Amongst all the numerous Crinoids found at Burlington, Iowa, we are aware of but a single instance of one being found with a *Platyceras* attached, and that is a specimen of *Actinocrinus ventricosus* in Mr. Wachsmuth's collection, which has a crushed shell of a *Platyceras* connected with its vault.

In all of these, and numerous other examples that might be mentioned, it is worthy of note that it is to species of Crinoids with a simple opening in the vault, and not to any of those with a produced proboscis, that we find these shells attached in this way;* and it is so rarely that we find shells of any other genus than *Platyceras*, apparently attached to, or in contact, with the body of a Crinoid, that it seems probable where other shells are occasionally so found, that their connection with the Crinoid may be merely accidental. If it could be established as a fact, that these Crinoids were actually devouring these Molluscs, by sucking out, or otherwise extracting and swallowing their softer parts, in any instance where they have been found with a shell attached over the opening of the vault, this would, of course, establish the fact that this opening is the mouth, or, at least, that it must have performed the office of both oral and anal aperture. But to say nothing in regard to all that is known of the habits and food of the recent Crinoids being so directly opposed to such a conclusion, the fact that so large a proportion as nearly one-half of all the individuals of some species should have died at the precise moment of time when they were devouring a *Platyceras*, and should have been imbedded in the sediment and subsequently fossilized without separating from the shell, seems, to say the least of it, very improbable.

And it is even more difficult to understand upon what principle an animal with its viscera incased in a hard unyielding shell, composed of thick, close-fitting calcareous pieces, and with even its digestive sack, as we have reason to believe, at least to some extent, similarly constructed, could have exerted such powers of suction as to be able to draw out and swallow, through an aperture in its own shell, often less than one-tenth of an inch in diameter, the sotter parts of a mollusk nearly or quite equal in volume to the whole of his own visceral cavity. hat they ever did so, however, becomes still more improbable when we bear in mind the fact, that the animal supposed to have performed this feat, lived, at least during the whole of its adult life, attached to one spot by a flexible stem, that only allowed it a radius of a foot or so of area to seek its prey in; while the mollusc it is supposed to have so frequently devoured, from its close affinities

*Possibly due to the fact, that in species with a proboscis there is much less room for attachment to the vault.

to the genus *Capulus*, may be supposed to have almost certainly lived most of its life attached to one spot.* In such a case, why should the Crinoid have so frequently left the *Platyceras* to grow within its reach to nearly its adult size before devouring it? But if from some unknown cause it should have done so, by what means could the Crinoid have pulled loose the Mollusk (which, from analogy, we may reasonably suppose held with some degree of tenacity to its place of attachment), and placed it with the aperture of its shell over the opening supposed to be its own mouth? That it could have used its arms and tentacula as prehensile organs, in this sense, is extremely improbable from their very structure, so much so indeed that few if any of the best authorities who have investigated the recent Crinoids, believe that they ever used these appendages to hand directly to the mouth, even minute organisms.†

But we believe the strongest argument against the conclusion that the Crinoids, so frequently found with the shell of a *Platyceras* attached to them, died while in the act of sucking out, or otherwise extracting the softer parts of these Mollusc, remains to be stated. In the first place, if such really was the nature of the relations between the Crinoid and the Mollusc, it is of course

*Most of the best European authorities on Palæontology refer these shells even to the existing genus *Capulus*.

†In many instances it is clearly evident that it would have been an *absolute impossibility* for certain types of our Carboniferous Crinoids to have handed any object, great or small, directly to the only opening through the vault. That is, where this opening is at the extremity of a straight rigid tube, often nearly twice the length of the arms, even to the extreme ends of their ultimate divisions. We are aware that some have supposed this tube, or proboscis, to have been flexible, and the Messrs. Austin even thought it was especially designed and used for the purpose of sucking out the softer parts of Polyps. If flexible, we might suppose that in those cases where it was so much longer than the arms, that it could have been curved so as to bring its extremity within reach of the ends of the arms; but although we have in a few instances seen this tube more or less bent, a careful examination always showed that, where this was not due to an accidental fracture after the death of the animal, it was caused by the plates composing it being on one side larger, or differently formed from those on the other, and evidently not to flexibility. We find the arms, which were evidently flexible, folded and bent in every conceivable manner, but the tube of the vault is, in nine cases out of ten, if not more frequently, when not accidentally distorted, found to be perfectly straight, or a little inclined to one side or the other.

self-evident that the continuation of the life of the latter must have necessarily been of very short duration after it came in contact with the Crinoid. Yet we have the most conclusive evidence that such was not the case; but that on the contrary, in most of, if not all of these instances, the *Platyceras must have lived long enough in contact with the Crinoid to have adapted the sinuosities of the margins of its shell exactly to the irregularities of the surface of the Crinoid.*

We have taken some trouble to examine carefully a number of specimens of *Platycrinus hemisphæricus*, and *Goniasteroidocrinus tuberosus*, from Crawfordsville, Indiana, with each a *Platyceras* attached, and in all cases where the specimens are not too much crushed or distorted, or the hard argillaceous shaly matter too firmly adherent to prevent the line of contact between the shell and Crinoid to be clearly seen, the sinuosities of the lip of the former closely conform to the irregular nodose surface of the latter. Owing to the fact that in some cases the shell has evidently been forced by accidental pressure against the surface of the Crinoid, so as to become somewhat crushed, this adaptation is not always so clearly evident; but in most cases it is more or less visible, while in some it is strikingly manifest. In one instance of a *Platycrinus* now before us, with a *Platyceras* attached, as usual, to its side, between the arm-bases of two of its adjacent rays, and of rather larger size than those usually found attached to this species, the adaptation of the irregularities of its lip, so as to receive the little nodes and other prominence of the Crinoid, is so clearly manifest that a moment's examination must satisfy any one that the shell must have grown there. Being, as we stated, a larger individual than we usually see so situated, it not only occupies the whole of the interradial or anal space to which it is attached, but its lateral margins on each side coming in contact with the arm-bases of the Crinoid, as the shell increased in size, had formed on either side *a profound sinus in its lip for the reception of these arms.* These sinuses are not only in precisely the *proper places*, but of exactly the *proper size and form* to receive the adjacent arm on each side; the entire adjustment being so exact, that it seems scarcely possible that the shell could have been removed during the life of both animals, and after the Mollusc had attained its present size, without either breaking its lip or breaking off the arms of the Crinoid. Unfortunately, in clearing away the rather hard argillaceous matrix, before the arrangement of the parts was clearly comprehended, these arms were broken away, but their stumps are still seen protruding from the sinuses, which are so deep as almost to present the appearance of isolated perforations, though it is evident, on a careful examination, that they are only deep emarginations extending up from the edge of the lip.

In looking at the sides of this *Platyceras*, which has the form of a very slightly arched cone,* and stands out nearly at right angles to the side of the Crinoid, it is easy to see, from abrupt curves in the lines of growth, along up its sides, on a line above the sinuses mentioned, that these sinuses commenced forming abruptly at points about half way up; and on measuring across between these points with a pair of dividers, the space between is found to coincide very closely with that between the inner sides of the arm-bases protruding from the sinuses. Hence it is evident that the shell had commenced forming these sinuses in its lip exactly at the period of its growth, when it had attained a breadth that brought the edges of its lip in contact with the arm-bases. After this, it had increased very little *in breadth* between the arms of the Crinoid, though it had grown somewhat wider above and below, and *nearly doubled its length.* Whether or not it covers the opening in the side of the vault of the Crinoid we are unable to say, since the folded arms (which are, as usual in these cases, well preserved) and adhering matrix, cover the vault. We have scarcely any doubt now, however, that the *Platyceras* does, in this, as in most of the other cases, actually cover the opening in the side of the vault of the Crinoid.

From the facts stated it is, we think, evident that these Molluscs actually lived long enough after their connection with the Crinoids, to which we find them attached, not only to have adapted the edges of their lip to fit the surface of the Crinoid, but to have generally increased more or less in size, and in some instances, at least, to have actually nearly or quite doubled their size. Admitting this to be the case—and we think there can be no reasonable doubt on this point—we can no longer believe that these Crinoids were preying upon the Molluscs; and we therefore think no well-grounded arguments can be based upon the fact of their being so frequently found attached in the manner described,

---

*It being the common species of *Platyceras* that is usually found attached to this *Platycrinus.*

in favour of the conclusion that the opening in the vault of these Crinoids is the mouth.

But, if they were not in the habit of eating these Mollusks, it may be asked what could have been the nature of the relations between the two, that so frequently brought them together as we now find them? The first explanation that suggests itself is, that possibly the Mollusk may have been preying upon the Crinoid. But the fact, already stated, that these Mollusks evidently lived long enough attached to these Crinoids, as we have every reason to believe, during the life of the latter, to have at least increased the size of their shells considerably, if not indeed during their entire growth, is alone an almost insurmountable objection to such a conclusion. Doubtless, like other marine sedentary animals, these Molluscs, when very young, floated freely about in the sea, until they found a suitable station to attach themselves, where they remained during life. May they not, therefore, have been attracted to the bodies of Crinoids by the numerous little organisms brought in by the action of cilia, along the ambulacral furrows of the arms of the Crinoids, or in currents produced by the motions of the arms of the latter? The excrementious matter of the Crinoid could doubtless have passed out under the foot of the *Platyceras*, supposing the opening in the Crinoid sometimes covered by these shells to have been the anus, but it is difficult to conceive how food could have passed in, if we suppose this opening to be the mouth.

ON THE EXISTENCE OF ROCKS CONTAINING ORGANIC SUBSTANCES IN THE FUNDAMENTAL GNEISS OF SWEDEN.

By Messrs. IGELSTRÖM, NORDENSKIÖLD, and EKMAN.*

1. ON THE OCCURRENCE OF THICK BEDS OF BITUMINOUS GNEISS AND MICA-SCHIST IN THE NULLABERG, PARISH OF OSTMARK, PROVINCE OF WERMLAND, IN SWEDEN.

By L. I. IGELSTRÖM.

The parish of Ostmark, as well as other parts of western and northern Wermland, is filled with high and steep hills of

* Reprinted from communications read to the Royal Swedish Academy of Sciences at Stockholm.

hyperite, between which the common crystalline rocks, gneiss, hornblende, mica-schist and others, intervene. The bituminous gneiss and mica-schist occur interstratified in common reddish granite-gneiss at the western part of the high and precipitous Nullaberg, occupying a thickness of more than twenty fathoms, and extending along almost the whole side of the mountain. The dip of the strata is about 70° eastward, and they are covered first by a bed of hyperite and then with parallel strata of other granitoid rocks.

Generally, the bituminous substance is rather uniformly distributed through the range, in the gneiss as well as in the mica schist, and the entire mass has a black colour. The naked eye is hardly able to discern any particles of coal. When coarsely ground the rock resembles gunpowder, but when ground finer, it grows darker, either of the colour of soot, or resembling pyrolusite. When beaten with the hammer, it emits a bituminous smell, like anthraconite, and also when heated by the blowpipe; it then gives a flame. When calcining 5.32 grammes in an open crucible of platinum, I was not able completely to burn the whole of the bituminous substance, even after adding several times nitric acid; a little coal always remaining unconsumed. The loss of weight, however, was 12.03 per cent; the ashes were gray. When heated in a retort of thin iron plates, twelve pounds emitted much combustible gas, while a yellow combustible oil, as well as a colourless incombustible fluid was collected in the recipient. When the gas was allowed to escape through a hole of one inch in diameter, a fine and bright flame was obtained during four hours; during the fifth and sixth hour the flame grew bluer and fainter. The powder in the retort remained as black as before the distillation, though with rather a high lustre. It had lost 15.6 per cent of its volume.—The specific gravity of the rock is 2,19.* It is so loose, that a man may in about half an hour sink in it a hole of two feet.

On a closer examination of the bituminous strata it is very difficult, from the general homogeneousness of the bed, to decide whether and where it is gneiss or mica-schist, that is impregnated with bitumen, but nevertheless one finds that both the above-named rocks, and thin layers of chlorite schist constitute

* When weighed in the hand, it feels very light, compared with silicates in general.

parts of the range. Thus, above the main bed and somewhat separate from it, I met with thin layers of common mica-schist, alternating with layers of mica-schist more or less impregnated with bitumen. Silvery laminæ of mica also form thin seams in the main bed. With regard to the gneiss, on the other hand, occasionally in the black bituminous rock one meets with somewhat paler stripes and seams, showing that feldspar here forms the principal constituent of the mass. The stratification is, however, distinct enough to show that it is not a dike, but stratified gneiss and mica-schist, conformable to the surrounding parts we here see before us. In some places the bituminous rock contains round, whitish, thinly interspersed particles of the size of a pea, as well as nodules of anthracite of about the same size. As I at first supposed the latter to be asphalt, I concluded, that the whole bed was impregnated with that substance; when, however, these nodules afterwards were proved, by experiments, to be anthracite, that supposition lost its foundation and yet I cannot decide what kind of bituminous substance it is, that to so large an extent impregnates the rock. It seems nevertheless to be fully decided, that the impregnation is analogous to that in alum-slate, for instance, and that consequently our gneiss and mica schist must be removed from the place they occupy as "primitive rocks," to the series of sedimentary and fossilferous strata, as limestone, alum-slate, &c.

2. Note on the Mineral Character of the Rock.

By A. E. Nordenskiöld.

There are at Nullaberg two kinds of bituminous rocks, viz:

a) a rock of a schistose structure, abounding in mica.

b) a rock almost devoid of mica, and showing but slight appearance of layers in the arrangement of its ingredients.

As Mr. Igelstrôm shows, these rocks alternate in parallel beds, with common mica-schist, gneiss, and hyperite. The principal ingredients are, in *b*—greyish white orthoclase, in *a*—greyish-white orthoclase and silver-white mica; in both mingled with variable portions of a black carbonaceous or coal-like substance. No quartz is to be discovered. When the mica prevails and the rock contains less of the carbonaceous substance, it has such a striking resemblance to ordinary mica-schist, that even the ablest geologist would mistake it for this common rock, and I should not wonder if such bituminous mixures of mica and feldspar, or bituminous mica-schist, were found to be abundant in almost all our districts of crystalline rocks. When the carbonaceous substance becomes more predominant, the silver-white colour passes into dark brown, and this colour totally prevails in the variety *b*, which at a superficial glance seems to be a quite homogeneous, black or dark brown substance. A closer examination, however, shows, that this colour comes from innumerable small black, well defined grains immixed in the greyish orthoclase. Some scales of mica, of the same aspect as the mica in the schistose variety, and small grains of calcite, may also be discovered. Occasionally the felspar and calcite are concentrated into somewhat larger white nodules, free from the black mineral.—If the variety *b*—(*b* contains less of bitumen)—is heated in the air or in oxygen, the carbonaceous substance is destroyed, and the blackish colour changes into greyish-white. Before the piece is red-hot, a combustible gas is given off, enveloping the heated mineral in a flame, resembling the flame of burning hydrogen. Even when heated in a retort the rock gives much gas, in this respect quite resembling bituminous coal. With boiling alkali a dark brown solution is obtained, which gives with muriatic acid a brown flocculent precipitate.

The carbonaceous substance is very brittle, and the rock is therefore more friable than common gneiss, not more, however, than might be presumed of a gneiss penetrated with cavities of the form and volume of the immixed coaly particles. But near the surface the rock is already much decomposed, and so brittle that large pieces may be crumbled with a few blows. The grains of orthoclase, both in the altered and unaltered rock, break *along the cleavages of the felspar*, and the fracture of the rock is thus crystaline. Accordingly we have here not to do with a sandstone, but with a rock, probably originated by the solidification and crystallization of a claylike sediment, consisting of organic substances and inorganic matter, of the same constituents as the common felspar. That a change in the relative position of the atoms, *i.e.*, a crystallisation *in a solid mass* tending to a disposition of its molecules according to the best conditions of equilibrium, did take place, *without the aid of water or heat*, during the immense time that has elapsed since the gneiss period, seems not at all improbable, when we consider, that such a change often takes place, for instance in the axis of a locomotive in the course of a few years, in the monoclinic sulphur or the yellow iodide of mercury in a few seconds.

3. Chemical Analysis of the Rock.

By F. L. Ekman.

The following are the results of an analysis of various specimens of Nullaberg-rock from the mineralogical collection of the Royal Academy of Science in Stockholm.

The principal ingredient in this species of rock was felspar, a portion of which formed colourless stripes, coarser or finer, in the fracture of the dark stone. Even the dark material itself was chiefly composed of felspar, which however was so thickly overspread with small grains of organic carbonaceous matter, as entirely to conceal the appearance of the felspar. These grains were in part visible to the naked eye, and when a little of the dark stone was crushed between glass plates under the microscope, the carbonaceous substance appeared as opaque, angular broken particles. and the felspar uncoloured; one or two flakes were slightly tinged with yellow.

Mica appeared thickly scattered in separate or conglomerate scales. Quartz I could not observe.

Carbonate of lime occurred together with felspar in the small round balls of white colour, copiously sprinkling some of the specimens, though in some instances it had been fretted out by the action of the air and water. It sometimes appeared, less visibly, mixed with the remaining mass, but was sometimes entirely absent.

In five specimens of different character I found the following proportions of organic matter (traces of water included) and carbonate of lime:

	1.	2.	3.	4.	5.
Organic matter......	7.10,	10.67,	10.36,	5.44,	9.08.
Carbonate of lime....	2.57	(0,07)	14.30	2.75	0.00.

The following is the analysis of the rock, when free from organic matter and carbonate of lime:

	1.	5.
Silica....................	65.03	65.25.
Alumina..................	19.61	
Red Oxyd of Iron.......	0.45	
Lime........	0.19	
Magnesia..................	0.20	
Potash......................	14.46	
Soda.........	1.06	
	101.00.	

When larger quantities (40—80 grammes) were macerated at the ordinary temperature with diluted nitric acid, well determinable quantities were obtained of phosphoric acid and chlorine, as also of lime, the last even in the specimen 5 (in which, though 11 grammes were analyzed, no carbonic acid was found). Hence one may conclude that the rock contains a little apatite. Traces of manganese and copper were also observed. The silicious ingredients of the rock were also a little dissolved, and it may perhaps be inferred, that the traces of silica were separated before testing for phosphoric acid.

The organic ingredient may be easily obtained in a very pure state by washing, when a sufficient quantity of the rock is employed. The purest specimen that I obtained afforded after combustion only 3.17 p.c. of a reddish ash, but still contained some mineral fragments. The ash, of which those fragments constituted perhaps the principal part, showed no reaction on curcuma paper. In a few centigrammes, collected after analysis, I found gypsum, oxyd of iron, silica (and phosphoric acid ?) apparently derived from the combustion of the organic matter.

The carbonaceous substance thus purified forms a light powder of a beautiful bluish black colour. It is but slightly hygroscopic and is not easily wetted with water. When heated, it concretes a little, but without melting or sensibly changing its state of aggregation, and produces a transient but brilliant flame; the remaining coal smoulders very slowly out. The specific gravity I found to be 1.299; after the removal of all remaining stony matter, it would probably be about 1.27. Analysis by combustion gave the following results (ash and water being supposed to be removed):

The carbonaceous substance obtained from

	No. 3.	No. 2.		Medium.
Carbon..........	88.68	88.79	—	88.74
Hydrogen.......	5.35	5.56	—	5.46
Azote............	—	—	0.67	0.67
Oxygen.........	—	—	—	5.13
				100.00

The carbonaceous substance is generally but little affected by solvents. Spirit of 90 per cent. pure alcohol became yellow and dissolved scarcely one per cent of a substance, probably colourless when pure, and easily soluble in alcohol; when heated it yielded a thick white vapour and slowly blackened. Ether dissolved ½ per cent. of a substance of the same nature but less coloured. Chloroform, like alcohol, was coloured deep yellow, and left a similar residuum, the quantity of which was however not determined. Oil of turpentine had no more dissolving effect than alcohol or ether. N.B: The experiments with alcohol, ether and oil of turpentine were performed by boiling the substance in the solvents for several hours.

A warm solution of one part caustic potash in twenty parts water, dissolved 5 per cent. and became black-brown. From this solution, by the action of acids, was obtained a very voluminous brown precipitate soluble in pure water. After the extraction of this 5 per cent, the remainder was unalterable in a heated solution of caustic potash, though exposed for several hours to its action.

The following are the results of some experiments made with reference to the products of dry distillation, performed on a small scale, the presence of air being as much as possible avoided, and in an apparatus that permitted a bright red-heat. When rapidly heated the substance * gave carbon 74 p.c. and volatile products 26 p. c. When slowly heated it gave 11 p. c. fluid products, of which about three-fourths consisted of a yellow neutral oil, lighter than water; the gases developed were first acid, afterwards alkaline, and the water after distillation was strongly alkaline.

One gramme of the substance gave, rapidly heated, 258 cubic centimentres of gas of 23° Centig. temp., collected and measured over water. In the gas when fully purified with carbonic acid I found 2.7 vol. p. c. of hydrocarbons absorbable by bromine. In another experiment, where the oils were for the most part decomposed during the distillation, 313 cubic centimeters of gas were obtained from one gramme of the substance.

In the analysis of the organic substance no attention has been paid to the amount of sulphur contained. Even in the original rock, when melted with carbonate of soda, this element plainly shows itself, and in the carbonaceous substance, containing 3.17 p.c. ash, I found no less than 0.81 p.c. Whether the iron remarked in the ash be there in sufficient quantity to unite with the sulphur and compose pyrites, or whether, as is possible, there be an overplus contained in the organic substance is as yet undecided.

* The substance always considered as free from ash.

Finally I may remark, that I have found Mr. Bahr's interesting statement that the rock contains iodine confirmed. When 7.5 grammes of substance, containing 21.7 p.c. of ash, were burned with 14 grammes of almost pure lime, the burned mass treated with water and nitric acid, and the iodine transferred to silver and thence to cadmium, the little amount of solution of cadmium showed strong signs of the presence of iodine. The iodine was recognized by receiving it first on chloroform, thence on silver again, and lastly on starch.

When twelve grammes of the same kind of lime were dissolved with proper care in water and the same kind of nitric acid as that used in the experiment, the solution, when analogously treated, yielded a little chlorine but no trace of iodine. For the sake of brevity I do not here detail any operations caused by the substance's containing sulphur, especially as fuller details of the experiments will shortly be published in the proceedings of the Royal Swedish Academy.

ON THE GEOLOGY AND SILVER ORE OF WOODS' LOCATION, THUNDER CAPE, LAKE SUPERIOR.

By Thomas MacFarlane.

Part II.

(*Continued from page* 47.)

On the north-western part of the location a large area is occupied by the rock which forms the summit of the cliffs of Thunder Cape. At the western end of these cliffs, on the location, this rock is found to overlie the grey argillaceous sandstones and shales, described in the first part of this paper. In following the line of junction between these and the overlying crystalline rock, the observer frequently fancies that he can detect unconformability; but so slight is the dip of the underlying strata, and so inaccessible in places is the point of contact, that it is impossible for him to obtain certainty until he reaches the eastern end of the cliffs. Here, not only does the unconformability become plainer, but the conglomerate bed and the white sandstones, which have been described as succeeding, in ascending order, the same grey argillaceous sandstones on the eastern part of the location, are found to crop out beneath the crystalline covering, and to be unconformably overlaid by the latter. An attempt has been made to represent the relations of these various rocks in the section which accompanies the map. From this it will be apparent that the summit rock of Thunder Cape is not a bed interstratified between the grey argillaceous and the white and red dolomite sandstones, but an overflow which has spread over both these groups after their deposition and partial disturbance. The cliffs at the east end of Thunder Cape would form the eastern extremity of this overflow, unless it should be found that the rock of the Paps between Black Bay and Lake Superior, and those of other overflows in the Nipigon district, resemble that of Thunder Cape. Southwest from Thunder Cape large areas are occupied by the same rock, which contributes in a marked degree to form the picturesque coast lying between Fort William and Pigeon River.

The rock whose geological relations have just been described, and which, with its roughly columnar structure, adds so much to the imposing appearance of Thunder Cape, is very hard and crystalline, and exhibits no appearance of stratification or parallelism among its constituent minerals. It is very little acted on by the atmosphere, but separates into large rectangular blocks, which, becoming detached from the rock above, form an enormous talus at the bottom of the cliffs, sometimes completely obscuring the debris from the underlying strata. The rock is readily recognizable as a compound one, its constituents being of distinctly different colours. These vary in size from one-twentieth of an inch in diameter to very minute grains, and in general the fine-grained varieties are found immediately over the underlying strata, while the coarse-grained varieties are more frequent on the summit of the cliffs. The principal constituents are greyish white feldspar and black hypersthene, the former mineral being generally the most abundant. The hypersthene is but slightly influenced by the atmosphere, and on exposed surfaces retains most of its lustre and hardness, while the accompanying feldspar is bleached and decomposed. A softer dark greenish coloured mineral, probably hornblende, is also present, as well as magnetite in small quantity. It would therefore appear that the rock in question is hypersthenite, or, as the name has been more recently modified, hyperyte. Four different specimens, tested as to specific gravity, gave respectively 3.061, 3.034, 3.009 and 2.922.

The explorations made upon the location during the summer and fall of 1869 did not result in the discovery of any new veins of much economic value. A few very narrow and unimportant veins, noted on the map, were found on the face of Thunder Cape cliffs, and at a few other points in the interior of the location. Much more important, because of great width, are the veins noted as occurring on Shangoinah Island, and running parallel with its length. In places this network of veins has a width of forty feet, enclosing, however, much rock, the greatest width of pure veinstone being about three feet. The veinstone consists of large-grained calcspar, accompanied by saponite and iron pyrites. Several days were spent in blasting on the vein and searching for silver in it, but without result; nor did the iron pyrites contain any, except the merest traces. It is to be remarked that the general course of this suite of veins is N. 50° E., consequently almost at right angles to that of the Silver Islet vein. On this account, and because of the coarse grain of of the veinstone, and because also of its similarity to that of the dyke veins, in which nothing of value has been hitherto discovered, it is not anticipated that the veins of Shangoinah Island will ever turn out to be of much value.

Pyritic Island, which lies inside of Shangoinah Island, was also carefully explored. No veins were detected anywhere upon it, but a band of reddish weathering rock runs through its length from north-east to south-west. It contains finely disseminated plumbago, copper, iron and magnetic pyrites, and also 0.02 per cent. of silver, a quantity, however, too small to be economically available.

The continuation of Silver Islet vein, across Burnt Island, and upon the main land, was carefully explored for a distance of about one mile from the lake. On Burnt Island a large quantity of earth was removed, and excavation done on the vein, which was found to be irregular at the point where it intersects the most southerly dyke. Here calcspar, quartz and fluorspar form the veinstone, with small grains of galena, blende, iron and copper pyrites, but no silver. The vein was uncovered at numerous points inland without obtaining any better result

The situation of the rich vein at Silver Islet is such that work was only possible upon it on the calmest days, when neither wind nor swell disturbed the water. Even at the best, its extreme coldness prevented the men from working in it longer than half an hour at a time, and then not very effectually. The same cause made it impossible to blast under water with success. The holes were bored, although with difficulty, but the insertion of the cartridge and the tamping was almost invariably a failure. Nevertheless, by working in a depth of from two to four feet of water, mostly with moils and bars, forty-six half-barrels of good ore were extracted from the vein. These formed three different parcels, which were despatched at different times, after the pieces had been broken down to a size not exceeding one inch and a half in diameter, and after a sample of each parcel had been taken in the regular manner. These samples I assayed on the spot before the blow-pipe, and afterwards in the muffle furnace. The results by the latter process, which did not differ materially from those done before the blow-pipe, are given in the following statement, together with the weights and values of each pareel.

No. of Parcel.	No. of Barrels.	Nett weight.	Percentage of Silver.	Ounces per ton of 2240 lbs.	Values per ton.	Total Values.
1	16	3429	2.760	889	$1111.25	$1701.10
2	21	4080	4 344	1417	1771.25	3226.20
3	9	1946	5.147	1680	2100.00	1824.37
	46	9455				$6751.67

Nothing could be more conclusive than these figures for establishing the value of the vein, and justifying considerable outlay in the attempt to establish a mine on Silver Islet. On the 12th of August last a shaft was begun in the centre of the islet, and afterwards a shaft-honse erected over it, containing, besides the shaft-house proper, a sleeping apartment, as well as a kitchen or eating apartment for the men. This building was protected on the west side by a screen of two-inch planks, extending from the ridge of the roof, at the same inclination, down to the rock of the islet. This served to ward off, from the house and shaft, the heavy spray driven over the islet and building during southwest gales. At such times we felt perfectly secure upon the islet, although from the heavy sea it was unapproachable by a boat. The sinking of the shaft was continued until a depth of 18 feet, or 12 feet below the level of the lake had been attained. At this depth several small veins were struck, which brought with them more water than could be advantageously raised by the windlass. The men were therefore removed to the main land, to cut the timber required for the cribbing and other extensive works already planned, and which it is intended to carry out energetically in the spring.

Besides the minerals mentioned in the first part of this paper as occurring in the vein of Silver Islet, large patches of the veinstone impregnated with graphite are frequently met with, and also, in the neighbourhood of the rich ore, cobalt bloom and nickel green. Besides the small nuggets and grains of pure metallic silver, there are also found in the rich ore thin plates and grains of a sectile mineral having a reddish brown colour like that of niccolite, and containing arsenic, cobalt, nickel and silver, the latter in greatest quantity. This would appear to be a new mineral, and worthy of more minute examination.

Actonvale, 1st February, 1870.

NATURAL HISTORY SOCIETY.

MONTHLY MEETINGS.

(*From October to December*, 1869.)

First monthly meeting, October 25th, 1869; Principal Dawson in the chair.

The following donations were announced:—

TO THE MUSEUM.

Brittle star from Panama, *Ophiura teres* Lyman; from R. J. Fowler.

Sixty species of British crag fossils; from A. Bell.

Three species of Montreal post-pliocene fossils; from R. McLachlan.

Bead and fragments of pottery dug up in Mansfield Street; from W. McLennan.

A Canadian Lynx, *Lynx Canadensis*; from Mrs. Demaray.

TO THE LIBRARY.

Reliquiæ Aquitanicæ; Parts 8 and 9; from the executors of the late Henry Christy.

Discoveries in Science by the Medical Philosopher, by Sir G. Duncan Gibb, Bart., M.A.; from the Author.

Queries on the Red Sandstone of Vermont and its Relations to other Rocks, by Rev. John B. Perry; from the Author.

Annual Report of the Trustees of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass., with the Report of the Director; from the Trustees.

Annuaire de l'Université Laval pour l'Année Académique 1869-70, Quebec; from the University.

Report of the Minister of Public Instruction of the Province of Quebec for the year 1867 and in part of the year 1868; from the Education Office.

General Report of the Minister of Public Works for the year ending June 30, 1868, Ottawa; from the Dominion Government.

The Spiders of Prussia, by A. Menge; from the Author.

PROCEEDINGS.

Principal Dawson read a paper "On some New Fossil Plants, &c., from Gaspé," of which the following summary is presented:

"The Peninsula of Gaspé, between the St. Lawrence and the Bay des Chaleurs, is of no small note in the history and geology of Canada. It was the first point in Canada at which Cartier touched in his first voyage; and, after availing himself of anchorage in Gaspé Bay and holding intercourse with the Micmacs, he prepared to prosecute his voyage up the mighty river of which he had learned from the Indians; but, opposed by the strong west winds of autumn, he abandoned the attempt, and bore away for France, leaving the exploration of the St. Lawrence for his second voyage. Gaspé had the honour to be the first part of Canada explored by the Geological Survey under Sir William Logan, when the geology of the peninsula was found to be most interesting and varied. At Cape Rosier the geologist sees the contorted shales of the Quebec group, which run all the way along the south side of the St. Lawrence from Quebec to this point. Passing toward Cape Bon Ami, the limestones of the Upper Silurian rest unconformably on these Lower Silurian beds, and rise into stupendous cliffs, 600 feet in perpendicular height, on the north side of Cape Gaspé. Dipping to the southward, these are overlaid at Little Gaspé by the Devonian sandstones, which extend along the north side of Gaspé Bay, and, rising on the south side, form a symmetrical valley occupied by the waters of the most beautiful bay in Canada. Towards the mouth of the bay the Devonian sandstones, the representatives of the Old Red Sandstone of Scotland, are overlaid by Lower Carboniferous rocks, and a little further to the southward are again pierced by the edges of the Upper Silurian limestones, forming, with the overlying carboniferous conglomerates, the magnificent scenery of Percé and its arched rocks. We have in Gaspé representatives of the Lower Silurian, the Upper Silurian, the Devonian, and the Lower Carboniferous periods, all admirably exposed in coast cliffs; and in the case of the Upper Silurian and Devonian, abounding in characteristic fossils. The visit of Principal Dawson had reference to farther study of the fossil plants of the Devonian sandstone, many species of which have been described in his papers in the "Canadian Naturalist" and in the "Journal of the Geological Society." With Messrs. G. T. Kennedy and G. M. Dawson, he explored the north and south sides of Gaspé Bay, and obtained large and interesting collections of fossil plants. Among these are two large trunks of *Protaxites Logani*, a beautiful species of *Psilophyton*, and a species of *Cyclostigma*, a genus hitherto found only in the Devonian rocks of Ireland. Several interesting remains were also found, including species of large fishes (*Machairacanthus*); and Mr. Kennedy was so fortunate as to find a *Cephalaspis*, the first representative of the genus as yet found in America. The animal fossils have been placed in the hands of Mr. Billings and Dr. Newberry for comparison, and the plants will probably be described in detail in the course of the coming winter."

Specimens of some of the more interesting fossils above referred to were exhibited to the Society.

Mr. A. S. Ritchie then read a paper on the Small Cabbage Butterfly (*Pieris rapæ*), which appeared in the September number of this Journal, page 293.

Mr. J. F. Whiteaves made a communication, entitled, "On some Results obtained by Dredging in Gaspé and off Murray Bay." This paper also will be found in the September number, at page 270.

Second monthly meeting, November 29th, 1869; Principal Dawson presiding.

DONATIONS TO THE MUSEUM.

A Chinese bank-note; from A. S. Hutchison.

TO THE LIBRARY.

Statutes of Canada, 1869; from the Dominion Government.

Manuscripts relating to the early history of Canada, Quebec; from the Literary and Historical Society.

Physical Culture in Harvard College, by Nathan Allen, M.D., Lowell, Mass.; from the Author.

PROCEEDINGS.

Col. Wolseley, Q.M.G., Dr. Griffith Evans, and A. Selwyn, F.G.S., Director of the Geological Survey of Canada, were elected members of the Society.

Mr. E. Billings read a paper "On the Genus Scolithus and some Allied Fossils," which will shortly appear in our pages.

Dr. P. P. Carpenter made a communication "On Different Modes of Computing Sanitary Statistics, with special reference to the opinions lately published by Mr. Andrew A. Watt."

Considerable discussion ensued on this subject, and Dr. Trenholme moved a vote of thanks to Dr. C. for the labour he had devoted to the subject, which was seconded by Mr. Drummond, and carried unanimously.

Mr. Joseph acknowledged that the Sanitary Association had done great good, but took exception to some of the figures.

Mr. D. P. Watt said we could not get over the facts of the excessive proportion of deaths under one year; nor of the fatal miasma of July and August.

Principal Dawson said that two things were established conclusions: 1st. We ought to have more accurate data; if the Council will not conduct registration as in other cities, they should let us know why they cannot; if only ten infants die prematurely, we ought to find out and remedy the evil. 2nd. Even in the healthy parts of the city, the summer months are usually unhealthy, in consequence of the prevalence of diseases difficult to cure. All should unite in seeking to remove those evils.

The third monthly meeting, which should have been held on the 27th of December, 1869, was postponed to January 31st, 1870.

J. F. W.

GEOLOGY AND MINERALOGY.

THE MAGNETIC IRON SANDS OF CANADA, by Dr. T. Sterry Hunt, F.R.S.—Extract of a letter published in the American *Engineering and Mining Journal* of February 8, 1870.—The sands from the mines of the crystalline rocks in Canada, as in most other regions, hold considerable quantities of iron ore, which along the shores of lakes and of the sea is seen partially separated by a natural process of concentration through the action of the water. The ancient marine sands which are found in the lower St. Lawrence, from the present sea-level to altitudes of several hundred feet, are often banded and barred with layers discolored by black iron ore grains, and in some places beds of several inches in thickness are almost free from the admixture of silicious sand. More generally, however, to obtain it of such a degree of purity requires a process of artificial concentration by washing or otherwise. The black sand thus obtained is not homogeneous, but may be separated into a magnetic and a non-magnetic portion, the latter predominating in the washed sand. While the magnetic part is nearly pure magnetic iron ore, the other portion contains from thirty to thirty-five per cent. of titanic acid, and consists in great part of titanic iron (menaccanite) with some admixture of garnet.

Successful attempts have been made to work these iron sands at Moisie, where they are treated in bloomery fires, and are reduced without difficulty, the daily yield of iron to each furnace being as great as in the similar furnaces of Northern New York, where non-titaniferous ores are used. The bar iron thus produced is of excellent quality and retains no titanium in its composition, while the fluid and readily crystallizable slags hold a great deal of titanic acid as a silico-titanate. The layers of iron sand at the Moisie are very rich, and the same is true of many other deposits in that vicinity and at Mingan, Natashquan, and elsewhere ; but in many localities there are great quantities to be obtained which yield by washing from eight or ten per cent. to thirty or fifty per cent. of heavy black sand. Attempts have been recently made to purify these by means of a magnetic separator, which leaves behind both the silicious and titanic portions. For the bloomery fire it is true such a degree of purification is not necessary, but for some of the newly proposed processes of direct conversion, or for the manufacture of malleable iron from pig metal by the Ellershausen process, and generally for ore intended for exportation, it is deemed desirable to get as high a per-centage of iron as possible, or in other words, to obtain pure magnetic iron ore. This, in the case of these titaniferous iron sands, can only be attained by the use of magnets. Dr. Larue, professor of chemistry at the Laval University, Quebec, has contrived for this purpose a simple and ingenious machine, which appears to be entirely novel in its arrangements, and is very efficient and rapid in its action. One of these I have seen in operation at Quebec, and of another put in operation at Clifton, New York, I have been furnished with an account by Dr. Larue. This machine, which is fitted with batteries of permanent magnets, occupies a space about six feet by five, and is four feet high. From three tons of sand, holding one-third of magnetic ore, it will separate in an hour one ton containing over ninety-nine per cent. of magnetic iron—or twenty-four tons in twenty-four hours. The wear and tear, and the motive power required are very small, and two men can, it is said, tend ten machines.

It was estimated at Clifton that the cost of purifying such iron sand would not exceed three cents per ton. Of course, if applied to massive ores, the cost of crushing and sifting would be added. By proper adjustment, this machine may be adapted to the preparation of lean massive ores for the bloomery fire, or for other direct methods of conversion into iron or steel. Meanwhile the deposits of iron sand which may be utilized by means of this machine, on the north shore of the St. Lawrence, from the Saguenay to Newfoundland, are practically inexhaustible. Dr. Larue informs us that inasmuch as a rich sand may be passed through the machine as rapidly as a poor one, the yield of the machine varies directly with the proportion of magnetite present; so that a sand containing say nine per cent. would yield six tons in twenty-four hours. Even the poorer sands may thus be used with advantage.

It is not, however, to the lower St. Lawrence that these sands are confined; they are met with in considerable quantities at Batiscan, between Quebec and Montreal, and a large accumulation of black iron sand at the mouth of Lake Huron attracted attention some years since. Similar deposits have been observed on both shores of Lake Erie, and I was informed more than twenty years ago that attempts had been made to collect the iron sand along the lake, and use it, together with bog ore, in a blast furnace on the Canadian shore. The iron sands of Taranaki, in New Zealand, are well known; and similar sands, according to Bruno Kerl, are worked in open hearths near Naples.

Black magnetic iron sands are found distributed in greater or less abundance, in numerous localities along the seaboard of Connecticut and Rhode Island, and it is said upon some of the adjacent islands. The utilization of these abundant and wide-spread deposits of an ore which is free from phosphorus and sulphur, and may be obtained in a great degree of purity by the magnet, is a problem well worthy the attention of metallurgists, and is already attracting considerable attention.

OBITUARY NOTICE.

By late advices from Christiania we learn, with regret, of the loss which science has sustained by the decease of Prof. Michael Sars, the eminent zoologist. He was born on the 30th of August, 1805, at Bergen, where his father was a shipowner. After finishing his academical studies at Christiania, and evincing at an early age his predilection for natural science, he entered into priest's orders, and in 1830 became pastor at Kinn, in the diocese of Bergen. Ten years afterwards he had charge of the parish of Manger in the same diocese. As both these parishes were on the sea-coast, Sars had constant opportunities of pursuing his zoological researches. In 1829 he published his first essay, entitled "Bidrag til Söedyrenes Natur-historie," and in 1846 the first part of his celebrated work Fauna littoralis Norvegiæ In 1854 he was appointed Professor Extraordinarius of Zoology at the University of Christiania, a position which he filled up to the time of his lamented death with great honour to his country, and to the satisfaction of the whole world of science. His celebrity as a zoologist, as well as a palæontologist, was fully recognised by all naturalists and geologists, and he was elected a member of several foreing scientific societies. Our own distinguished countryman, the late Edward Forbes, individually showed his appreciation of Sars's labours in the eloquent pages of his own posthumous work, "The Natural History of the European Seas," when he said, "More complete or more valuable zoological researches than those of Sars have rarely been contributed to the science of Natural History, and the success with which he has prosecuted investigations, claiming not only a high systematic value, but also a deep physiological import, is a wonderful evidence of the abundance of intellectual resources which genius can develope, however its lot be cast." * * * By the observations of Sars on the development of the Medusæ he greatly advanced our knowledge of that remarkable physiological phenomenon known as the alternation of generations, which Chamisso had first indicated in the Salpæ. His last publication, "Mémoire pour servir à la connaissance des Crinoïdes vivants," caused especial interest, by showing that a race of animals, supposed to be extinct for a period so long as only to be measured by the duration of several past geological epochs, occurred in a living state in the abysses of the Norwegian seas; and this discovery mainly induced the recent exploration of our own seas at great depths, which has produced such wonderful results The published works of Sars are seventy-four, and they are not less sound and valuable than numerous.

It is exceedingly to be regretted that, in spite of the most rigid economy, the large family of Professor Sars is left in very impoverished circumstances, six of the children being wholly unprovided for."—*Extracted from a notice by Mr. J. G. Jeffreys, F.R.S., in "Nature."*

EDITOR'S NOTE.—The Authors request that the following alterations be made in their articles:—

For Dec., 1866, vol. iii, p. 156, (reprint p. 20) line 4, for 3,516 read 3,536.
" " " " " 6, " 280 " 282.
" " " " " 5, for "which" read "so that the total deaths." [This error is repeated in the First Annual Report of the Sanitary Association, page 3, column 2, line 28, where for "children" read "persons."]

For June, 1869, present vol. p 189, (reprint p 4) table 4, the *supposed population* should be 106,375; and the deaths per 1000, 35.3; altering the average of the latter to 35.2. P. P. C.

For Sept., 1869, present volume.
Page 140, line 11, for "this region" read "continental Acadia,"
" 143, " 6, insert here pp. 147 (omitting the table), 148, 149 and 150 as far as line 34
" 152, " 21, for "second" read "fifth," and three lines below, for "fourth" read "seventh."
" 154, " 21 and elsewhere, omit the references to *Primula Mistassinica*.
" 155, " 27, insert "III. CONTINENTAL TYPE."

INDEX.

D. A. W.