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AND

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CONTENTS.

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AQUARIA STUDIES.

Part I.

By A. S. Ritchie.

The rage for aquaria has somewhat subsided in the fashionable world; still fashion reigns to a certain extent, and exerts an influence even in the zoological world. There has been a *furore* for sponges such as the beautiful Venus' Flower Basket (*Euplectella speciosa*), from the Philippines, for novelties in shells or in insects, and at fashionable prices.

All are not votaries of fashion,—though, in the minds of some, the fickle goddess may fan some latent spark of "Nature's fire" into a flame. While aquaria, in countless numbers, are being sacrificed by the auctioneer, the student of nature watches with intense interest the various productions of animal and vegetable life in his minature fish-pond, and sees, with admiration, their perfect adaptation to their place in the economy of nature.

A well-known naturalist writes: "The graceful fish, the brilliant reptiles, the shining insects, that people this rare world, whilom hermetically sealed up from our yearning view, are now displayed in the aquarium,—sporting, feeding, slumbering—pursued and pursuing,—leaping into life, and falling into dissolution,—each in its natural haunts, and yet 'all at home in these crystal palaces.'"

The fresh water aquarium with us, constructed and stocked on scientific principles, should represent faithfully a Canadian pond or stream. Nothing mars the effect more than to see marine shells, gay corals, madrepores, and echinoderms, however beautiful and interesting in themselves, in a fresh water aquarium. Even gold-fish are out of place among our Canadian fishes there, and detract from the truthfulness of the representation of a local fauna. Our waters contain the beauties of the Creator's hand just as much as those of a foreign shore, and the object of all lovers of aquaria should be to correctly illustrate the habits of native species.

The bottom of the tank ought to resemble the bed of a pond or river, with pieces of rock-work here and there, having their tops standing out of the water, to allow those creatures which prefer *out-door exercise* to breathe the fresh air at pleasure.

The principles on which an aquarium should be constructed are the following. The vessel should be either oblong or square, but not globe-shaped, on account of its distorting the image of whatever is contained in it. This should contain animal and vegetable life, in fresh or salt water, which, like the water of a river or sea, need never be changed. The vitalization of the water, without its being changed, constitutes the main principle of the aquarium; this principle we shall now endeavour to explain.

Living animals absorb oxygen, and give off carbonic acid gas. Plants, on the contrary, exhale oxygen, and inhale carbonic acid. What the one accepts the other rejects; that which would suffocate the one if it was not removed, the other would die from exhaustion if it could not obtain.

In stocking an aquarium, judgment and discretion are required, so as to have an equal proportion of animal and vegetable life. It should also be remembered that the more rock you introduce the fewer fish must be put in. A little experience in the keeping of aquaria will soon make people aware of any disproportion in the balance of animal and vegetable life. If plants are in excess, this is shown by the particular clearness of the water and by the restlessness of the fish. Their motions are spasmodic; they swim backwards and forwards in darts and jerks, as if trying to escape from something. If, on the other hand, there is too little vegetation, the fish swim lazily, with their mouths out of the water, panting for oxygen.

Our aquarium is three feet six inches long, by two wide, and twenty inches in depth. It has a glass top or roof-shaped covering; this is to keep out dust, and to prevent some of the inmates going from home, also for the purpose of fern growing. The bottom is covered with about two inches of sand or gravel, having rock-work at each end, with the tops of the stones standing out of the water. These last have cups cut in them for the reception of mosses and ferns, while the portion above water gives the reptiles and crustaceans the opportunity of a short stroll at pleasure.

We have grown *Anacharis alsinastrum* and *Vallisneria spiralis* with comparative success, the great enemy to their entire success being the cray-fishes, which browse on the plants, and destroy them after a time. We dispense with the larger plants altogether now. The aquarium stands in a darkish corner, and the water is as clear, and smells as sweet, as when put in two years ago. A little water must be added now and then to compensate for evaporation. We never clean the glass on the side next the wall, which is covered and grown over with confervæ and other lowly plants of various kinds. This, and not crowding too much animal life into the vessel, is the secret of success.

We shall now introduce the reader to some of our favourites, and first some odd fishes which possess many and varied traits of character.

That dapper little fellow, with his coat shining with scarlet and green, and armed with spines, is the little Stickleback (*Gasterosteus* *). He is the prince of gallants, and will fight for his lady-love to the death. A peculiarity in the economy of individuals of this species is, that they build a nest, the male watching and following the young until they can fish for themselves. We have had the nest built in the aquarium of several pieces of weeds that were introduced, but saw no young ones; if they ever had any the other fish must have devoured them. The female kept possession of the nest, which was in a corner of the tank, while the male kept watch outside. Woe to the unwary minnow, or sun-fish, that comes near his domicile,—his coat becomes more brilliant, his little eyes redden and flash, and with spines erected, he rushes at his enemy and charges him with his numerous bayonets.

Our next example is rather a handsome fish, which always swims along the bottom, moves by jerks, and darts to and fro; from

* The scientific names of the fishes mentioned in this article, have been altered in accordance with the latest nomenclature.—J.F.W,

his peculiar style of motion, he is named the Darter (*Boleosoma tesselatum*.) He is said to have no air bladder, which accounts for the difficulty he has in rising to the surface. He is a quiet retired character, but always manages to be on hand at feeding time.

The Striped Minnow (*Rhinicthys atronasus*) is the dandy of the tribe,—always sporting himself in the fore-ground. He is a little forward at times, and sometimes makes mistakes, such as rushing at a fly that has alighted on the outside of the glass, and only knows his real position (a dandy in prison) when his nose comes in contact with the glass.

We have a tyrant in our colony, the common Sun-fish (*Pomotis auritus*.) He must be king, and his rule is despotic. None are allowed to eat until he has finished, and even after getting the lion's share he chases all who dare to attempt to help themselves. One day he nearly fell a victim in consequence of his bad temper. A fine Cray-fish (*Astacus Bartonii*) had his home in the corner of the aquarium; at the close of feeding time he would sally forth to pick up anything that was left; the sun-fish made a dash at the antennæ of the cray-fish (which are always in motion when on a purveying expedition); like lightning the claws of the crustacean were thrown up in self-defence. He caught our finny friend above the tail, and only our timely interposition saved the sun-fish's life. After this we made a close prisoner of him in one of the corners of the tank, by placing a square of glass against the side and end.

The most graceful fish in our family is the American Perch (*Perca flavescens*), his proportions are so elegant, and his shape is so well adapted for swimming. He has a powerful stroke-oar in his tail, and few can match him on a trip round his domain. His powers of eating are extraordinary. Many a poor minnow pays the penalty of being a little too small for his company. Still, when regularly fed, he behaves himself as well as a respectable perch ought to do.

A very pretty Black Basse (*Centrarchus fasciatus*), is our next friend; we were not long favoured with his company,—he was too good for such a station. The waters of the St. Lawrence or the Ottawa were his home, and he pined for their gravelly bottoms and rippling waves. His retiring manner was our admiration; he always loved the shade of the rock-work. Many a stray fly was quietly dropped into his corner, which he never took without a look of recognition and thankfulness; but death!—inexorable death!!—called him away.

The Cat-fish (*Amiurus catus*) is one of the hardiest fishes we possess. His chief end is to eat,—which he does almost to suffocation. He refuses nothing. As he roots with whiskered mouth among the gravel at the bottom, he heeds neither the attacks of the stickleback, cray-fish, nor sun-fish. When annoyed he merely gives a shake of his head with the greatest nonchalance and keeps his nose at work, picking up all the rejected bits left by his patrician relations. He is of great use as a scavenger, and two or three specimens are a great acquisition to all aquaria.

The Pond Sucker (probably a small species of *Catastomus*) is a shy fish, and extremely reserved. In form, its body, from the dorsal fin to the tail, is rather tapering, and in swimming the body appears bent;—it is covered with beautiful silvery scales. He sometimes, though erroneously, gets the name of "Shiner." He has no teeth in the upper jaw, and is, therefore, unable to bite at his food, which is drawn into the mouth by suction, hence the name.

The Black Minnow (*Umbra limi*) is also of retiring habits, and is easily startled. He asserts his dignity, however, at feeding time, as he moves about with a graceful air, and is one of the first to help himself when there is anything in the way of meat to be had.

We have kept the Golden Carp, or Gold-fish (*Cyprinus auratus*) in the tank to please the ladies, but we objected to his presence on account of his being a stupid fish, and not indigenous (although introduced into gentlemen's ponds in Massachusetts, where it thrives well); besides, while along with the representative fishes of our waters, our aquarium carried a falsehood on its face. This will never do for science, we said, and were going to turn him out, but all we could find of him was the backbone and the eyeless head floating on the top of the water. The other fish knew he was a stranger,—perhaps they did not like the colour,—at any rate every one was against him, from the perch to the striped minnow. Whenever he attempted to come to the front to feed, there was a general charge at the poor gold-fish. Being thus prevented from feeding, he got so weak as to allow himself to be caught, and thus fell a victim to his cowardice and stupidity. We say cowardice, for he was as large as any fish in the tank, and a great deal larger than most. The smallest minnow would make him beat a hasty retreat. The old-fashioned fish globe is the place for the golden carp.

This concludes our remarks on the fishes of our aquarium, which contains ten species. At the time we write there were thirty-one specimens in the tank.

We shall now pass on to another class:—Reptiles. First in point of size comes our friend the Painted Turtle (*Chrysemys picta*). He is about four inches long, and a very lively specimen,—sporting now in the water, now on the rocks. In the water he is at home, and like all the rest of our family, he loves good eating. He devours his food voraciously, and swallows it by a series of gulps. We kept him about six months. He died from disease, as a *post-mortem* examination proved; the viscera were overgrown with a black fungus, and now the shell is all that remains of the poor turtle.

The Water Newt (*Triton millepunctatus*) is a great acquisition to the aquarium. At first we had a number of this species, but on account of the depredations of the fish our stock got reduced to two specimens. They liked the water, and would lie quietly on the top of it until the fish made war on their toes—biting a toe off this one, and part of a leg off another one, until only two remained unscathed. They took to the rocks and the moss in self-defence, taking an occasional dip, which they accomplish as quickly as possible. They have cast their coats twice with us. Their motions and positions in the water are very grotesque, yet very graceful at times. No aquarium is complete without them. They went the way of all newts, however, after a two years' sojourn with us. We always have them replaced by fresh ones.

The next in order is a veteran Frog (*Rana halecina*). When first introduced into our tank he preferred the water; he would lie carelessly floating on the surface until some of his finny allies would make a dash at his toes with open mouth, to his great disgust and annoyance. He had the advantage of them, however, and took up his residence on the moss in one of the cups of the rock-work at the edge of the water. He sometimes took a bath, which he only partially enjoyed, as he well remembered the propensity of his friends the fish. He is an adept at fly-catching, which he effects by his tongue as he lies on the moss.

Fancy his feelings as he lies under the influence of chloroform on the stage of the microscope, while we examine the circulation of the blood in the membrane between his toes. At first he disliked thus being bandaged up like a mummy; but frogs, like ourselves, can accommodate themselves to circumstances. He has figured before the public, under the microscope, during two winters, but has since died.

We shall now glance at a creature of a different order and class—a crustacean—the American Cray-fish (*Astacus Bartonii*), and a curious creature he is; almost every thing suits his palate. He is very provident, and lays up what he is unable to eat in the holes under the rock-work. He is a good gymnast, and can stand on his head, or on his tail, or can walk as it suits him,—as fast the one way as the other,—backwards, forwards, or sideways,—it matters not. He hid himself for a time, as his coat was getting shabby and too small for him. He came forth at last with a complete new suit; roamed about for some time, but has again vanished, with no ostensible reason. This is the first instance of this creature changing his shell in our aquarium.

With the exception of a few species of water beetles, *dytiscus*, *acilius*, and *colymbetes*, which the fish gradually mastered—notwithstanding the hardness of their elytra,—the curtain falls on the denizens of our aquarium.

We intend, in continuation of our aquaria studies, to lift the curtain once more, and, with the assistance of the microscope, to illustrate some forms of animal and vegetable life which cannot be well seen by the unassisted eye.

ON LAURENTIAN ROCKS IN EASTERN MASSACHUSETTS.

By Dr. T. Sterry Hunt, F.R.S.*

In a paper read before the American Association for the Advancement of Science at Washington in April, 1854, and published in this Journal for September in the same year, (vol. xvii, page 193,) I noticed the crystalline limestones of north-

* From Silliman's Journal for January, 1870.

eastern Massachusetts, which were described by the late Dr. Hitchcock as enclosed in the great gneissic and hornblendic formation stretching through that portion of the state. These limestones, which are met with at various points from Bolton by Chelmsford on to Newburyport, present a close mineralogical resemblance to those of the Adirondacks and Laurentides, and also to those of the Highlands of New York and New Jersey, a resemblance which extends to the gneissic rocks which in these various regions accompany the crystalline limestones. I, at that time, accepted without examination the view maintained by Mather and H. D. Rogers, that these limestones in southern New York and New Jersey were altered Silurian strata, although mineralogically identical with those farther north of undoubted Laurentian age. Led by this conclusion to attach comparatively little importance to mineralogical and lithological resemblances, and guided by other considerations given in the paper just referred to, I then suggested that the crystalline limestones and their accompanying rocks in north-eastern Massachusetts might probably be of Devonian age. The subsequent investigations of Hall, Logan and Cooke in the Highlands of New York and New Jersey have however left no doubt that these supposed altered Silurian rocks are really of Laurentian age, and led me to suspect that the same might be the case with those of eastern Massachusetts. This view, which was shared by Prof. James Hall, I ventured to put forward at the meeting of the American Association for the Advancement of Science at Salem in August, 1869, when I showed that it was probable, not only on lithological grounds, but from the fact that the Laurentian rocks appear to the southward of the great palæozoic basin in New Brunswick and Newfoundland, which are geologically but a north-eastern prolongation of New England, and moreover from the outcropping of the lowest Silurian strata at Braintree, near Boston. A few days later I visited Newburyport, and in company with Dr. Henry C. Perkins of that place, had, for the first time, an opportunity of observing the gneisses and limestones in question. Their aspect confirmed my suspicion of their Laurentian age, and led me to suggest to him the propriety of searching for *Eozoon Canadense* in the limestone which there occurs mingled with serpentine. Specimens of it were thereupon placed in the hands of Mr. Bicknell of Salem, well known as a skilled microscopist, and shortly after it was announced by Dr. Perkins that Mr. Bicknell had discovered in them the Eozoon. This notice, which appeared in September in a Newburyport journal, is reproduced in the American Naturalist for November. My own specimens collected in August last near Newburyport, at the locality known as the Devil's Den, did not, however, furnish any traces of Eozoon, and I may here remark that I had already, so long ago as 1864, caused slices to be made of a specimen of limestone from that locality, which were then examined by Dr. Dawson with negative results. In November, however, Mr. Bicknell visited Newburyport and got from a quarry, about a quarter of a mile distant from the place just mentioned, specimens of a serpentinic limestone in which he again found Eozoon. Slices which he has kindly sent me have also been examined by Dr. Dawson, who confirms Mr. Bicknell's observation, and finds in them *Eozoon Canadense,* though fragmentary and not very well preserved. The tubuli, as in the specimens from Grenville, are injected with serpentine, and may be seen on etched surfaces as well as in transparent slices. A crystalline mineral is however abundantly disseminated in the limestone, and unskilled observers might have difficulty in recognizing the fossil.

Another locality, about twenty-eight miles to the south-westward of Newburyport, has however, afforded me much better specimens. In company with Mr. L. S. Burbank of Lowell, a zealous and successful teacher of geology and mineralogy, I visited in October last the limestone quarries of Chelmsford, some five miles from Lowell. This limestone and its accompanying gneiss closely resemble the Laurentian rocks of other regions, and scapolite, apatite and serpentine occur as associated minerals, though the latter was rare in the quarries then visited. A few days afterward Mr. Burbank kindly sent me specimens of a mixture of limestone and yellowish-green serpentine from another quarry in the vicinity, which I had been unable to visit, and these have proved to be rich in *Eozoon Canadense.* The continuous and complete calcareous skeleton of the fossil does not appear in these specimens, which seem like some portions of the rock from Grenville, as described by Sir W. E. Logan, to be made up of fragments of the calcareous shell of Eozoon, mingled with grains of serpentine, and cemented by crystalline carbonate of lime. In the specimens from Grenville, and from most other localities, the mineral matter replacing the sarcode and filling up the canals and tubuli in the calcareous Eozoon skeleton, is generally serpentine or some other silicate. Both Dawson and Carpenter, however, it will be recollected, found that in the fragmentary Eozoon from Madoc, and in some small portions from Grenville, the injected mineral was, like the shell itself, pure carbonate of lime, though readily distinguishable by differences in texture and transparency from the shell. Such is also the case with all the Chelmsford specimens yet examined, which abound in fragments of shell exhibiting in a very beautiful manner the cylindrical diverging and branching tubuli. The accompanying serpentine is disseminated in grains, but has no connection with the organic forms, so that, unlike the specimens in which it is the injecting mineral, the structure of these cannot be brought out by etching with acids.

These specimens from Chelmsford, it shouldbe said, have been examined and satisfactorily identified by Dr. Dawson. The argument from mineralogical resemblances in favor of the Laurentian age of the limestone in question is therefore now supported by the undoubted presence in them of *Eozoon Canadense*. In this connection it should be said that the crystalline rocks of Newburyport and Salisbury, though separated in Hitchcock's geological map from the gneisses to the south-west, and united to the syenites of Gloucester and Rockport, seem to me very unlike the latter, and closely related lithologically to the gneiss of Chelmsford, which encloses the crystalline limestone. The crystalline limestones occurring with gneissic rocks near Providence, Rhode Island, merit a careful examination for Eozoon, inasmuch as from their lithological characters they may with probability be supposed to be of Laurentian age.

Montreal, Dec. 12, 1870.

METEOROLOGICAL RESULTS FOR MONTREAL FOR THE YEAR 1869.

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

The following Meteorological Report is condensed from the records of the Montreal Observatory, lat. 45° 31 N., long. 4h. 54′ 17″ West of Greenwich. The cisterns of the barometers are 182 feet above the mean sea level.

The readings are corrected for any instrumental errors, and those of the barometer have been reduced to 32 F.

Atmospheric Pressure.—The highest reading of the barometer occurred at 7 A.M. 1st January, and indicated 30.390 inches. The lowest reading was at 6 A.M. on the 4th February, and was 28.841 inches, giving an annual range of 1.549 inches.

The following table shows the highest and lowest reading for each month in inches :—

	January.	February.	March.	April.	May.	June.
Highest	30·390	50·251	30·201	29·967	29·812	30·201
Lowest	29·129	29·841	29·100	29·042	28·842	29·298
	July.	**August.**	**September**	**October.**	**November**	**December**
Highest	30·000	30·352	30·375	30·249	30·462	30·643
Lowest	29·275	29·650	29·549	29·349	29·151	29·375

Temperature of the Air F.°—The highest reading of the thermometer during the year was on the 26th July, when it was 84°4. The lowest reading was on the 1st March, and was —9°9 (below zero), giving a range or climatic difference of 94°3, which shows a difference minus of 26°8 compared with the observations of 1868.

The mean temperature for the year was 42°93, which is nearly four-tenths of a degree higher than the mean annual temperature for Montreal.

Below is a table showing the monthly mean, also the highest and lowest temperature for each month, with the amount of rain and snow :—

Months.	Mean Temper'ture in F.°	Highest Temper'ture	Lowest Temper'ture	Rain. Depth in Inches.	Snow. Depth in Inches.
January	20°13	45°9	—4°0	0.233	28.07
February	19°44	38°9	—5°4	None	73·76
March	24°06	53°2	—9°9	1·118	14·07
April	41°00	66°2	29°0	1·107	1·93
May	52°96	78°9	32°6	2·855	3·14
June	58°84	81°0	45°2	4·000	....
July	68.51	84°4	52°0	4·995	....
August	65.66	85°7	51°0	8·675	....
September	65°55	76°1	55°9	4·096	Inapp.
October	46°13	82°0	24°7	6·827	6·49
November	30°28	66°2	11°1	0·655	13·96
December	22°88	40°7	—2°3	1·004	25·95

The following table shows the mean temperature and the amount of precipitation for each quarter :—

	Months.	Temper'ture		Rain.	Snow.
Winter Quarter.	December	16°00	....	Inapp.	27·96
	January	20°13	....	0.223	28.07
	February	19°44	....	None	73·76
	Mean	18.52	Amount..	0.223	129·79
Spring Quarter.	March	24°06	....	1.118	14.07
	April	41°00	....	1.107	1·93
	May	52°96	....	2.855	3·41
	Mean	39°34	Amount..	5.080	19.11
Summer Quarter.	June	58°84	....	4.000	....
	July	68°31	....	4.995	....
	August	65°66	....	8.675	....
	Mean	60°93	Amount..	17.670	....
Autumn Quarter.	September	65°53	....	4.096	Inapp.
	October	46°13	....	6.827	6.49
	November	30°25	....	0.655	13·96
	Mean	47°30	Amount..	11·578	20.48

Rain fell on 86 days, amounting to 35.545 inches. A very heavy storm, accompanied by loud thunder and vivid lightning, occurred on the night of the 19th-20th of August, and the large amount of 3-782 inches of rain fell in 6 hours 15 minutes.

Snow fell on 76 days, amounting to 167.37 inches. This large amount includes the heavy fall of February. The first snow of autumn fell on the 27th September, in inappreciable quantity. Winter fairly set in on the 4th of December.

Wind.—The most prevalent wind during the year was the N.E. The next in frequency, the W. The least prevalent wind was the S.E.

There were 128 clear nights suitable for astronomical purposes. This is about the usual average.

The Aurora Borealis was visible frequently during the year, but was not accompanied by any grand display.

The meteoric shower of 13th-14th November was rendered invisible by cloudy weather.

The partial eclipse of the moon on the 27th January could not be well observed, owing to clouds and hazy weather.

The solar eclipse of the 7th August, which was only partial at Montreal, was visible, and furnished some interesting phenomena.

ON THE GRAPHITE OF THE LAURENTIAN OF CANADA.

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

(From the Quarterly Journal of the Geological Society for Feb., 1870.)

In my paper of 1864, on the Organic Remains of the Laurentian Limestones of Canada, as a sequel to the description of *Eozoon Canadense*, I noticed, among other indications of organic matters in these limestones, the presence of films and fibres of graphitic matter, and insisted on the probability that at least some of the lower forms of plant life must have existed in the seas in which gigantic Foraminifera could flourish. Dr. Hunt had previously, on chemical evidence, inferred the existence of Laurentian vegetation*, and Dana had argued as to the proba-

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* "American Journal of Science" (2), xxxi. p. 395. From this article, written in 1861, after the announcement of the existence of laminated forms supposed to be organic in the Laurentian, by Sir W. E. Logan, but before their structure and affinities had been ascertained, I quote the following sentences:—"We see in the Laurentian series beds and veins of metallic sulphurets, precisely as in more recent formations; and the extensive beds of iron-ore, hundreds of feet thick, which abound in that ancient system, correspond not only to great volumes of strata deprived of that metal, but, as we may suppose, to organic matters which, but for the then great diffusion of iron-oxyd in conditions favourable for their oxydation, might have formed deposits of mineral carbon far more extensive than those beds of plumbago which we actually meet in the Laurentian strata. All these conditions lead us then to conclude the existence of an abundant vegetation during the Laurentian period."

Since the above note was printed in the Quarterly Journal, I have ascertained that it is innacurate as to dates: Dr. Hunt having, in May 1858, before the discovery of *Eozoon Canadense*, asserted, in an article in the Amer. Journal of Science (xxv. 436), that "the presence of iron ores, not less than that of graphite, points to the existence of organic life even during the Laurentian or so-called Azoic period." The same argument will be found in more detailed form, in his papers Quar. Jour.

bility of this on various grounds*; and my object in referring to these indications in 1864, as well as to the supposed burrows of annelids, subsequently described by me †, was to show that the occurrence of *Eozoon* was not to be regarded as altogether isolated and unsupported by probabilities of the existence of organic remains in the Laurentian, deducible from other considerations.

Now that the questions which have been raised regarding *Eozoon* may be considered settled, not only by the adhesion of the greatest authorities in palæontology and zoology, but by the discovery of similar organisms in rocks of the same age elsewhere, by specimens preserved in such a manner as to avoid all the objections raised to the mineral condition of the fossil ‡, and by the discovery of such modern analogies as that furnished by *Bathybius*, it may be proper to invite the attention of geologists more particularly to the evidence of vegetable life afforded by the deposits of graphite existing in the Laurentian.

The graphite of the Laurentian of Canada occurs both in beds and in veins, and in such a manner as to show that its origin and deposition are contemporaneous with those of the containing rock. Dr. Sterry Hunt states § that "the deposits of plumbago generally occur in the limestones or in their immediate vicinity, and granular varieties of the rock often contain large crystalline plates of plumbago. At other times this mineral is so finely disseminated as to give a bluish-gray colour to the limestone, and the distribution of bands thus coloured, seems to mark the stratification of the rock." He further states:—"The plumbago is not confined to the limestone; large crystalline scales of it are occasionally disseminated in pyroxene rock or pyrallolite, and

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Geol. Society, 1859, p. 493, Amer. Jour. Science, July 1860 (xxx., 134, as well as in the last-named Journal for May 1866, as quoted above.—J. W. D.

* Manual of Geology. I may also be permitted to refer to my own work "Archaia," p. 168, and Appendix D, 1860.

† Quart. Journ. Geol. Soc. vol. xxii. p. 608.

‡ I cannot, after examination of the specimen, and of others subsequently obtained by Sir W. E. Logan, attach any value to the supposition of Messrs. Rowney and King, that the Tudor specimen has been produced by infiltration of carbonate of lime into veins. The mechanical arrangement of the laminæ and their microscopic structure forbid such a supposition, as well as the comparison of them with the actual calcareous veins occurring in the same rock.

§ "Geology of Canada," 1863, p, 529; and Report for 1866, pp. 218–223.

sometimes in quartzite and in feldspathic rocks, or even in magnetic oxide of iron." In addition to these bedded forms, there are also true veins in which graphite occurs associated with calcite, quartz, orthoclase, or pyroxene, and either in disseminated scales, in detatched masses, or in bands or layers "separated from each other, and from the wall rock by feldspar, pyroxene, and quartz." Dr. Hunt also mentions the occurrence of finely granular varieties, and of that peculiarly waved and corrugated variety simulating fossil wood, though really a mere form of laminated structure, which also occurs at Warrensburgh, New York, and at the Marinski mine in Siberia. Many of the veins are not true fissures, but rather constitute a net-work of shrinkage cracks or segregation veins traversing in countless numbers the containing rock, and most irregular in their dimensions, so that they often resemble strings of nodular masses. It has been supposed that the graphite of the veins was originally introduced as a liquid hydro-carbon. Dr. Hunt, however, regards it as possible that it may have been in a state of aqueous solution* at a heat approaching ignition; but in whatever way introduced, the character of the veins indicates that in the case of the greater number of them the carbonaceous material must have been derived from the bedded rocks traversed by these veins, while there can be no doubt that the graphite found in the beds has been deposited along with the calcareous matter or muddy and sandy sediment of which these beds were originally composed.

The quantity of graphite in the Lower Laurentian series is enormous. In a recent visit to the township of Buckingham, on the Ottawa River, I examined a band of limestone believed to be a continuation of that described by Sir W. E. Logan as the Green Lake Limestone. It was estimated to amount, with some thin interstratified bands of gneiss, to a thickness of 600 feet or more, and was found to be filled with disseminated crystals of graphite and veins of the mineral to such an extent as to constitute in some places one-fourth of the whole; and making every allowance for the poorer portions, this band cannot contain in all a less vertical thickness of pure graphite than from 20 to 30 feet. In the adjoining township of Lochaber Sir W. E. Logan notices a band from 25 to 30 feet thick, reticulated with graphite veins to such an extent as to be mined with profit for the mineral. At another

* "Report of the Geological Survey of Canada,' 1866, p. 233.

place in the same district a bed of graphite from 10 to 12 feet thick, and yielding 20 per cent. of the pure material, is worked. When it is considered that graphite occurs in similar abundance at several other horizons, in beds of limestone which have been ascertained by Sir W. E. Logan to have an aggreate thickness of 3500 feet, it is scarcely an exaggeration to maintain that the quantity of carbon in the Laurentian is equal to that in similar areas of the Carboniferous system. It is also to be observed that an immense area in Canada appears to be occupied by these graphitic and *Eozoon*-limestones, and that rich graphitic deposits exists in the continuation of this system in the state of New York, while in rocks believed to be of this age near St. John, New Brunswick, there is a very thick bed of graphitic limestone, and associated with it three regular beds of graphite, having an aggregate thickness of about five feet.*

It may fairly be assumed that in the present world and in those geological periods with whose organic remains we are more familiar than with those of the Laurentian, there is no other source of unoxidized carbon in rocks than that furnished by organic matter, and that this has obtained its carbon in all cases, in the first instance, from the deoxidation of carbonic acid by living plants. No other source of carbon can, I believe, be imagined in the Laurentian period. We may, however, suppose either that the graphitic matter of the Laurentian has been accumulated in beds like those of coal, or that it has consisted of diffused bituminous matter similar to that in more modern bituminous shales and bituminous and oil-bearing limestones. The beds of graphite near St. John, some of those in the gneiss at Ticonderoga in New York, and at Lochaber, Buckingham, and elsewhere in Canada are so pure and regular that one might fairly compare them with the graphitic coal of Rhode Island. These instances, however, are exceptional, and the greater part of the disseminated and vein graphite might rather be compared in its mode of occurrence to the bituminous matter in bituminous shales and limestones.

We may compare the disseminated graphite to that which we find in those districts of Canada in which Silurian and Devonian

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* Matthew in "Quart. Journ. Geol. Soc.," vol. xxi. p. 423. "Acadian Geology, p. 662."

† Granby, Melbourne, Owl's Head, &c., "Geology of Canada," 1863, p. 529.

bituminous shales and limestones have been metamorphosed and converted into graphitic rocks not dissimilar to those in the less altered portions of the Laurentian.† In like manner it seems probable that the numerous reticulating veins of graphite may have been formed by the segregation of bituminous matter into fissures and planes of least resistance, in the manner in which such veins occur in the modern bituminous limestones and shales. Such bituminous veins occur in the Lower Carboniferous limestone and shale of Dorchester and Hillsborough, New Brunswick, with an arrangement very similar to that of the veins of graphite; and in the Quebec rocks of Point Levi, veins attaining to a thickness of more than a foot, are filled with a coaly matter having a transverse columnar structure, and regarded by Logan and Hunt as an altered bitumen. These palæozoic analogies would lead us to infer that the larger part of the Laurentian graphite falls under the second class of deposits above mentioned, and that, if of vegetable origin, the organic matter must have been thoroughly disintegrated and bituminized before it was changed into graphite. This would also give a probability that the vegetation implied was aquatic, or at least that it was accumulated under water.

Dr. Hunt has, however, observed an indication of terrestrial vegetation, or at least of subaerial decay, in the great beds of Laurentian iron-ore. These, if formed in the same manner as more modern deposits of this kind would imply the reducing and solvent action of substances produced in the decay of plants. In this case such great ore beds as that of Hull, on the Ottawa, 70 feet thick, or that near Newborough, 200 feet thick*, must represent a corresponding quantity of vegetable matter which has totally disappeared. It may be added that similar demands on vegetable matter as a deoxidizing agent are made by the beds and veins of metallic sulphides of the Laurentian, though some of the latter are no doubt of later date than the Laurentian rocks themselves.

It would be very desirable to confirm such conclusions as those above deduced by the evidence of actual microscopic structure. It is to be observed, however, that when, in more modern sediments, Algæ have been converted into bituminous matter, we cannot ordinarily obtain any structural evidence of the origin of such bitumen, and in the graphitic slates and lime-

* "Geology of Canada," 1863.

stones derived from the metamorphosis of such rocks no organic structure remains. It is true that, in certain bituminous shales and limestones of the Silurian system, shreds of organic issue can sometimes be detected, and in some cases, as in the Lower Silurian limestone of the La Cloche mountains in Canada, the pores of brachiopodous shells and the cells of corals have been penetrated by black bituminous matter, forming what may be regarded as natural injections, sometimes of much beauty. In correspondence with this, while in some Laurentian graphitic rocks, as, for instance, in the compact graphite of Clarendon, the carbon presents a curdled appearance due to segregation, and precisely similar to that of the bitumen in more modern bituminous rocks, I can detect in the graphitic limestone occasional fibrous structures which may be remains of plants, and in some specimens vermicular lines, which I believe to be tubes of *Eozoon* penetrated by matter once bituminous, but now in the state of graphite.

When palæozoic land-plants have been converted into graphite, they sometimes perfectly retain their structure. Mineral charcoal, with structure, exists in the graphitic coal of Rhode Island. The fronds of ferns, with their minutest veins perfect, are preserved in the Devonian shales of St. John, in the state of graphite; and in the same formation there are trunks of Conifers (*Dadoxylon onangondianum*) in which the material of the cell-walls has been converted into graphite, while their cavities have been filled with calcareous spar and quartz, the finest structures being preserved quite as well as in comparatively unaltered specimens from the coal-formation.* No structures so perfect have as yet been detected in the Laurentian, though in the largest of the three graphitic beds at St. John there appear to be fibrous structures, which I believe may indicate the existence of land-plants. This graphite is composed of contorted and slickensided laminæ, much like those of some bituminous shales and coarse coals; and in these there are occasional small pyritous masses which show hollow carbonaceous fibres, in some cases presenting obscure indications of lateral pores. I regard these indications, however, as uncertain; and it is not as yet fully ascertained that these beds at St. John are on the same geological horizon with the Lower Laurentian of Canada, though they certainly underlie the Primordial series of the Acadian

* "Acadian Geology," p. 535. In calcified specimens the structures remain in the graphite after decalcification by an acid.

group, and are separated from it by beds having the character of the Huronian.

There is thus no absolute impossibility that distinct organic tissues may be found in the Laurentian graphite, if formed from land-plants, more especially if any plants existed at that time having true woody or vascular tissues; but it cannot with certainty be affirmed that such tissues have been found. It is possible, however, that in the Laurentian period the vegetation of the land may have consisted wholly of cellular plants, as, for example, mosses and lichens; and if so, there would be comparatively little hope of the distinct preservation of the forms or tissues, or of our being able to distinguish the remains of land-plants from those of Algæ.

We may sum up these facts and considerations in the following statements:—First, that somewhat obscure traces of organic structure can be detected in the Laurentian graphite; secondly, that the general arrangement and microscopic structure of the substance corresponds with that of the carbonaceous and bituminous matters in marine formations of more modern date; thirdly, that if the Laurentian graphite has been derived from vegetable matter, it has only undergone a metamorphosis similar in kind to that which organic matter in metamorphosed sediment of later age has experienced; fourthly, that the association of graphitic matter with organic limestone, beds of iron ore, and metallic sulphides greatly strengthens the probability of its vegetable origin; fifthly, that when we consider the immense thickness and extent of the Eozoonal and graphitic limestones and iron-ore deposits of the Laurentian, if we admit the organic origin of the limestone and graphite, we must be prepared to believe that the life of that early period, though it may have existed under low forms, was most copiously developed, and that it equalled, perhaps surpassed, in its results, in the way of geological accumulation, that of any subsequent period.

In conclusion, this subject opens up several interesting fields of chemical, physiological, and geological inquiry. One of these relates to the conclusion stated by Dr. Hunt as to the probable existence of a large amount of carbonic acid in the Laurentian atmosphere, and of much carbonate of lime in the seas of that period, and the possible relation of this to the abundance of certain low forms of plants and animals. Another is the comparison already instituted by Professor Huxley and Dr. Carpenter, between the conditions of the Laurentian and those of the deeper parts of the modern ocean. Another is the possible occurrence of other forms of animal life than *Eozoon* and Annelids, which I have stated in my paper of 1864, after extensive microscopic study of the Laurentian limestones, to be indicated by the occurrence of calcareous fragments, differing in structure from *Eozoon*, but at present of unknown nature. Another is the effort to bridge over, by further discoveries similar to that of the *Eozoon bavaricum* of Gümbel, the gap now existing between the life of the Lower-Laurentian and that of the Primordial Silurian or Cambrian period. It is scarcely too much to say that these inquires open up a new world of thought and investigation, and hold out the hope of bringing us into the presence of the actual origin of organic life on our planet, though this may perhaps be found to have been Prelaurentian. I would here take the opportunity of stating that, in proposing the name *Eozoon* for the first fossil of the Laurentian, and in suggesting for the period the name "Eozoic," I have by no means desired to exclude the possibility of forms of life which may have been precursors of what is now to us the dawn of organic existence. Should remains of still older organisms be found in those rocks now known to us only by pebbles in the Laurentian, these names will at least serve to mark an important stage in geological investigation.

NOTE ON THE GENUS EOPHYTON.

Until within a few years, the oldest known land plants were a few Lycopodiaceans, forms from the upper part of the Upper Silurian. Recently Barrande and Geinitz have announced land plants probably Lycopodiaceans from olden Silurian beds. Still more lately Torell has described, from Cambrian or Primordial rocks in Sweden, a plant, or supposed plant, which he has named *Eophyton Linnæanum*. The drawings and descriptions, however, render it very doubtful whether this is not merely a cast of scratches or workings of unknown origin, similar to those which are very abundant on Carboniferous and Silurian rocks in Eastern America, and which have often been described as fucoids. Mr. Hicks has, however, recently described in the *Geol. Magazine*, Dec., 1869, a fossil from the Lower Arenig rocks of Wales. This plant is a striated stem, showing a very coarse tubular tissue, comparable with that of *Nematœzla* or *Prototoxites* of the

Devonian, and perhaps indicates a plant of somewhat high organization. Whether it has any affinity with the *Eophyton* of Torell is more than doubtful. It is thus described by Mr. Hicks :—

" As none of the figures hitherto given of the genus *Eophyton* show either its internal structure or articulations of its stems, and as I am in possession of a specimen from the Lower Arenig rocks of Ramsey Island, near St. David's, which resembles in some respects the *Eophyton Linnæanum* Torell, but which shows both articulations of the stem, and an internal vascular structure, a description of the species may probably be useful, and may tend to elucidate the true nature of *Eophyton*, concerning which so much doubt seems to exist at present.

" There can be no reasonable doubt of the vegetable nature of this fossil, and I think its affinity to the vascular Cryptogams is most clearly shewn.

" These Lower Arenig rocks, from whence the specimen was obtained, rest apparently quite conformable on Upper Lingula-flags,* and underlie the true Arenig or Skiddaw rocks. Nearly all the species obtained from these beds are new, and they indicate a fauna intermediate between Tremadoc rocks and the true Arenig rocks. Indeed, in the report to the British Association, by Mr. Salter and myself, in 1866, they were classed as Tremadoc rocks; but I have since thought it advisable to separate them and to place them in an intermediate position. The Brachiopoda from these rocks have been described by Mr. Davidson (*Geol. Mag.*, Vol. V. p. 303), but all the other species are yet undescribed.

" *Eophyton* (?) *explanatum*, n.sp.—A raised, moderately convex stem, about four lines in breadth; widening, however, and becoming somewhat compressed at the joints. The surface is ribbed, and furrowed along its whole length. At the lower joint the ribs bend outwards, evidently to form a branch. The joint is obliquely placed, widened out, and its course distinctly marked by a deep sulcus. The cortical substance is very thin, and can be removed to shew the internal structure. The internal

* So marked in the Geological Survey Maps. I am inclined, however, to think that they are representatives of the Tremadoc rocks, for *Ling. Davisii*, which is the only fossil present, is equally characteristic of Tremadoc rocks, and reaches here also into these Lower Arenig rocks.

structure is made up of compressed columns, running the whole length from joint to joint, evidently of a tabular nature, and bound together by very thin tissue. At the base of the stem, the broken ends are visible.

"Unless *Eophyton Linnæanum* is proved to have a jointed stem and an internal structure similar to our specimen, it will probably be necessary to make a generic distinction; but at present it is better to retain this under Dr. Torell's generic name."

CONTRIBUTIONS TO CANADIAN METEOROLOGY.

Compiled from the Records of the Isle Jesus and Montreal Observatories.

By CHARLES SMALLWOOD, M.D., LL.D., D.C.L., Professor of Meteorology in the University of McGill College, Montreal.

The following table has been drawn up for the purpose of showing the respective dates of the setting in and of the breaking up of our Canadian winters for the past twenty-one years, and for illustrating the climatology of Montreal and its vicinity.

The first column gives the years from 1849 to 1869 inclusive; The second shows the time of the first fall of snow in autumn in however small quantities. This amount, as a general rule, does not exceed a quarter of an inch in depth on the surface, and invariably disappears, lasting but a very short time, and, in some cases, only a few minutes. The third column shows the date, and the fourth the amount in inches of the heavier snow fall. This snow very seldom entirely disappears; traces may be seen in sheltered places and on the hills and mountains. The dates in the fifth and sixth columns shows the days of the first frost of autumn, and the earliest date that the thermometer marks 32° F. These dates may seem somewhat anomalous, inasmuch as the descent of the thermometer to 32° F., (the freezing point,) and the first frost of autumn, do not in all cases coincide. This difference is owing to several causes, such as terrestrial radiation, amount of clouds, direction and velocity of the wind, and the humid state of the atmosphere. The effect of the first frost of autumn is generally perceived on the leaves and flowers of plants, and although, in some cases, the thermometer has marked 32° F., frost has not perceptibly affected vegetation, owing to some of the causes above mentioned. The seventh column gives the date of the last fall of snow, without reference to quantity, which is sometimes very small. The eighth column shows the respective dates at which the thermometer stood at 32° F. for the last time in spring, and is a near approximation to the last frost, but as vegetation is not so prolific in spring, the effects on flowers and plants are not so well marked as in the autumn, although occasionally late frosts have proved very injurious to fruit trees and early vegetables. The ninth column is intended to show the dates when winter may be said to have fairly set in, for the ground is then frozen to some depth, and may also be covered with some snow. The ditches are then full from the previous autumnal rains, and are frozen over, as well as the small rivers, and loads are crossing on the ice, all out-door work is, consequently, suspended. The tenth and last column gives the date at which the ice left the River St. Lawrence, in front of the city, the river being clear of ice. The arrival of steamers and small sailing vessels generally occurs in a very short time afterwards,—sometimes the same day.

1	2	3	4	5	6	7	8	9	10
Years.	First Snow of Autumn in comparatively Inappreciable Quantities.	First Snow of Autumn in Appreciable Quantities.	Depth in Inches.	First Frost of Autumn.	Date of First Descent of Thermometer to 32° F.	Last Snow of Spring.	Date of Last Descent of Thermometer to 32° F.	Winter fairly set in.	Date of the Ice leaving the St. Lawrence in Front of the City of Montreal.
1849	Nov. 27	Dec. 1	2.00	Oct. 15	Oct. 6	Apr. 13	Apr. 18	Dec. 10	Apr. 7
1850	" 17	Nov. 18	2.14	" 14	" 14	" 14	" 20	" 7	" 9
1851	Oct. 25	" 15	1.50	" 2	" 16	" 8	" 14	Nov. 21	" 9
1852	" 17	" 11	1.20	Sept. 17	Sept. 29	" 16	" 24	Dec. 18	" 19
1853	" 24	Oct. 24	2.00	" 12	" 30	" 14	May 1	" 17	" 24
1854	" 15	Nov. 17	1.10	" 11	" 11	" 30	" 7	" 4	" 25
1855	" 24	" 17	2.74	Aug. 9	" 29	" 11	" 10	" 23	" 28
1856	Nov. 1	" 25	1.30	" 26	Oct. 4	May 31	" 6	Nov. 29	" 24
1857	Oct. 20	" 16	2.01	Sept. 7	Sept. 30	Apr. 27	" 14	Dec. 21	" 18
1858	Nov. 4	" 13	3.25	Aug. 25	Oct. 23	" 21	" 14	" 20	" 9
1859	Oct. 20	Oct. 21	2.30	Oct. 7	" 8	" 23	Apr. 27	" 10	" 4
1860	Sept. 29	" 15	1.10	Sept. 3	Sept. 29	May 20	May 20	" 2	" 10
1861	Oct. 23	Nov. 3	0.32	" 5	Oct. 21	Apr. 17	" 4	" 21	" 24
1862	Nov. 10	" 26	1.84	Aug. 24	" 10	May 7	Apr. 27	" 19	" 23
1863	" 1[illegible]	" 26	1.94	Oct. 24	" 27	" 2	" 21	" 9	" 25
1864	Oct. 8	" 5	3.10	Sept. 26	" 29	Apr. 18	" 5	" 12	" 13
1865	" 28	Oct. 29	0.66	Oct. 21	" 23	" 20	" 19	" 22	" 10
1866	" 4	Dec. 6	0.80	Sept. 16	Sept. 24	May 3	May 2	" 16	" 19
1867	Nov. 5	Oct. 14	1.60	" 23	Nov. 3	" 2	" 4	" 1	" 22
1868	Oct. 17	" 21	4.92	Oct. 4	Oct. 17	Apr. 23	" 1	" 7	" 17
1869	Sept. 27	" 22	6.47	Sept. 28	" 20	May 3	Apr. 29	" 4	" 23

NOTES ON SOME OF THE PLANTS IN THE HERBARIA OF LINNÉ AND MICHAUX.

By DANIEL C. EATON, M.A., Professor of Botany in Yale College.

Prof. Eaton, of New Haven, U. S., the eminent American Pteridologist, when in Europe on a visit in 1866, examined many of the standard herbaria, and made notes on the American plants contained in them. He has most liberally placed a series of these notes on the North American Filices in my hands for perusal, has allowed me to take copies of them, and to print such selections from them as I might deem of sufficient interest: those relating to the collections of Linné, now in London, and of Michaux, in Paris, are here given. The herbarium name of each plant is placed within quotation marks, as is also such notes (of habitat, etc.) as were deemed of sufficient interest to be copied from the sheets to which the respective specimens were attached. Mr. Eaton's observations follow. I have not printed these *verbatim*, as, not being intended for publication, they were, more or less, made up of indications and signs which I have attempted to write out with exactness. One or two observations of my own are placed within brackets, and bear my initial. For convenience of reference I have arranged the species in the order of their occurrence in the Species Plantarum, and in the Flora Boreali-Americana. D. A. WATT.

THE LINNÆAN FILICES.

Notes made in the hall of the Linnean Society, London, August 7, 1866:—

"ONOCLEA SENSIBILIS"—one sterile frond and one fertile frond of the true plant.

"OSMUNDA PENSYLV."—a short sterile leaf of perhaps Struthiopteris or probably of *Osmunda Claytoniana;* veinlets once and twice forked, segments broad and round, the lowest pinnæ long as any. (It cannot be Struthiopteris, and perhaps is not Osmunda, but some Aspidium. D.C.E., anno 1870.)

"OSMUNDA LUNARIA"—consists of two fronds of our *Botry. lunarioides* and one frond *B. rutæfolium* (A. Braun)—the latter very much like the former, and (by its ticket) from Petropolis. There is no true Lunaria in the herbarium.

[It must be borne in mind that the ancients were very careless about their plants, and very careful about their books.

The Lunaria of the Sp. Pl. p. 1519 is unquestionably the species we now call by that name. It is, however, not a little singular that Linné should have had both the American and European forms of the *O. ternatum* of Thunberg without recognizing them as distinct from his Lunaria.—W.]

"OSMUNDA VIRGINIANA"—is the true *Botrychium virginianum*, one frond from Kalm (being marked "K") and one from Clayton (?) marked "Lunaria matricariæ-folio Clayt. n. 706."

OSMUNDA REGALIS—one unnamed frond from Kalm is put next to another that is marked *O. regalis*.

"OSMUNDA CLAYTONIANA"—two fronds of this species in which the fructification is *not terminal*, but the upper sterile pinnæ are unexpanded, as noted by Dr. Gray long ago, and recently by Dr. Milde.

"OSMUNDA CINNAMOMEA"—one fertile and one sterile frond from Kalm; very good.

"ACROSTICHUM POLYPODIOIDES"— is the *Polypodium incanum* of Swartz.

"ACROSTICHUM AUREUM"—very good.

ACROSTICHUM AREOLATUM—Sp. Pl. p. 1526, not found; the *Woodwardia angustifolia* of Smith is the plant described.

ACROSTICHUM PLATYNEURON—p. 1529, not found; the plant described is *Asplenium ebeneum*.

"ACROSTICHUM ILVENSE"—is our North American *Woodsia obtusa*.

[Here Linné appears to have confounded our particularly distinct *Woodsia obtusa* with his Ilvense, and to have missed describing another good North American species. There is no doubt that the Ilvense of his writings is that of modern botanists.—W.]

"ACROSTICHUM EBENEUM"—is *Gymnogramme calomelanos* small form, or possibly *G. tartarea*; a West Indian fern.

"PTERIS AQUILINA"—very good.

"PTERIS CAUDATA"—one frond, very delicate, is good caudata; one with very broad segments is a caudate but not uncommon form of aquilina.

"PTERIS ATROPURPUREA"—one frond from Kalm of our *Pellæa atropurpurea*.

"ASPLENIUM RHIZOPHYLLUM"—is Camptosorus from Kalm; three fronds from one root, and one frond with auricles $1\frac{1}{2}$–$2\frac{1}{2}$ inches long.

"Asplenium Trichomanes"—very good.

"Asplenium Ruta muraria"—very good.

Polypodium virginicum—not found.

"Polypodium Lonchitis"—is *Aspidium Lonchitis.* Not a North American specimen, as indeed are not several of the following:

"Polypodium auriculatum"—three fronds, one of which may be *Aspid. auriculatum* of Asia, one marked "Pennsylvania" is certainly our *Asplenium ebeneum,* and one marked "K" (Kalm) our *Aspidium acrostichoides.*

[Of all Prof. Eaton's notes this is the most remarkable, as showing a confusion of perfectly distinct species. The specimen of *Aspl. ebeneum* probably belongs to the *Acros. platyneuron* above quoted, while the distinction between *Aspid. auriculatum* and *A. acrostichoides* is very clear, although Swartz said of the latter, "nimium affine præcedenti."—W.]

"Polypodium Phegopteris"—three fronds of the true plant, and one of *Aspidium Thelypteris* marked "Pennsilv."

"Polypodium fragrans"—is *Aspidium fragrans;* very good.

"Polypodium fontanum"—is *Woodsia glabella,* 1½ inches high.

[It is indeed remarkable that Linné should have possessed this little fern so interesting to American botanists, known as European only within the last few years, and still more recently as Asiatic. In the Sp. Pl., p. 1550, he gives two localities:—Siberia, where *W. glabella* occurs; and Provence, in the south of France, whence the *Asplenium Halleri* of continental botanists (to which species his *P. fontanum* is commonly referred) might well have come. Although Linné's description indicates an Asplenium, we may, perhaps, hereafter have to write *Woodsia fontana! Asplenium Halleri* is confined to south Europe; *W. glabella* is circumpolar, and, while it scarcely occurs south of latitude 45°, has been found in Baffin's Bay nearly thirty degrees further north.—W.]

"Polypodium cristatum"—is *Aspidium cristatum,* fruiting.

"Polypodium Filix mas"—is one frond of very good *Aspidium Filix-mas,* and one, not marked, of *A. molle.*

"Polypodium Filix-fœmina"—is very good *Asplenium Filix-fœmina.*

"Polypodium aculeatum"—is very good *Aspidium aculeatum.*

"POLYPODIUM NOVEBORACENSE"— one frond having the lower part gone; it is not Thelypteris, but is probably our *Aspid. noveboracense;* it has simple veins, and is slightly pubescent.

"POLYPODIUM MARGINALE"—one frond of *Aspid. marginale.*

"POLYPODIUM BULBIFERUM"—one frond of *Cyst. bulbifera* marked "galley fer," a note quite inexplicable.

"POLYPODIUM FRAGILE"—is *Cyst. fragilis.*

"ADIANTUM PEDATUM"—two good fronds, "K" (Kalm).

MICHAUX'S FILICES.

Notes made in Paris, May 22, 1866. The species are arranged in the order in which they occur in the Flora Bor.-Amer. vol. ii., pp. 260–280. The names in the Flora sometimes differ from those of the Herbarium:—

"PTERIS LINEATA—sur les bords de la riv. Aisa-hatcha le 1er Avril Floride," is a Vittaria—the *V. angustifrons* of p. 261.

"PTERIS ATROPURPUREA—Am. septentrionale;" is our *Pellæa atropurpurea.*

"PTERIS GRACILIS—Rochers pres la Malbaye" is our *Pellæa gracilis.*

"PTERIS AQUILINA—Canada;" is the true plant.

ADIANTUM PEDATUM—not noticed.

"BLECHNUM BANISTERIANUM—Pluckn. tab. 179, fig. 2. Hab. in montib. Carolinæ" is a fragment of a sterile frond of *Osmunda cinnamomea;* it is the *Woodwardia B.* of page 263.

"BLECHNUM ONOCLEOIDES—Osmunda caroliniana *Walt.* in Carolinæ, Georgiæ;" is *Woodwardia angustifolia.*

BLECHNUM SERRULATUM—not noticed.

"ASPLENIUM RHIZOPHYLLUM—New Jersey" is *Camptosorus rhizophyllus.*

"ASPLENIUM TRICHOMANES — Canada, Pennsylv. Caroline hautes montag;" three small fronds of the true plant.

"ASPLENIUM TRICHOMANOIDES—hautes montagnes de Caroline, Pluckn. t. 89, fig. 8 et t. 287, fig. 2;" is *Aspl. ebeneum.*

"ASPLENIUM ANGUSTIFOLIUM—Moris. iii., § 14, t. 2, fig. 25, ad ripas Ohio;" one fertile frond of the true plant.

ASPLENIUM THELYPTERIOIDES—not noticed.

"ASPLENIUM ADIANTHUM NIGRUM—an varietas? minor, in montium rupibus Carolinæ septentrionalis;" is *Aspl. montanum.*

"ASPLENIUM RUTA MURARIA—in fissuris rupium montium excelsorum Carolinæ septentrionalis;" small specimens of the true plant.

"POLYPODIUM ACROSTICHOIDES — Pennsylvania, Carolina, Tennessee et Carol. maritim" is *Aspidium acrostichoides.*

"POLYPODIUM THELYPTERIOIDES — montibus Allegeni a Canadâ; Hab. in Canada et ad Carolinanum; Lac Champlain;" is *Aspid. Thelypteris*; a very small sterile frond on same page is doubtful, it may be *Asplenium Filix-fœmina.*

"POLYPODIUM MARGINALE—Kentucky, Pennsylvania, Nectoux;" is *Aspidium marginale.*

"POLYPODIUM PUNCTILOBULUM—Canada;" one frond of *Dicksonia punctilobula.*

"POLYPODIUM BULBIFERUM—in Canada;" two fronds of *Cyst. bulbifera.*

"POLYPODIUM FILIX-FŒMINA ?—in Canadâ, a rapporter a son esp." is *Asplenium Filix-fœmina,* and

"POLYPODIUM ASPLENIOIDES—a Novâ Angliâ ad Carolinam;" is the same species.

"POLYPODIUM CRISTATUM—Montib. Carolinæ ? et certe in Canada;" is one rather small frond of *Aspidium spinulosum.*

"POLYPODIUM TENUE—Quebec;" is one frond of *Cyst. fragilis.*

"POLYPODIUM RUFIDULUM—Hab. in rupibus Canadæ, Novæ Angliæ, et Novæ Cæsareæ;" is *Woodsia Ilvensis.*

"POLYPODIUM LANOSUM—Hab. in excelsis montibus saxosis Tennessee et Carolinæ septentrionalis;" is *Cheilanthes vestita* of Gray's Manual, five medium-sized fronds.

[Michaux's appears to be the earliest publication of this species; the next (with some doubt as to whether he does not refer to *Ch. tomentosa*) is that of K. Sprengel in Anleitung zur Kenntniss der Gewachse vol. iii. (1804) p. 122, who describes his species as follows:—

"Adiantum vestitum nenne ich eine Art, die Bosc d'Antic in Carolina fand. Sie hat einen 3-fath gefiederten Wedel, der über und über mit feinem wolligtem Haare bedeckt ist. Die Blättchen der iüii. Ordnung sind ei-lanzettförmig, die der letzten Ordnung sind linienförmig gekerbt und schlagen sich um die Samenhäufchen zurück. Bosc nannte diesen Farn Acrostichum hispidum." Where "Bosc named this fern" I have not been able to find out, nor can I see any reason why hispidum should have been changed into vestitum, for if Lamarck (the friend and biographer of Bosc) and Swartz be right, Sprengel did not even alter the genus. Bosc botanized in the Southern States between 1798 and 1800, Michaux more than ten years earlier, though his flora was not published until 1803. There is no good reason why the latter's name should not be restored, and the plant called *Ch. lanosa* (Michx), though long usage may justify a continuance of error.* It is remarkable that this somewhat common fern, which ranges from New York west to Illinois and south to the Carolinas and Georgia, should have been omitted from Sir Wm. Hooker's Species Filicum, the *Ch. vestita* of that work being the *Ch. gracilis* of Fée and Mettenius—the *Ch. lanuginosa* of Gray's Manual.—W.]

" Polypodium Dryopteris—juxta L'Assomption in Canada legi;" three fronds of the true plant.

" Polypodium vulgare—Moris. sect. 14, t. 2, f. 3, P. Virginiense minus, Hab. in arborib. a Canadâ ad Floridam ;" one frond of the true plant.

" Acrostichum polypodioides—Pluckn. t. 89, fig. 9, in arboribus Floride ;" is the *Polypodium incanum* of Swartz, the *Polyp. ceteraccinum* of p. 271.

" Polypodium hexagonopterum—Pluckn. t. 284, fig. 2, Hab. in Virginiâ, Carolinâ, terrestre ;" one good average-sized frond of our *Phegopteris hexagonoptera*.

" Polypodium connectile—Hab. in Canadâ ;" one good frond of *Pheg. polypodioides* with the lowest pinnæ *free*. [Polyp. Phegopteris *Linn*. Pheg. polypodioides *Fée*, Pheg. vulgaris *Metten*. or more correctly Pheg. connectile (*Michx*).—W.]

" Acrostichum aureum—sur la riv. Aisa-hatcha Floride ;" part of a fertile frond of the true plant.

" Onoclea sensibilis—Hab. a Novâ Angliâ ad . . . " and on a second sheet " Onoclea an sensibilis ?—? Connecticut ;" both are that species.

" Acrostichum ? nodulosum—Canada, juxta Montreal, legi ;" is *Struthiopteris Germanica*.

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* The synonyme of this plant is as follows :—

Polypodium lanosum *Michx* Herb.
Nephrodium lanosum *Michx* Flora ii. p. 279.
Adianthum ? hispidum *Bosc* ex *Lamarck* et *Swartz*.
Acrostichum ? hispidum *Bosc* ex *Sprengel*.
Adiantum vestitum *Sprengel* Anleit. iii. p. 122 ?
Aspidium lanosum *Swartz* Synopsis Filicum, p. 58, et
Cheilanthes vestita *Swartz* Syn. Fil. p. 128 ; *Schkuhr* Krypt. t. 124 ; *Gray's* Manual ed. 1st, p. 625 ; *Mettenius* Cheilanthes No. 27 ; *Hooker* and *Baker* Synopsis Filicum p. 134 ; etc.

" OSMUNDA REGALIS—Hab. a Novâ Angliâ ad Carolinum, Pluckn. tab. 181, f. 4;" is the true plant.

" OSMUNDA CINNAMOMEA—Baise Caroline;" is the true plant.

" OSMUNDA INTERRUPTA—Kentucky" and a second specimen with the same name marked "Canada;" are *O. Claytoniana.*

" OSMUNDA VIRGINICA—Moris. iii., sect. 14, tab. 4, fig. 5, a Canada ad Virginiam et in montibus Carolinæ;" is *Botrychium virginianum.*

" OSMUNDA LUNARIOIDES — in pascuis sabulosis juxta Charleston;" one specimen of the ordinary form *Botry. lunarioides;* a very small two-fronded specimen on another sheet is marked "Osmunda lunarioides? innominata au bord de monte a peine."

" CTEISIUM PALMATUM—Hab. in occidentalibus Virginiæ, Carolinæ septentrionalis ad Kentucky, Tennessee;" a good specimen of *Lygodium palmatum;* a second specimen is marked "Sur Obed river, Dady's creek et plusi. creeks a 25 miles de West Point sur Clinch river."

" OPHIOGLOSSUM VULGATUM—New Jersey;" the true plant.

" OPHIOGLOSSUM BULBOSUM—in sabulosis Carolinæ;" two small specimens slightly bulbous, one of them 2—3-fronded.

POLYPODIUM PLUMULA—One frond of this species is in the herbarium bearing no label.

These comprise all the Filices which are shewn as Michaux's, and kept separate from the general herbarium.

PURSH'S FILICES.

[I have Prof. Eaton's very full notes on the North American ferns contained in the Hookerian herbarium at Kew, from which I extract the following relating to one or two of Pursh's more obscure species. The references are to his Flora Americæ Septentrionalis, vol. ii. London, 1814.—W.]

"WOODSIA HYPERBOREA"—(p. 660) is the normal form of *W. Ilvensis.*

"ASPIDIUM NOVEBORACENSE"—(p. 661) is *A. Thelypteris;* it was contained in the species cover of *Asplenium thelypteroides.*

"ASPIDIUM FILIX-MAS"—(p. 662) was included in the species cover of *Aspidium Goldieanum,* and consisted of a mixture of that species and *A. cristatum.*

"ASPIDIUM ASPLENIOIDES"—(p. 664) is good *Asplenium Filix-fœmina,* and

"ASPIDIUM FILIX-FŒMINA"—is the same species mixed with *Cyst. bulbifera.*

"WOODWARDIA VIRGINICA"—(p. 670) is the true plant from New Jersey.

"WOODWARDIA THELYPTERIOIDES"—(p. 670) consists of a smallish frond of *W. Virginica*, and one of *Aspidium Thelypteris.*

ON NORITE OR LABRADORITE ROCK.

By T. STERRY HUNT, LL.D., F.R.S.

[Read before the American Association for the Advancement of Science, at Salem, August, 1869.]

(*From Silliman's Journal for March,* 1870.)

The various rocks composed essentially of a triclinic or anorthic feldspar, with an admixture of hornblende, pyroxene, hypersthene or diallage, have by lithologists been designated by the names of diorite, dolerite diabase, hypersthenite and gabbro, among others. The latter name has by many been regarded as synonymous with euphotide. I, however, pointed out many years since that the true euphotide is not a feldspathic rock, but consists of a mixture of diallage with saussurite, a white heavy silicate apparently identical with zoisite. By an admixture of labradorite or an allied feldspar, however, euphotide passes into the so-called gabbro, which I have defined as a diallagic diabase, and which is closely related to norite. The name of hypersthene rock or hypersthenite (sometimes contracted into hyperite), was given by MacCulloch* to a rock consisting of labradorite, or a related feldspar, and hypersthene, found by him in the Western Islands of Scotland, and subsequently recognized by Emmons in the Adirondack Mountains of Northern New York. By both of these observers it was regarded as an erupted rock. In 1851, I detected it among the Laurentide hills of Canada, where, as in New York, it extends over considerable areas. Farther examinations of this rock in place showed that though hypersthene, generally in very small proportion, is a frequent element, it is often replaced by a green granular pyroxene, and still more often both of these are wanting, so that we have a

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* MacCulloch, Geology of the Western Islands, i. 385-390.

rock composed almost entirely of a triclinic feldspar, whose composition is generally near that of labradorite, but varies in different examples from that of andesine to near that of anorthite. To these rocks I provisionally applied the name of anorthosites, the pure feldspathic type being regarded as normal anorthosite; associated with which, however, were to be found hypersthenic and pyroxenic varieties. Red garnet, epidote, a black mica, and more rarely dichroite and quartz, are all occasionally found sparingly disseminated in these anorthosites of New York and Canada, which cannot be distinguished from those first observed by MacCulloch in the Isle of Skye, as I have convinced myself by an examination of the specimens there collected by him, and now preserved in the collections of the Geological Society of London. Titaniferous iron ore (menaccanite) also occurs in grains and masses frequently in these rocks, both in Skye and in North America, where it sometimes forms beds or masses of considerable size. Details as to the chemical and mineralogical characters of these rocks, will be found in the L. E. & D. Philos. Magazine for May, 1855, and in the Geology of Canada, 1863, pages 588-590.

The subsequent investigations of Sir William Logan have shown that these anorthosites in Canada belong to a great series of stratified crystalline rocks, which by the Geological Survey of Canada have been designated the Labrador or Upper Laurentian series, and which repose unconformably upon the older or true Laurentian gneiss and limestones. The area of the Labrador formation most examined lies in the counties of Argenteuil and Terrebonne, to the north and northwest of Montreal, and has a breadth of more than forty miles. It is, however, met with on the north-east shore of Lake Huron, according to Dr. Bigsby,* and at several points below Quebec, notably in the parish of Château-Richer, at Bay St. Paul and around Lake St. John on the Saguenay, where it occupies a large area. Proceeding north-eastward along the left bank of the St. Lawrence, Mr. Richardson has lately observed it at the mouth of Pentecost River, about 160 miles below the entrance of the Saguenay, and I have found it forming the shore of the Bay of Seven Islands, forty miles farther down. This area is probably connected with the wide extent of this rock observed by Prof. Hind on the River Moisie. In all of these regions it appears to be surrounded and limited by the

* Geology of Canada, 1863, page 480.

ordinary Laurentian gneiss. Bayfield, moreover, describes a rock with a base of labradorite as forming the coast for several miles toward Mingan. Finally, it is widely spread on the coast of Labrador, where its characteristic mineral was first found, and from whence it takes its name.

Prof. A. S. Packard, Jr., has given us valuable information with regard to the occurrence of labradorite rocks at some points on the Labrador coast.* One of its localities is at Square Island, just north of Cape St. Michel, were the rock consists chiefly of crystalline labradorite, smoky-gray in color, translucent, and opalescent, with greenish reflections. This feldspar often shows cleavage planes two inches broad, and is associated with a little vitreous quartz, and with coarsely crystalline hypersthene, which appears in relief on the weathered surfaces. This labradorite rock, according to Prof. Packard, is surrounded by and probably rests upon Laurentian gneiss. At Domino Harbor he found domes or bosses of a similar labradorite resting upon strata which consist in great part of a slightly schistose quartzite, having for its base a granular vitreous quartz, and enclosing grains of black hornblende, or more rarely hypersthene, black mica, and red garnet. Feldspar is generally wanting, but in some parts these quartzites become gneissic, and they where nowhere seen in uncomfortable contact with the Laurentian gneiss of the vicinity. These quartzose strata Prof. Packard refers, with some doubt, to the Huronian system. The minerals which they contain are not, however, met with, so far as known, in the Huronian quartzites; and, on the contrary, are very characteristic of the quartzites of the Laurentian system, which attain a great thickness in many parts of its distribution. The overlying domes of labradorite rock, which Prof. Packard was inclined to regard, in this case, as erupted through Huronian quartzites, are probably nothing more than outlying portions of the newer Labrador formation resting upon the Laurentian strata, as already observed by him at Square Island. Along the western coast of the island of Newfoundland Mr. Jukes observed, at Indian Head and at York Harbor, dark colored rocks composed of labradorite and hypersthene and others on albite (?) and hypersthene, which may probably be found to belong to the Labrador series.

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* On the Glacial Phenomena of Labrador and Maine. Mem. Bost. Acad. Nat. Hist., vol. I., part ii.. pp. 214–217.

Rocks composed chiefly of labradorite or a related feldspar greatly predominate in the Labrador series, but these, at least in the area near Montreal, which is the one best known, are interstratified with beds of a kind of diabase, in which dark green pyroxene prevails, with crystalline limestone similar in mineralogical character to that of the Laurentian system, and more rarely with quartzites and thin beds of orthoclase gneiss. I have more than once insisted upon the rarity of free quartz, and the general basic character of the rocks of this series, an observation with which I am credited in Dana's Manual of Geology (p. 139), where it seems to be applied to the whole of the rocks there classed as Azoic, including the Laurentian, Labrador and Huronian systems. It is, in fact, remarkable that the silicated rocks of the latter two consist chiefly of labradorites, diorites and diabases; gneissic and granitic rocks being exceedingly rare among them, though quartzites abound in the Huronian. In the Laurentian system, on the contrary, though basic silicated rocks are not wanting, orthoclase gneisses, often granitoid in structure, and abounding in quartz, predominate.

The anorthosite rocks of the Labrador series present great variations in texture, being sometimes coarsely granitoid, and at other times finely granular. They not unfrequently assume the banded structure of gneiss, lines of pyroxene, hypersthene, garnet, titanic iron-ore or mica marking the planes of stratafication. Probably three-fourths of the anorthosites of this series, in Canada, whether examined in place, or in the boulders which abound in the St. Lawrence Valley, consist of pure or nearly pure feldspar rocks, in which the proportion of foreign minerals will not exceed five hundredths. Hence we have come to designate them by the name of labradorite rock. The colors of this rock are very generally some shade of blue, from bluish-black or violet to bluish-gray, smoky-gray or lavender, more rarely purplish passing into flesh-red, greenish-blue, and occasionally greenish or bluish-white. The weathered surfaces of these labradorite rocks are opaque white. The anorthosites, which occupy a considerable area in the Adirondack region, as described by Emmons in his report on the Geology of the Northern District of New York, and as seen by me in hand-specimens, closely resemble the rocks of the Labrador series in Canada.

In all of these localities the coarse or granitoid varieties often hold large crystalline cleavable masses, generally polysynthetic macles, and frequently exhibiting the peculiar opalescence which belongs to labradorite. Although rocks composed of labradorite or similar feldspars, with hornblende or pyroxene, occur in various other geological formations, both as indigenous greenstones and as erupted masses, they never, so far as my observation in North America goes, exhibit the peculiar character just described; namely, that of a granular or granitoid rock composed of nearly pure labradorite or some closely related feldspar, frequently opalescent, and generally of a bluish color, often violet, smoky-blue or lavender-blue. This type of rock seems in North America to characterize the Labrador series.

It may here be remarked as an interesting fact bearing on the distribution of the Labrador series, that two large boulders of labradorite rock, one of the beautiful dark blue variety, are found on Marblehead Neck, on the coast of Massachusetts.* It does not seem probable that these masses could have been derived from any of the far-off localities already mentioned, and the fact that the gneiss of eastern Massachusetts is, as I have recently found, in part of Laurentian age, suggests that an outcrop of the Labrador series may exist in some locality not far removed. In this connection it may be added that I have lately found characteristic labradorite and hyperite rocks in southern New Brunswick, a few miles east of St. John, occupying a position between the Laurentian and the Huronian or Cambrian rocks, which there make their appearance, accompanied by Lower Silurian strata, to the south of the great carboniferous basin of the region. This interesting locality was recently pointed out to me by Mr. G. F. Matthew of St. John, to whom we are indebted for a great part of our knowledge of the geology of southern New Brunswick. Chester and Bucks counties, in Pensylvania, and the Wachita Mountains, in Arkansas, are cited in Dana's Mineralogy as localities of labradorite, but as I have never examined specimens from these places, I am unable to say whether they resemble the characteristic anorthosites of the Labrador formation already described.

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* Specimens of these rocks, correctly determined and labelled, are found in the collections of the Essex Institute at Salem. To these my attention was called at the time of the meeting, in August last, by Prof. C. Hitchcock, after which, in company with Dr. G. B. Loring and Prof. Packard, I visited the locality at Marblehead Neck, and collected farther specimens of the characteristic labradorite rock.

The name of norite, in allusion to Norway, was given by Esmark to a rock composed chiefly of labradorite, which is found in several localities in that country.* I had already remarked the close resemblance between two specimens of norite obtained from Krantz of Berlin, and the labradorite rocks of North America just noticed, when, in 1867, I had the opportunity of examining, at the Universal Exhibition at Paris, a collection of Norwegian rocks selected for ornamental purposes, exhibited by the Royal University of Christiania. Prominent among these was a series of the norites, which could not be distinguished from the labradorite rocks of the Upper Laurentian or Labrador series of this continent. In a printed note, accompanying this collection from the University, it is said that the numerous varieties of rocks consisting of labradorite with hypersthene, diallage and bronzite, have been, in the geological map of Southern Norway published at Christiania in 1866, designated by the common name of gabbro. This note at the same time suggests that the "name of norite should be preserved for certain varieties of gabbro rich in labradorite, which varieties may in great part with justice be called labradorite rock, since labrador feldspar is their predominent element." With this excellent suggestion I heartily concur, remarking, however, that the name of gabbro, as an ill-defined synonym for certain anorthosite rocks, including in part diorite, diabase, hyperite, and even confounded with the non-feldspathic rock, euphotide, may very well be dispensed with in lithology.

By referring to the geological map just mentioned, it will be seen that these so-called gabbros occupy considerable areas in the Laurentian gneiss region of Norway. By the authors of the map, Messrs. Kjerulf and Dahl, the gabbros are regarded as eruptive, though they are described at the same time as often assuming the character of stratified rocks. It should, however, be noticed that the geologists go so far as to regard the whole of the granitic gneiss of the region as unstratified and of plutonic origin.

The specimens of these norites exhibited in Paris were in blocks, polished on one side, and as was observed in the note accompanying them, presented a curious resemblance to certain varieties of marble. It is worthy of remark that Emmons, in his report on the Geology of the Northern District of New York,

* See, farther, Zirkel, Petrographie III., 131.

suggested the application of the labradorite rocks of Essex County as a substitute for marble (pages 29, 418). An ornamental vase of the same rock, turned in a lathe with the aid of a black diamond, has been in the Museum of the Geological Survey of Canada since 1856.

Of the collection of norites from Norway the specimens from Sogndal and Egersund presented fine varieties of grayish or brownish violet tints, while a dark violet norite came from Krageroë, and also from the islands of Langoë and Gomoë, and a white granular variety from the gulf of Laerdal in the diocese of Bergen.

It is only in rare cases that the cleavable feldspar of these norites exhibits the peculiar opalescence which distinguishes the finer labradorite found in some parts of the coast of Labrador. Opalescent varieties of this feldspar are, however, occasionally met with in the area near to Montreal and in northern New York. In the Paris Exhibition of 1867 there were exhibited from Russia, large polished tables of a beautiful violet colored granitoid norite, portions of which exhibited a fine opalescence. This rock, I was informed, comes from a mountain mass in the Government of Kiew, but of its geognostical relations I am ignorant.

These peculiar labradorite rocks, presenting a great similarity in mineralogical and lithological character, have now been observed in Essex County, New York, and through Canada, at intervals, from the shore of Lake Huron to the coast of Labrador. They are again met with in southern New Brunswick, in the Isle of Skye, in Norway, and in south-western Russia, and in nearly all of these localities are known to occur in contact with and apparently reposing, like a newer formation, upon the ancient Laurentian gneiss. Geikie in his memoir on the geology of a part of Skye,* appears to include the norites or hypersthenites of that island with certain syenites and greenstones, which he describes as not intrusive, though eruptive after the manner of granites (loc. cit., p. 11–14). The hypersthenites are represented in his map as occurring to the west of Loch Slapin. Specimens in my possession from Loch Scavig, a little further west, and others in MacCulloch's collection from that vicinity, are, however, identical with the North American norites, whose stratified character is undoubted. I called attention to these resemblances in the Dublin

* Quar. Jour. Geol. Soc , xiv., p. 1.

Quarterly Journal for July, 1863,* and Haughton, who in 1864 visited Loch Scavig, has since described and analysed the rock of that locality, which consists of labradorite, often coarse grained, with pyroxene and menaccanite, and is evidently, according to him, a bedded metamorphic rock (Dublin Quar. Jour., 1865, p. 94). He, it may be remarked, designates it as a syenite, a term which most lithologists apply to rocks whose feldspar is orthoclase.

I desire to call the attention of both American and European lithologists to this remarkable class of rocks, of which the norites may be regarded as the normal and typical form, in the hope that they may be induced to examine still farther into the question of the age and geognostical relations of these rocks in various regions, and to determine whether the mineralogical and lithological characters which I have pointed out are geological constants.

NOTES ON THE BIRDS OF NEWFOUNDLAND.

By Henry Reeks, F.L.S., &c.

The following article, on the Zoology of a part of British America as yet but little explored, is taken from the "*Zoologist*" (London, England,) for 1869. The close similarity between the birds of Newfoundland and those of the Province of Quebec, will be very apparent to Canadian ornithologists.—Ed.

Before commencing a systematic list of the avi-fauna of Newfoundland, it will perhaps be necessary to say a few words on the island itself. Newfoundland, as my readers are probably

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* I, at the same time, called attention to the Laurentian aspect of the crystalline limestones of Iona, which I found in MacCulloch's collection. Limestones not unlike these occur in Skye, intermixed with serpentine, and are, according to Mr. Geikie, associated with the protruded syenites of that region. With all deference to the authority of that eminent geologist, I cannot help suggesting that a re-examination of the district would show that the highly-inclined metamorphic crystalline limestones, holding serpentine, and associated with syenitic rocks, belong to an older system (probably Laurentian), and are thus distinct from the nearly horizontal fossiliferous liassic limestones near by, which are only locally altered by intrusive rocks. American geologists will at once recall the misconception which led most of our best observers during many years to look upon the old Laurentian limestones of New York and New Jersey as altered portions of the overlying paleozoic strata.

aware, forms one of the valuable British colonial possessions on the coast of North America. Its geographical position lies between lat. 46° 37′ and 51° 40′ north, and long. 52° 41′ and 59° 31′ west: it is bounded on the north by the Straits of Labrador, on the west by the Gulf of St. Lawrence, and on the south and east by the Atlantic Ocean, and has a seaboard of nearly two thousand miles. There is a chain of mountains, or rather in many places high table-land, running almost throughout the island in a N.E. and S.W. direction. The low land is made up of vast savannas, intersected by extensive woods, lakes and rivers—one inland lake alone being sixty-five miles long, and containing an island as large as the Isle of Wight, and which seems to have been the last stronghold of the Red Indians. Since the extermination of this persecuted race (which probably took place not more than thirty years ago) the whole of the interior of the country has been uninhabited. Several "histories" of Newfoundland have appeared from time to time, and among the best of these I may mention one by Chief Justice Reeves, published in 1793, another by Anspach in 1820, and the last by the Rev. C. Pedley in 1863; but, strange as it may appear, none of these authors give any reliable information on the natural history of this extensive island; which, besides being rich in its fauna and flora, will, I have no doubt, prove equally so in minerals. In some places I have also seen as good a surface-show of petroleum oil as in the well-known oil-regions of Pennsylvania. A two years' residence, under the most favourable circumstances, in a country nearly as large as England, and where the forests are still primitive and in many places almost interminable, is scarcely sufficient time to warrant anything like a correct list of the animals or plants; but when impeded by such a severe accident as I sustained from frost, which kept me a prisoner to the house for several months, no other apology is necessary for the incompleteness of these "Notes," which none can possibly regret more than the writer. There are few inhabited countries, perhaps, on the face of the globe, where the naturalist gets less assistance in the oological department than in Newfoundland. The whole and sole occupation of the settlers on the north-west coast is fishing and furring,—the former in summer and the latter in winter,—and upon their success entirely depend the stock of provisions they will be enabled to obtain, by barter with the traders, for the long period of nine months, when no vessels visit the unsafe harbour of Cow Head. Of course the postal arrangements there are not exactly A 1—never exceeding *one* delivery a day, and this at intervals of from one month to six weeks in June, July, and August, and usually *not at all* between the first of September and 1st of the following June. During the nesting season the assistance of a man worth anything could scarcely be obtained under a sovereign a day, and then, for want of knowledge of those birds not used as food, he may bring you a lot of eggs unknown and unidentified, and consequently worthless. My plan was probably better: I offered a fair reward for all eggs with which I was tolerably familiar; and although I got but few, I ran a far less risk of paying for worthless articles. Although I am answerable for all statements in these "Notes," except when otherwise expressly stated, my friend, Prof. Newton—than whom no one is more competent—has kindly undertaken to look through the list previously to publication, for the purpose of calling my attention to any passages which may require further verification or particularizing, and thereby enhance their value. I have much pleasure in addressing these "Notes" to Mr. Spencer F. Baird, of the Smithsonian Institution, and Mr. G. N. Lawrence, of New York, in remembrance of their kindness to me during my stay in the United States. The classification and nomenclature of the authors of "Birds of North America" has been adopted in the following list.

FALCONIDÆ.

Pigeon Hawk (Falco columbarius, *Linn.*)—This beautiful little hawk, so closely resembling the merlin (*F. Æsalon*), is a summer migrant to Newfoundland, and is tolerably common: its food consists chiefly of small birds, especially some of the smaller species of Tringæ, which abound on the coast in the fall of the year. Since my return I have compared specimens of this species with others of F. Æsalon, and, although I cannot find any material or reliable difference in *size*, the species are easily separated by examining the tails. Both sexes in F. columbarius have *four distinct* black bars—three exposed, and one concealed by the upper tail-coverts. In F. Æsalon the female *only* has the tail-bars distinct, and they are *six* in number—five exposed and one concealed. The bars on the tail of the adult male F. Æsalon, although *six* in number, are only partially defined, and consequently very indistinct. The bill of F. Æsalon is slightly more compressed laterally, but not so much so horizontally as that of F. columbarius. The tibiæ in my adult male specimens of the American bird (F. columbarius) are darker ferruginous, with narrower longitudinal lines, than in my English specimens of F. Æsalon; but this distinction may not be constant. I had almost forgotten to state that the inner webs of the tail-feathers of F. columbarius are white, except where crossed by the black bars —in this respect differing from F. Æsalon, which has scarcely any variation in either web, both being bluish ash.

Greenland Falcon (F. candicans, *Gmelin*).—This is the "white hawk," of the Newfoundland settlers. It is pretty regular in its periodical migrations, especially in the fall of the year. I was not successful in obtaining specimens; I do not think it breeds in any part of Newfoundland.

American Sparrow Hawk (F. sparverius, *Linn.*)—A summer migrant to Newfoundland, but not so common as F. columbarius.

The following species of Falco may reasonably be expected to occur (and probably do so) in Newfoundland occasionally:—The duck hawk (*F. Anatum*) and the Iceland falcon (*F. islandicus*).

American Goshawk (Astur atricapillus, *Wilson*).—I have only the authority of the settlers for including the "goshawk" in my list of Newfoundland birds. I have no reason to doubt their accuracy, as the more enlightened on Ornithology recognised the plate of this species in Faun. Bor. Am., where the scientific name only is given.

Cooper's Hawk (Accipiter Cooperi, *Bonap.*)—A summer migrant; not uncommon.

Sharpshinned Hawk (A. fuscus, *Gmelin*).—A summer migrant, and about equally common with the preceding. I have not seen the young of this species, but the adult very closely resembles our sparrow hawk (H. Nisus) both in flight and plumage. I have not, however, compared specimens, but hope to do so before the conclusion of these "Notes," and give the result.

Redtailed Hawk (Buteo borealis, *Gmelin*).—A summer migrant, but not so common as on the mainland. I only examined one specimen, shot in Newfoundland.

The following species of Buteo probably occur on the island: The redshouldered hawk (*B. lineatus*, Gmel.) and the broadwinged hawk (*B. Pennsylvanicus*, Wilson). I think I have seen the latter on wing, but obtained no specimen.

Black Hawk (Archibuteo Sancti-Johannis, *Gmelin*).—Common;

more especially in the immature plumage, in which state some specimens so closely resemble A. lagopus that it is hard to distinguish between the species. I had an individual of the former species—A. Sancti-Johannis—which agreed so well with descriptions of A. lagopus that I named it as such in my note-book. I kept this specimen alive for upwards of two months, and fed it almost entirely on trout (*Salmo fontinalis*), to which it seemed particularly partial, but invariably refused smelts (*Osmerus viridescens*), either dead or alive, and fresh from the water. I never tried any other specimens of fish, and cannot account for the bird's dislike to the smelt; it may have been the peculiar cucumber-smell—certainly not the taste—which this delicious little fish possesses. I do not think A. Sancti-Johannis a "fisher" by nature; at least, I never saw it in the act of fishing. Unfortunately I did not preserve the skin of this bird (the feathers got rather shabby during confinement); had I done so, I think it would have puzzled more than one good ornithologist to separate it from skins of the European A. lagopus, inasmuch as the under surface of the body was no darker than ordinary specimens of A. lagopus, although I never examined any afterwards but what were, as a rule, much darker. My bird was a female and measured twenty-three inches, wing sixteen and three-quarter inches, and, from the appearance of the ovary, would have laid the following year (1867). The black hawk—or, rather it should be buzzard—is a summer migrant to Newfoundland, but, as a rule, remains later in the fall than most of the Falconidæ.

American Hen Harrier (Circus Hudsonius, *Linn.*)—Although one of the most abundant hawks in the Atlantic States of America, and said by my old friend Downs to be equally common in Nova Scotia, I did not, strange to say, obtain a single example in Newfoundland, although I found some of the settlers knew the bird by its white rump, and distinguished it by the name of "hen hawk." I am almost certain of having seen it on the wing myself at Cow Head. Without specimens, it is impossible for me to say in what peculiarities of plumage (if any), &c., this bird differs from the European C. cyaneus.

Bald or Whiteheaded Eagle (Haliæëtus leucocephalus, *Linn.*)—This handsome bird is called the "grepe" in Newfoundland. It is tolerably common, but as the settlers increase, this noble bird gradually, but surely, decreases. Twenty years ago, or even less, several eyries existed in the immediate neighbourhood of Cow Head, but at present the sites only remain; it is said to breed on a peculiar island-rock, called "The Prior," in the mouth of the Bay of Islands. I have, on more than one occasion, seen the "grepe" fishing at Cow Head and Bonne Bay, and obtained one egg from the latter place. The nest was built in a large pine-tree, and contained two eggs—one addled: the egg is very similar to that of H. albicilla.* The bird is only a summer migrant to Newfoundland.

It is not improbable that Aquila canadensis may eventually be found to visit Newfoundland.

American Osprey, or Fish Hawk (Pandion carolinensis, *Gmel.*) —This fine species is common in Newfoundland: it is a summer migrant, coming in May and retiring in the early part of October. Often, on a calm summer's evening, as I lay on the grass smoking my pipe, have I watched two or three pairs of these birds fishing in the harbour. Suddenly the slow circling flight is stopped,—the quick eye discerns its scaly prey,—the body assumes an almost vertical position; the wings for a moment vibrate rapidly, as if to give their owner impetus, and then with almost unerring aim, like an arrow from a bow, the osprey drops into the water. In a few seconds he reappears, and rising a few feet from the water, the rapid vibration of wings is again observable, but this time only to drive the claws more firmly into the sides of his finny morsel, with which he slowly sails away to some high tree in the woods, where probably is a nest,—

"Itself a burden for the tallest tree."

This beautiful hawk does not escape the ruthless "gunners" in Newfoundland, although utterly useless after death to the settlers. The osprey builds in trees in the extensive woods, either near the sea-coast or some inland lake. The eggs which I obtained from Bonne Bay cannot be distinguished from European specimens received from the late Mr. Wheelwright. Having no English specimens of the osprey by me, I am unable to point out any differences whereby they may be selected from American examples. The authors of 'Birds of North America' give none;

* In the Proc. Zool. Soc. for 1863 (p. 252) Dr. Sclater recorded H. albicilla as a Newfoundland bird, an error which he corrected in the 'Proceedings' of the same Society for 1865 (p. 701).

both Wilson and Audubon considered the European and American osprey of the same species.

Strigidæ.

American Barn Owl (Strix Pratincola, *Bonap.*)—Apparently rare in Newfonndland: I only examined one specimen during my residence there, which, having only the first joint of the wing broken, was kept alive several days by the children of the man who shot it: this occurred in August, 1866. It is probably a summer migrant.

Great Horned Owl, (Bubo Virginianus, *Gmel.*)—Visits Newfoundland for the purpose of nidification, and is not very uncommon during that season, and more especially later in the summer when the young leave the nests. It is called the "cat owl" by the settlers. The only nest which came under my observation was built *on the ground*, on a tussock of grass in the centre of a pond. The same nest had been previously occupied for several years by a pair of geese (*Bernicla canadensis*). I think it the more important to note this observation (which, however, may not be constant even in Newfoundland, as birds of prey are very varying in this respect) as Mr. E. A. Samuels, in the 'Birds of Massachusetts,' says it "nests in hollows of trees, and in high forks of pines."

Mottled Owl, or *American Screech Owl*, (Scops Asio *Linn.*)—A summer migrant to Newfoundland, and tolerably common. As this is one of the commonest owls in North America, it seems strange that Mr. Downs should not meet with it in Nova Scotia, especially as it frequents the States bordering on the Atlantic more than those inland.

American Long-eared Owl, (Otus Wilsonianus, *Lesson.*)—Not common: I only examined one specimen, which was killed near Cow Head. It appears to be a summer migrant.

American Short-eared Owl, (Brachyotus Cassini, *Brewer.*)—Not common, but I think rather more so than Otus Wilsonianus. It is a summer migrant.

Barred Owl, (Syrnium nebulosum *Forster*). Apparently a summer migrant, but not common; at least I only obtained one specimen, shot at Cow Head in September, 1866.

Saw-whet Owl, (Nyctale acadia *Gmelin*).—Not uncommon, and well known to the settlers as the "saw-whet." I only obtained one specimen, which was picked up dead at Cow Head, and appeared to be uninjured. It is a summer migrant.

Sparrow Owl, (Nyctale Richardsoni, *Bonap.*)—I include this species on the authority of Mr. Downs, who states, in his "Notes on the Land Birds of Nova Scotia," that it is "abundant in Newfoundland;" but, strange to say, I never met with a single specimen, neither were the settlers acquainted with the species: I have very little doubt, however, that it occurs on the island. It is this species which closely resembles the European Nyctea Tengmalmi, but not having specimens I am unable to point out the distinctive characters.

Snowy Owl, (Nyctea nivea *Daudin*).—Tolerably common, and probably remains in Newfoundland throughout the year, although very rarely seen during the summer months, but this may be owing to its following in the wake of its chief prey, the polar hare (*Lepus glacialis*), and ptarmigan (*Lagopus rupestris*), which retire to the high land as soon as the snow partially disappears. The "white owl," as the settlers term this species, is a bold, rapacious bird, and not easily driven from its slaughtered prey. One of the specimens, which I obtained at Cow Head, was feeding on an eider duck—probably a wounded bird which it had killed—and was twice knocked over with stones, the last time apparently killed, before it would relinquish the duck: it had, however, sufficient life and strength to force its claws into the arm of the man who picked it up, although protected with all the clothes he usually wore. A large Newfoundland dog, used for retrieving seals, &c., refused to go near this bird after it was knocked down with stones: the men who were present assured me that the bird kept making a "hissing" noise, apparently at the sight of the dog. During my residence in Newfoundland I heard several amusing anecdotes of the snow owl, but, although I can vouch for the truth of them, it is scarcely necessary to reproduce them all in the pages of the "Zoologist:" I will, however, relate one or two which I do not think have before appeared in print. William Youngs of Codroy (Newfoundland), having continually had the bait stolen from one of his fox traps, determined to watch the trap and shoot the robber: for this purpose he selected a fine moonlight night, with snow on the ground, and, with his gun in his hand, a white swan-skin frock on, and a white handkerchief tied round his cap, he secreted himself in a small bush about twenty yards from his trap, fully determined to shoot the first comer; but his determination proved fruitless, for a large white owl—probably the thief—seeing something white sticking up through the centre of the bush, and evidently mistaking it for a fine plump willow grouse, instantly made a "stoop," and, at the same time, sending its claws almost to the man's brains, suddenly disappeared with the cap and white handkerchief: the man was so startled for the moment that he was unable to shoot at the bird. The snowy owl is a frequent attendant—although generally unnoticed—of the sportsman, and often succeeds in carrying off a grouse or duck before the retriever gets to it. On one occasion some men were waiting in ice "gazes" for the purpose of shooting wild geese (*Bernicla canadensis and B. brenta*), when one of them, named James Carter, left his "gaze" to go and have a chat with his neighbour, incautiously leaving his new white swan-skin cuffs and gun behind him. He had scarcely left his "gaze" when an unseen enemy, in the shape of a fine snowy owl, pounced in and succeeded in getting clear off again with both of the white cuffs. A fine adult bird of this species entered my host's house, *via* the chimney, and fought so valiantly for its life that the man had to kill it with a "pew"—a piece of pointed iron fastened to a wooden handle about four feet long, and used for throwing codfish from the boats. A good many snowy owls are annually caught in the fox-traps of the settlers; and when very fat, which they frequently are, are considered good eating by many, and I see no reason why they should not be so, but I could never sufficiently overcome my repugnance to birds of prey as food to taste one. None of the settlers appeared to know anything of the breeding of this bird, although Mr. Downs states that it "breeds in Newfoundland." Mr. Cordeaux has kindly examined parasites of Nyctea nivea from Newfoundland, and informs me that they are identical with others from European specimens.

Hawk Owl, (Surnia ulula *Linn.*)—Perhaps the commonest owl in Newfoundland, or, from being a day-flying species, is more frequently seen than any other. It is a bold, familiar bird, generally found in the neighbourhood of houses, preying on chicken, tame pigeons, &c.,—remaining throughout the year, but not so abundant in the depth of winter as at other seasons. In the fall ot the year, and probably at other times, the hawk owl has a habit of perching on the bare and dead top of high fir trees, from which it commands a good view of the immediate neighbourhood, and suddenly drops upon any unfortunate object in the shape of food that may happen to pass within a convenient distance.

(*To be continued.*)

ON THE ORIGIN AND CLASSIFICATION OF ORIGINAL OR CRYSTALLINE ROCKS.

By Thomas Macfarlane.

I.—INTRODUCTION.

"All attempts to separate sharply from each other the various "rocks or mineral aggregates of which the earth's crust is com- "posed, and to arrange them systematically, have failed." "We "cannot consider the rocks as species, nor arrange them in a "system corresponding to their nature, nor even, in describing "them, treat them all in the same manner." *

So wrote Bernhard Von Cotta in 1862. On reading such sentences we are tempted to ask: Are species always sharply defined in other sciences? Are all systems perfect or natural? Why should lithology be an exception to other sciences, and its students be deprived of the advantages of a systematic arrangement of the objects to be studied? A "natural" system is not demanded, even were such a thing possible, in this or any other science. The more rigid any method of classification, and the more marked and unbending its divisional lines are made, the more unnatural it becomes.

It is exceedingly gratifying to find that, undeterred by the difficulties of rock classification, such lithologists as Von Hochstetter, Kjerulf and Zirkel, have been found willing to attempt it. Their labours, and those of other workers in the same field, have shed a flood of light upon a previously obscure and uninteresting subject. Although a perfect system will, perhaps, never be attained, still each attempt at properly arranging our knowledge of the subject has its value. Chemical analysis and microscopical

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* Cotta; Die Gesteinslehre, pp. 1, 4.

examination of rocks have very much contributed towards rendering such attempts successful. In the present paper it is proposed to give a systematic view of the various classes and species of crystalline rocks, in arranging which it is intended that their chemical composition shall have greater prominence and weight than has been usual heretofore.

However much it may seem desirable in this department of science, where all the systems of classification have been confessedly imperfect, to invent a system independent altogether of the ideas, more or less well founded, which prevail as to their origin and age, and in which their physical and chemical characters should only have consideration, it must not, on the other hand, be forgotten that what is still more desirable in such a system is that it should re-arrange our knowledge of the subject in a clearer form, render it more easy of comprehension to the student, and be so dovetailed into the past of the science as to be useful for its advancement in the future. On this account it becomes impossible to neglect even the theoretical views of our forerunners in this science of petrology, far less their arduous and often underrated geognostic labours. It also becomes requisite to give a proper value to all the considerations which may have influenced their views, and to build upon the foundation which they have left us, the results of the observations and research of the investigators of our own day.

Considerations as to the manner of formation, texture, chemical and mineralogical composition, age and localities of rocks, have all, more or less, influenced geologists in naming and classifying them. The well-known distinction between eruptive and sedimentary rocks will occur to every reader as an instance of classification according to origin. Hunt's division of crystalline rocks into indigenous and exotic, and Scheerer's distinction of plutonites and vulcanites are both founded upon their real or supposed manner of formation. Lava and Rhyolite are examples of special rocks similarly named. Then, with regard to texture, probably no other character possessed by rocks has given rise to a greater number of generic terms. Schist, slate, porphyry, trachyte, amygdaloid, conglomerate, and breccia, are examples of this, but of special names founded on texture only a few can be instanced, such as granite and aphanite. The influence of chemical composition on lithological nomenclature is not, as yet, very marked, for it is only recently that the analysis of rocks has had much attention. Quite lately, however, Cotta has proposed to distinguish as basites those eruptive rocks containing less, and as acidites those containing more than sixty per cent. of silica; and Scheerer, Kjerulf and Roth have each indicated methods of classification founded, to a very considerable extent, on general chemical composition. By far the greater number of special names in lithology are based upon mineralogical characters. This is the case with pyroxenite, hornblende schist, quartzite, and many simple rocks, while among those of a compound nature, where it was impossible to indicate their mineralogical composition in one word, recourse was had to special names, with definite ideas attached to them as to mineralogical constitution. Thus, diorite came to denote a rock composed of triclinic felspar and hornblende; granulite, a schistose compound of quartz, orthoclase and garnet; dolerite, a mixture of labradorite, augite and magnetite. As regards classification, the mineralogical nature of rocks has always been abundantly considered. In this way we have Hunt's orthosites and anorthosites; Senft's labradorites and alabradorites, while Zirkel has made the nature of the different felspar species the corner-stone of his system of classification,—crystalline or original rocks being divided into orthoclase rocks, oligoclase rocks, labradorite rocks, anorthite rocks, and rocks void of felspar. The manner in which considerations as to geological age influence the names of rocks may be illustrated by the following examples. Sometimes certain porphyries and trachytes are, in hand specimens, scarcely distinguishable from each other. When, however, such rocks occur among carboniferous or permian strata, geologists have been inclined to term them porphyries; and, on the other hand, when they are of tertiary or recent age, the name trachyte is generally given them. Exactly the same mode of determination, if such it can be called, has been adopted in the case of greenstone and basalt, or rocks of such indistinct mineralogical composition as trap and aphanite. With reference to locality it has principally occasioned special names, such as syenite, dunite and andesite, or caused varieties of certain other species to be indicated by such terms as banatite, sievite, cherzolite, &c. From these considerations it would appear that, generally speaking, origin has been allowed to determine the various divisions and sub-divisions among rocks; that the majority of the generic names have reference to texture, while mineralogical composition and locality have had the greatest share in originating the special names of rocks.

In striving to attend to what has been indicated as desirable and necessary in any attempt at classifying rocks, it has appeared to us most judicious to attach greatest weight to their various characters in the following order: 1, origin; 2, texture; 3, chemical composition; 4, mineralogical composition; and 5, locality. If a system be required at all resembling those of other branches of science, these characters might be allowed respectively to determine the classes, orders, families, species, and varieties of rocks.

II.—CLASSES OF ROCKS.

If we, at the present day, look around us, and ascertain, from actual experience, what the methods are which nature employs in producing rocks, we find that they result from the operation of two very distinct agencies. On the one hand we may see in different countries, widely separated from each other, streams of melted matter issuing from volcanoes and solidifying to rocks on their sides or at their feet, while on the other hand we may observe, on every sea beach or river delta, sand and clay, the debris of pre-existing crystalline masses or fragmentary strata being gradually consolidated to new rocks. Exactly parallel to these operations of nature are certain artificial processes at work around us, the products of which are entirely analogous to the two classes of rocks just indicated. We may stand before an iron furnace and watch the steady stream of slag flowing from the hearth into a large iron wagon, and there solidifying to a mass of solid, sometimes crystalline rock; and we may also visit a stamp mill where valuable metallic particles are being extracted from poor vein-stones, and find, in the slime-pits of the establishment, banded layers of half solidified strata, requiring but a little time to effect their perfect consolidation.

These two means employed by nature in producing rocks have been steadily recognized by the majority of geologists, and the two classes which result have been indicated by a superabundance of names. Unstratified and stratified; igneous and aqueous; eruptive and sedimentary; exotic and indigenous; primary and secondary; (protogene and deuterogene;) crystalline and elastic; massive and fragmentary; original and derivate, are all terms which have been used for distinguishing these two great classes, and the least objectionable among them would appear to be the two last mentioned. The first of these, original (Ursprüngliche,) was first adopted by Zirkel* for denoting igneous or eruptive rocks, while the term derivate was first suggested by David Forbes† as equivalent to secondary or sedimentary rocks. The latter term we have ventured to modify, and in the following pages we shall use the names original and derived for indicating the two great classes. These names would seem to deserve the preference, for the following reasons. It is admitted by geologists, on all hands, that the material which constitutes the various sedimentary formations, consisting of limestone, hardened clay, or consolidated sand, although it may have been immediately derived from pre-existing rocks of a detrital nature, originally came from the decomposition and disintegration of crystalline rocks, of such as are known to constitute the oldest formations of the earth's crust, or to have broken through and deposited themselves on the outside of it. It is further an accepted theorem, universally acknowledged by scientific men, that our globe was originally in a state of igneous fusion, and that all the material which constitutes the rocks of our day existed in the form of a melted zone encircling the central part of the globe. It is evident that, before the conditions for the formation of sedimentary rocks could exist, the liquid globe must have become, to some extent, solid; a crust, at least, must have been formed upon it, from the disintegration of which the material of such sedimentary rocks could have been derived, and upon which that material could have been deposited. This crust, and the rocks which from time to time after its solidification penetrated or were erupted through it, must, consequently, have been the first rocks, and they must have yielded the material for all those subsequently formed by aqueous agencies. It would, therefore, appear legitimate to name the former class original, and the latter, derived rocks.

Where, as in the case of the volcanic and sedimentary rocks which are being formed at the present day, we can observe the process of their formation, no doubt can arise as to their origin. These rocks, however, form but a very minute fraction of those which build up the earth's crust, and it becomes necessary, in order properly to discriminate among the latter, to point out the

* Petrographie I., p. 173.

† The Microscope in Geology, p. 6.

distinguishing characters of original and derived rocks. The further we go back in geological time, and the older the rocks are which we are called on to classify, the greater is the difficulty of doing so, and the more divergent the opinions of geologists become as to their origin. The stratigraphical relations of rocks are most effective in determining this, but it will be necessary at present to confine ourselves to considerations of a more purely petrological nature. This is the more easily done, since the lithological characters afford abundant means of recognizing original and derived rocks, and distinguishing them from each other.

Original rocks are made up of crystalline particles of one or more minerals, principally silicates. These are seldom perfect in crystalline form, are frequently more or less irregular or distorted, and are intimately bound together to a compact whole, without the intervention of any foreign substance as a cementing material. They are thus mutually interlocked to a crystalline mass, which, however, possesses at the same time an average mineralogical and chemical composition. This would seem to indicate that the mass must have been originally liquid, and, to some extent, in the same condition during crystallization, otherwise it would have been impossible for the various chemical constituents to move toward the points where the minerals were being formed into whose composition they enter. On the other hand, this liquidity must have been somewhat limited in degree, for the minerals seem to have pressed against each other, so as to have mutually interfered with their crystalline development, and so as also to have fitted perfectly into each other on complete solidification. The size of the crystalline particles varies from a foot or more in diameter down to that of microscopical minuteness. It is even the case that they become so minute as to occasion a perfectly vitreous structure which even the microscope is incapable of resolving into distinct minerals. In all such cases, although the rock can scarcely be termed crystalline, it remains, what its mode of occurrence plainly shows, an original rock.

Derived rocks are made up of the disintegrated fragments or particles, and the chemical constituents of previously existing rocks, abraded or dissolved away by water or other agents. These fragments or particles are sometimes angular, sometimes rounded off, and always bound together by means of an intervening cement, which is independent of, and may be altogether different in nature from, the enclosed fragments. They vary in their dimensions even more widely than the constituents of original rocks. There are sometimes found in them blocks of several cubic feet contents; and, on the other hand, they are frequently composed of the finest particles of dust. The cement which unites these particles is subject to great differences, both as regards its quantity and its nature. Sometimes it consists of the material of a newly erupted original rock which has happened to envelope and bind together fragments of a pre-existing crystalline or sedimentary rock. Sometimes it consists of the finely divided detritus of the rock of which the larger fragments are composed. Sometimes the finely comminuted cement is from a different rock than the fragments. Sometimes it is of an infiltrated crystalline nature. In some cases the fragments, and in others the cement predominates. Apart from the finely divided sandstone or clay which sometimes fills the interstices between the fragments, carbonate of lime, silica and iron oxide are the substances which, more frequently than any others, form the cementing material in these fragmentary rocks.

Recent investigations regarding the chemical composition of rocks have rendered the distinction between the original and derived classes still more marked, and made it possible to point out another essential point of difference between them. Original rocks possess a chemical composition in which a definite relation exists between the quantity of silica and that of the various bases which they contain. In derived rocks this definite relation is not to be observed. This peculiarity of chemical composition possessed by original rocks was first pointed out by Bunsen, and has been quite recently insisted upon as a feature distinguishing them from derived rocks by Von Richthofen in his "Communications from the West Coast of North America."*

These two great divisions do not, however, exhaust all the classes into which rocks have been divided. It has long been supposed, and more recently the belief has gained ground, that many of the rocks belonging to the divisions above indicated have experienced, since their solidification or deposition, certain changes in their chemical and mineralogical composition, and in their physical characters, whereby they have been rendered quite unlike their originals, and this without their having been disintegrated or displaced. The influences to which these changes

* Zeitschrift der Deutschen Geologischen Gesellschaft, vols. xix and xx.

have been ascribed are various. Heat, water holding different substances in solution, gases, atmospheric agencies acting separately or combined, have all played an important part in effecting these changes. The rocks thus modified have been called metamorphic, altered or hypogenous rocks, without very marked reference to the classes from which they have resulted. In the following pages the name altered will be applied only to those original rocks, and the term metamorphic only to those derived rocks which have experienced, *in situ*, such changes as those here indicated. It is not, however, proposed in the present paper to discuss the relations of derived and metamorphic rocks, but, in endeavouring to classify those of the original class, the altered rocks sometimes resulting from them will be noticed.

(To be Continued.)

THE PLANTS OF THE WEST COAST OF NEWFOUNDLAND.

By John Bell, M.A., M.D.

The account of the plants of the west coast of Newfoundland, in a recent number of this journal, ended with my visit to St. George's Bay.

As we sailed south, from that locality to the harbour behind Cod Roy Island, I observed that the forests had in some places been burned by the devastating fires, which are so often carelessly originated in these parts, and that grass had sprung up in the areas thus cleared, on which large herds of cattle were pasturing. These cattle belong to the people of the island-harbour village, which is composed of about thirty or forty families, whose schoolmaster visited us on our arrival. Large patches of snow still lay glistening in the sun on the tops of this somewhat elevated range of hills.

On the following morning, July 6th, we started on an expedition up the Great Cod Roy River, which, like many of the smaller rivers entering the Gulf of St. Lawrence, has its stream level for a few miles inland, until it reaches the mountain region, when it becomes more rapid and less navigable. It resembles them, too, in the manner of its *débouché*. On nearing the place where the river seemed to empty, we could at first see no entrance, but upon coming closer to the shore we found a deep narrow channel at the end of a long tongue of sand and gravel enclosing a lake or broad expanse of river, which at the time of our arrival was literally covered with gulls. Near this lake was a swamp overgrown with hoary alders, in and around which I found the Marsh Marigold (*Caltha palustris*), Spotted Touch-me-not (*Impatiens fulva*), Great Water and Curled Docks (*Rumex hydrolapathum et crispus*), Hemp-Nettle (*Galeopsis tetrahit*), Chickweed (*Stellaria media*), two Plantains (*Plantago major et Virginica*), Thyme-leaved Speedwell (*Veronica serpyllifolia*), with some Clovers and Bedstraws.

After ascending the river for a short distance, we stopped on the north shore, at the house of a settler named James Ryan, in whose garden I was surprised to find a great variety of cultivated vegetables and flowers. At this place I found vegetation to be about a fortnight in advance of what it was in St. George's Bay, doubtless the result of its more sheltered position and southern exposure. With his great variety of flowers and vegetables Ryan had also imported a great variety of European weeds, for at no place on the coast did I observe so many vegetable pests as at this settlement. Some of his cultivated and pasture fields presented as many imported weeds as those of some of the older farms of Canada. The Yellow-Rattle (*Rhinanthus crista-galli*), that pest of the maritime provinces, grew everywhere, and Ryan complained that it killed out all kinds of grass. It was accompanied by the Heal-all (*Brunella vulgaris*), the common Dandelion (*Taraxacum dens-leonis*), and Canada Thistle (*Cirsium arvense*), which did not confine itself to places under cultivation.

Along a boggy rill were growing, in flower, the American Brooklime (*Veronica Americana*), the bristly and creeping Crowfoots (*Ranunculus Pennsylvanicus et repens*), Canadian Burnet (*Sanguisorba Canadensis*), Round-leaved Dogwood (*Cornus circinata*), with other herbs and bushes already mentioned in my former paper. The view from this place was magnificent. The river, like a long narrow lake, lay below the house and stretched away inland, here and there dotted with boats and salmon nets, or intersected by points on which were settlers' houses and out-buildings, whose sides and shingled roofs seemed like marble in the glistening rays of the sun, while separated from the river by a strip of low wooded land, towered up the high, deep-gullied mountains, with patches of snow near their bare heathy summits. As we paddled upwards above this place the scenery was very beautiful,—each bend in the winding river presented some new and enchanting combination of water, meadow, wood, and mountain, in varying shades and colours. Along the river bank, which was bordered with green and hoary alders, beaked hazel, red dogwood (*Cornus stolonifera*), and other species of Cornus, I picked up the Water Horehound (*Lycopus Europæus*), Mouse-ear Chickweed (*Cerastium vulgatum*), and Small-flowered Crow-foot (*Ranunculus abortivus*).

About twelve miles from the mouth of the river the Balm-of-Gilead Poplar (*Populus balsamifera*), grew in clumps along the stream and in their shade the Cow parsnip attained an immense size. On the alluvial flats bordering the river the magnificent Ostrich and Cinnamon Ferns (*Struthiopteris Germanica et Osmunda cinnamomea*), spread out their luxuriant fronds in the form of great green vases among the high cranberry bushes (*Viburnum opulus*), and the water and straight yellow-leaved avens shot up their wiry stems amongst the grass and sedges. Quantities of several species of Pondweeds formed tangled masses in the quiet pools, on whose surface floated the round shining leaves and yellow flowers of the Spotted Dock. In some places along the river the ground in the wood was covered with a thick soft carpet of various mosses, (*Hypnum Boscii, crista-castrensis, splendens et delicatulum*), and the trunks of the trees were matted with tufts of *Neckera pennata*. In these rich damp woods the sweet, little one-flowered Pyrolas (*Moneses uniflora*), hid their single white blossoms in the mossy carpet, and the False Beech-drops (*Monotropa hypopitys*) pushed up their wax-like stems. Here, too, the smaller Lady's Slipper (*Cypripedium parviflorum*) nodded its mocassin-like flowers to its plainer cousins, the Dwarf and Northern green Orchids (*Platanthera obtusata et dilatata*), and the many flowered Coral-root (*Corallorrhiza multiflora*). Among the many ferns observed were the Lady Fern (*Asplenium filix-fœmina*) and the New York Shield-Fern (*Aspidium Novæboracense*), with numerous bushes of the swamp Gooseberry (*Ribes lacustre*), wild Red Currant (*Ribes rubrum*), Few-flowered Arrow-wood (*Viburnum pauciflorum*), the Swamp Fly-honeysuckle (*Lonicera oblongifolium*), Low and Alpine Birch (*Betula pumila et nana*), while the tall wild nettle gave a sharp reminder of its presence with its pungent hairs.

At about fourteen miles from the mouth of the Great Cod Roy River some of the party went four or five miles south to the summit of the mountain range running east and west. At first our course lay through a hardwood bush and over several little streams, whose banks showed that they had been raging torrents earlier in the spring. In this bush I got the Spring Beauty (*Claytonia Caroliniana*), and a Galium with four broad leaves and little white flowers. As we ascended the damp, chilly mountain side, the trees became smaller, and the white birch and fir trees more numerous, until near the top nothing remained but stunted spruces, with trunks not thicker than a man's arm, but as hard as horn and probably as old as their taller brothers below. In some places these dwarfs were growing so closely together, and their tops had become so flattened and matted with the weight of snow in winter, that I actually walked for a considerable distance upon them like on an elevated pavement. The very top of the mountain presented a bare, desolate appearance. Large patches of snow twenty or thirty feet deep remained in the shaded depressions, while others were filled with boggy lakes, on the little islands in which the sea gulls seemed to have their nests, from the wild manner in which these birds screamed and flew around as we approached the ponds. In some places the gneiss rocks were broken and bare, in others covered with lichens, mosses and heaths. Among these I found the Bearberry Willow (*Salix uva-ursi*), the Alpine Bearberry (*Arctostaphylos alpina*), with the Phyllodoce (*P. taxifolia*), and other heaths already mentioned.

On returning to the schooner, a botanical survey of the little island of Cod Roy was rewarded by the discovery that the *Cornus Suecica* grew everywhere in profusion with its Canadian sister. This *Cornus* I afterwards found to be quite as common as the Canadian bunchberry all along the western Newfoundland coast, and on the north shore nearly as far west as Pointe des Monts. The other plants worthy of note on the island were the Fall Dandelion (*Leontodon autumnale*), the common American Cranberry (*Vaccinium macrocarpon*), the Wood-Rush (*Luzula campestris*), the Cloudberry (*Rubus chamæmorus*), the Mountain Cinquefoil, and a variety of the beach pea, so downy with short soft hairs as to look almost glaucous.

During the 11th and 12th July we ran up to Long Point, north of Cape St. George. In a boggy meadow near the end of the point I found the Alpine Bistort in flower (*Polygonum viviparum*), the Arrowgrass (*Triglochin maritimum*), and Mountain Fly-honeysuckle (*Lonicera cœrulea*). At West Bay, a little farther down the east side of this long point, the shallows are studded with the Fall Bulrush (*Scirpus lacustris*), and near the shore the common Soft Rush (*Juncus effusus*) grew in clumps in the mud. On the banks the Hedge Bindweed (*Calystegia sepium*) drew its trailing stems over the bushes, and from the rocks the common Bladder Fern (*Cystopteris fragilis*) spread its fragile and varying fronds.

We next sailed north to the Bay of Islands, which is a long narrow inlet divided into two arms, a short distance from the sea, and, as its name indicates, it contains a number of small rocky islands. At its mouth is a round granite island, whose steep sides dip perpendicularly into the deep channel on either side, through which the tide rushes with considerable rapidity as it rises and falls. On the south side of the entrance are several very high mountains, whose sides are nearly perpendicular, and form a bare wall, against which the waves perpetually lash, and against which we were almost wrecked on entering the bay, owing to the rapid flow of the tide and the strong shifting gusts of wind which blew around the crags, and to which I have no doubt these peaks owe the not very euphonious but expressive name of the Blow-me-down Mountains. As the early French navigators sailed along these newly discovered shores, they generally called the various points of interest after the name of the saint on whose day they arrived at the place, while the English names have too often been repetitions of those of some European place, or have been suggested by some passing fancy of the sailor. A few miles up the Bay of Islands I found the common bitter Cress (*Cardamine hirsuta*), and the Marginal fruiting Shield-Fern (*Aspidium marginale*), growing at the foot of a slaty cliff.

The Humber River enters at the head of the south arm of the Bay of Islands. This noble river is the outlet of Grand Pond, and with its tributaries winds through a large portion of Newfoundland. It is, or could easily be, made navigable up to the main fork, a distance of about forty miles, for flat-bottomed steamboats like those used on the Ohio. Along the river flats, in the valleys and on the "barren," when these are drained and the country is a little more cleared, there will be room for thousands of farms, and the hills will afford walks for immense flocks of sheep and pasture for countless herds of cattle, the surplus of all which will find a ready market at the ports and fishing stations, at the lumbering, manufacturing and mining establishments, which ere long will make this old and neglected colony one vast scene of active and profitable industry. The climate of the island is favourable to the developement of its agricultural resources of every kind. Instead of the cold foggy atmosphere, which is generally supposed to hang over this island, quite the reverse is the case—the air is clear and warm, and the temperature during the year remarkably equable, the mercury in winter seldom falling below zero of Fahrenheit's scale, or in summer rising above 90°, while the mean temperature of the year is about 44°. I never saw finer weather than during the two months I was on the island. It is only on the S.W. corner that fogs prevail to any extent, from the proximity of that part to the Gulf stream.

At half the distance between the sea and the main fork of the Humber, the river spreads out into a broad expanse of about fifteen miles in length, called Deer Lake, from which the mountains rise range after range, and stretch away into the dim distance. Along the banks of the river, before reaching Deer Lake, I observed the Black Ash (*Fraxinus sambucifolia*) to be quite abundant. The Aspen Poplar (*Populus tremuloides*) was not uncommon, and the Scarlet-fruited Thorn (*Cratægus coccinea*) here and there shewed its spring branches along the rocky banks. A pretty little white composite flower grew on the damp rocks with the pinguicula and violets; but I was unable to get a specimen of it. In other places the green and hoary alders, red osier dogwood, sweet-gale and dwarf willows bordered the stream to the water's edge. The woods were principally composed of the following trees:—Black and white Spruce and Balsam-fir (*Abies nigra, alba et balsamea*), Mountain Ash (*Pyrus Americana*), Black Ash, Choke and wild Red Cherries (*Prunus Virginiana et Pennsylvanica*), Cranberry trees and Sweet Viburnum (*Viburnum opulus et lantago*). On a little island on the north side of Deer Lake I found the Mountain Painted Cup (*Castilleia septentrionalis*) and one of the deciduous Equisetums. In the shallows of the lake the Water Milfoil (*Myriophyllum spicatum*) floated in abundance, with other weeds. On entering the Humber at the upper end of Deer Lake, our progress was often arrested by the oars becoming entanged in masses of Eel-grass and Pond-weeds, which filled the dark-brown waters at the sides of the slowly flowing stream. In the neighbourhood of the fork no plants were observed different from those already mentioned; but one expedition to Grand Pond, in the centre of the island, brought back specimens of the Bastard Toad-flax (*Comandra livida,*) *Epilobium latifolium* and *angustifolium* and *Viburnum opulus.* After spending a few days at the main fork of the Humber, we started down the river, and after a long pull of from ten in the morning till eleven at night, reached the schooner in safety. At the mouth of the river we passed several long salmon nets, some of which were stretched so far across the stream as to render it almost impossible for any salmon to reach their spawning ground. In buying some salmon from one of the fishermen, it was singular to find how very ignorant he was of the value of the various silver coins in common use, so general is the system of obtaining by barter all goods imported to these stations.

For two nights after our arrival we had the rare opportunity of seeing the woods on fire on a magnificent scale, on the north side of the south arm of the bay. This grand conflagration commenced from a "smudge," or smouldering, smoking fire of rotten wood, lighted by some woodmen at the head of the bay to keep away mosquitoes. The weather had been warm and dry for some time previously, and had prepared the firs, birches, fallen wood, and even the vegetable mould for this terrific bon-fire. As the fire spread along the ground, and from tree to tree, it sent immense clouds of smoke and wreaths of flame upwards to the sky, and created a draught for itself, which added yet greater fierceness to the devouring element, and carried up ashes and burning cinders, which again fell to the ground only to be new *foci* of destruction. The crackle, roar and crash of the burning and falling trees could be heard for miles; and as the fire, with almost the rapidity and violence of an explosion, ran up the immense fir and birch trees on the tops of the hills, it made a sight which, when once seen, can never be forgotten. As the fire travelled along the hills towards the fishing station, opposite which the schooner was anchored, the ashes and cinders covered the deck, and it required constant watching to prevent the sails from catching fire, while the ship's crew were away helping to tear down fences to prevent the spread of the fire, and to save the houses of the settlers. A fall of rain on the morning of the 22nd of July quenched the ardour of the conflagration, and a smart easterly breeze springing up the same afternoon, gaily carried us homeward-bound, through the imposing portals of the Bay of Islands.

WHY ARE INSECTS ATTRACTED BY ARTIFICIAL LIGHTS?

By A. S. Ritchie.

This question has given rise to many speculative answers,—none of which as yet are generally satisfactory.

Mr. Guyon writes thus in Science Gossip*:—"If a room were thoroughly darkened, with the exception of a small opening, such as a key-hole, through which the outer daylight was allowed to enter, such an aperture would appear from within, by contrast, almost as bright as the flame of a candle, and any winged insects enclosed in such a room would be pretty certain to direct their flight to the opening. Moths in a room are probably under a sense of being lost and confined, and as bees hurry up and down the window, so nocturnal lepidoptera knock against the ceiling, or dash into the candle flame, perhaps equally with the impulse to escape. Insects seem to be under a fixed impression that the direction of the light is the way out." The same author writes: "The idea has often occurred to me—though it may be rather a fanciful one,—that possibly the insects might regard the flame as light shining from an aperture through which they might make their escape,—somewhat as children imagine the stars to be pin-holes in the sky."

These remarks, so far as we understand them, do not tell us what brings insects from their various haunts into our rooms. They only prove that these creatures prefer light to darkness,—a very natural conclusion, we think, seeing that nature has supplied them with well-developed eyes.

The second answer given to the question runs as follows:—"Most of the night-loving insects are so affected by the sudden appearance of light, that when a candle is introduced, they rush madly into the flame as though they were deliberately inclined to commit suicide." . . . "The true cause of this proceeding has not yet been satisfactorily explained. It has been suggested

* Vol. for 1869, page 57.

that their eyes do not absorb (as in most insects), but reflect the light,—an organization which enables them to distinguish objects in a state of partial darkness, but which leads to their destruction when the light is strong. Blinded, as it were, by excess of radiance they lose all discernment in the blaze, and perish in the flame."

Our opinion with regard to the structure and office of the eyes of insects is in accordance with the above remarks; all that is answered, however, is the cause of their perishing in the flame, which we attribute to paralysis of the optic nerve by the excess of light.

The third answer to the question runs thus :—" We know," (' I have often seen it,' says the writer), " that certain flowers emit of an evening a strong phosphorescent light, visible at some some distance. How many do so whose light is only visible to the keen eyes of insects we do not know ; but I think it probable that many more do than we are aware of. Is it too wild a suggestion that nature has supplied those storehouses of insect food, —the flowers,—with this phosphoric glow as a beacon light to these hungry night rovers, and responding to the invitatation, they make for our lighted windows as to a banquet hall ? "

We venture to make the following remarks on the quotations cited :—If it be true that plants give off a peculiar light, this, to a certain extent, answers the question, and goes far to prove that insects are attracted by the light to feed. Dr. W. B. Carpenter says on this subject: " It has been asserted that many plants,—especially those of an orange colour, such as *Tropæolum majus* (Nasturtium), *Calendula* officinalis (Marigold), *Helianthus annuus* (Sunflower), — disengage light in serene and warm evenings, sometimes in the form of sparks, sometimes in a more uniform manner, and many physiologists are disposed to question these assertions, from their not having been themselves able to witness the phenomenon." We have spoken on this subject to several botanists who have never witnessed this light-giving property in plants.

We shall now give our opinion on this subject, and will do so as fully and clearly as possible, by answering the following questions :—

First.—What species of insects are generally attracted to our open windows by artificial lights, such as lamps, &c. ?

Secondly.—What are the habits of those species, and for what purposes are they attracted ?

Thirdly, and lastly.—Is it on dark or moonlight nights that insects are attracted to artificial lights?

In answering these questions, our opinions are based upon actual observation and experience.

To the first question, viz.: What species of insects are generally attracted to our open windows by artificial lights? we suggest the following reply: We have taken representatives of nearly all the orders of insects in our rooms by lamplight during the past ten years,—but mainly Lepidoptera (or moths). The following is a statement taken from notes of captures on an evening in July, 1869. Working with the microscope at an open window, with the lamp burning on the table, the following insects were attracted by the light:—First, a beetle (*Harpalus Pennsylvanicus*), rather a strange fellow to be about at this hour; next visitor, a water beetle (*Acilius fraternus*), then followed several moths, principally small species; the mosquito also made its appearance, and some small Ephemerœ. They flew out and in at the window, and in the reflected light across the street, numbers of moths could be seen as they crossed the rays from the lamp. Comparatively few rushed into or against the lamp,—evidently finding the light too strong for them, they flew out of the window to join in the dance going on outside, where the greatest number appeared to be. This answers the question in regard to the species generally attracted.

We shall now consider the second question, viz.:—What are some of the habits of those species, and for what purposes are they attracted? Without going into particulars about the habits of the several species, we will confine ourselves to the several orders as regards their being attracted by lights. Nearly all the specimens we have seen are nocturnal,—these feed and seek their mates by night. There are exceptions to this, as to most other rules, for in the case of some of the insects named, *e.g.*, *Harpalus* and *Acilius*,—both are diurnal species. The first named was abundant last summer, flying into lighted rooms in numbers, perhaps awakened by the light shining from the window on the side-walk, under which it had retired for the night, and so got up a little ahead of time. The other, *Acilius*, has been found at fault before, as also some of the large species of the family *Dytiscidæ*. They have been seen to pitch themselves on the glass roofs of conservatories, probably taking the shining glass for the surface of a pool or pond.

The reason for the appearance of water beetles at such unseasonable hours may be accounted for thus:—In summer the little ponds and pools are dried up, when it becomes necessary for them to shift, and in their wanderings they are no doubt dazzled and attracted by the light.

The order Lepidoptera comprises the majority of our evening visitors, such as moths. There are three classes of these creatures, divided into diurnal, twilight and nocturnal flyers. The eyes of the nocturnal species are constructed something like the owls, that is they are incapable of bearing the bright light of the sun. Any one conversant with the habits of these creatures will have noticed on confining a moth in a small box or in a partially darkened room, how its eyes shine. This shews that a difference exists between moths' eyes and those of other insects,—for instance, in those of the dragon fly, which spends its day in the rays of the sun, placed in a like position, no such effect is observed. This bears out the suggestion that the visual organs of nocturnal Lepidoptera reflect, and do not absorb, light.

On the other hand, observe the appearance of some of the Splingidæ and other nocturnal moths. In the day-time we have often observed them sticking to the trunk of a tree, or in the crevice or corner of a fence. Failing to secure them instantly, they would fly foolishly hither and thither, evidently annoyed by the sunlight, darting among the brushwood and bushes till at last they were captured,—none the better as cabinet specimens, on account of their wings being rubbed or antennae broken.

The purposes for which these creatures come out at night are two-fold,—I speak here of the typical night flyers of the order Lepidoptera.

The first of these purposes is for feeding. The following circumstance will corroborate this view: — Having sugared some trees on the mountain, I hung a lantern about two feet above where the sugar was spread. The night was very suitable for mothing,—dark and warm. We had not to wait long with our nets before several moths made their appearance, and with ready mouth, licked the sugar. Specimens of diptera also congregated, attracted by the smell as well as the light. Few flew to the light, but rested on or near the part rubbed with the sugar. The second purpose is with a view to finding their mates in order to perpetuate their species. It may be mentioned here that one of the chief aims of an insect's life seems to be to accomplish this end. This is more particularly the case with regard to moths, as may be seen from the following circumstance, which happened four years ago:—Sitting, with the window open, and a lamp burning on the table, a large moth flew into the room. I shut the window and captured it. It was a female of *Telea polyphemus.* The window was scarcely closed when something flew against it; knowing it to be another moth, the sash was again opened; in a very few seconds in the moth came, and flew up and down the ceiling, when the inevitable net soon enclosed it. This moth was the male of the above species, and its visit was, no doubt, a clear case of love-making. I mention another circumstance with regard to the females of the larger moths in particular, which I have observed frequently. A female never dies without depositing her eggs in some way or other. I have pinned moths time and again on the trunk of a tree, and in every instance (if not at the time of piercing the creature on the tree) always in the box before she died, when they are ejected on the introduction of the pin; they are unformed and soft. The creature, apparently aware of some change coming over her, does her best for the continuation of her kind up to the latest moment of her existence. Insects, especially Lepidoptera, copulate on the wing, and sometimes at great heights. We had an opportunity of witnessing this at Belœil mountain on the occasion of the field meeting of this Society last summer.

Examples of *Papillio turnus* were abundant,—flying higher than the trees,—and higher than the old ruin on the top of the mountain.

Vanessa antiopa was also observed, evidently enjoying themselves, as they flew towards the sun,—away above trees and other objects,—for diurnal Lepidoptera pair, and fulfil the end of their being in the bright beams of the sun. May we not draw the same conclusion with regard to the nocturnal species?

On moonlight nights where are the moths? No doubt flying at great heights, seeking each others company for the purpose of perpetuating their kind; and on moonless nights—as will be shewn further on,—those creatures are attracted by artificial lights for the same purpose. I would venture to offer the following suggestions: I have always found that moonlight nights were bad nights for mothing. On clear, moonlight nights these creatures find all they require in the broad expanse of field and forest. The journeys they take, and the enjoyment they have are uninterrupted on such occasions; but when a moonless, warm, moist, but not wet, evening comes, they are aroused by artificial lights, which to them, I believe, is their best substitute for moonlight. The conclusions I arrive at are, that nearly all insects which come out at night, come either for the purpose of feeding, or of continuing their species. They cannot, on account of the structure of their eyes, serve one of the purposes for which they were made, during the bright sunshine. The pale, mellow beams of the moon is their Pharos, and suits them best. You may sit at your open window, with your lamp or lamps, on a bright, moonlight night, and the number of typical night flyers, or insects of any kind, will be few indeed; experience is the best teacher, and so it has been in the present instance. But on a moonless night, with your lamp, you may make many captures. Insects on dark nights then seem to be attracted by lights, either in your rooms or by lanterns in the woods, because such light come nearest to the light they love and enjoy, namely, that of that

> "Orbed maiden, with white fire laden,
> Whom mortals call the moon."

NOTES ON VEGETABLE PRODUCTIONS.*

By Geo. E. Bulger, F.L S., F.R.G.S., C.M.Z.S., &c.

Seeds of the Wild Liquorice (*Abrus precatorius* Linn.)—These seeds are the produce of a twining plant, which seems to have been brought originally from the West Indies, though it is now common enough in India and other eastern countries. It belongs to the papilionaceous division of the natural order *Leguminosæ*. The English call it wild-liquorice, and the French *liane à réglisse.* There are several varieties, and three differently-coloured kinds of seeds are well known—black, white and scarlet. The last mentioned have a jet-black spot at one end, and, as they are very hard, glossy and brilliant, they are a good deal in request as beads for necklaces and other ornaments amongst the Hindoos. They are called retti-weights in India, and are used by jewellers and druggists, each seed being popularly supposed to be equivalent to one grain; but Dr. Mason says he has weighed

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* Part of a small collection recently presented to the Museum of the Natural History Society of Montreal.

many of them, and found them to vary from one to two grains. The native goldsmiths are said to make an adhesive compound from them, which is employed in the finer work of jewellery. Several parts of the plant are applied to various medicinal purposes. The root is used as a substitute for liquorice—hence the English name—and Lunan says that a decoction of the leaves is drunk in the West Indies instead of tea. According to Linnæus the seeds are very deleterious, but, as the Egyptians use them for food, they can hardly be so injurious as the great botanist has led us to suppose. As a plant, the *Abrus precatorius* does not possess much beauty, and the pale-purple flowers are neither gay nor striking. I have not seen it growing very abundantly in India, though I have found it pretty widely distributed in that country, as well as in Burmah. Mr. Gosse says it is a common hedge-climber in Jamaica, and it is doubtless equally plentiful in the other islands of the West Indies. The derivation of the generic name is from *abros* (pretty), in allusion, probably, to the beauty of the little seeds; and Loudon says the specific designation, *precatorius*, is due to the fact of their being used as beads for rosaries.

SEED-POD OF THE MORETON-BAY CHESTNUT TREE (*Castanospermum Australe* Cunn.)—The *Castanospermum Australe*, as its English name imports, is an inhabitant of the forests near Moreton Bay, in Australia. It is a handsome tree, belonging to the nat. ord. *Leguminosæ*, with an abundance of elegant foliage; and, in the season of bloom, the bright saffron-orange papilionaceous flowers are very gay. The seeds are large, and, in some slight degree, resemble chestnuts in taste and appearance. They are enclosed in an inflated legume or pod, which is hard and woody in its texture, and of a pale, reddish-brown colour. They are nearly globular in shape, and each pod contains from two to five seeds. Is is said that they furnish an article of food to the natives of the country where they grow, and that Europeans have been known to subsist upon them for some time without any injurious effects. The tree—the only one of its genus known to science—is very ornamental, and has been successfully cultivated in East Indian gardens, including the famous Lal Baug at Bangalore. The generic name is compounded from *castanea*, a chestnut, and *sperma*, a seed.

NICKAR BERRIES (seeds of *Guilandina bonduc* H. K.)—*Guilandina bonduc* is a thorny, climbing shrub of the nat. ord.

Leguminosæ. It grows abundantly in India, and is also common in the West Indies and other tropical countries. Burton mentions it in his *Abeokuta*, and in Harvey and Sonder's *Flora Capensis* it is enumerated as an inhabitant of South Africa. Two species are described under the names, respectively, of *bonduc* and *bonducella*, but, if the latter is distinct, I have not seen it, and several botanical writers of repute ignore it entirely, excepting as a synonyme of *bonduc.* * The flowers of *bonduc* are yellow, the leaves abruptly pinnated, and the whole plant is plentifully armed with ferocious spines. The prickly legumes usually contain two only of the grey and shining seeds, which, being very hard, are used as beads and marbles. They are extensively employed in medicine amongst the natives of the East, and are reputed, in Egypt, to be prized as charms against sorcery. They are frequently called bonduc-nuts, and are so strongly coated with silex, that, Sir Emerson Tennent tells us, they are said to strike fire like a flint. Royle asserts that *Guilandina bonduc* was the *akutmookt* of Avicenna, and that there are grounds for supposing

* Since the above was written, Mr. Whiteaves has drawn my attention to a paragraph in the *Treasury of Botany*, wherein, on the authority of Mr. A. Smith, *Guilandina bonduc* is described as having solitary prickles on the leaves, and producing yellow seeds, whereas *bonducella* is stated to have prickles in pairs, and lead-coloured seeds. Mr. Whiteaves has also shewn me specimens from the West Indies of both kinds of seeds, which are certainly very distinct in coloration. I am unable to solve the problem, or to decide whether the differently-coloured seeds belong to the same species or not; but I never saw the yellow ones in India, where I gathered, with my own hands, many hundred specimens of the grey kind; and I have the high authority of Wight and Arnott to support me in my opinion that the so-called species of *bonduc* and *bonducella* are identical. I quote from the *Prodromus Floræ Peninsulæ Indiæ Orientalis*, as follows: "It might be thought preferable to adopt the name *Bonducella*, as it was of that form only that Linnæus had seen specimens, *Bonduc* having been taken up from Plunkenet's figure; but the two being identical, not even varieties, we have preferred that which is simpler, and not a derivative of the other." I suspect that many of the less important characters of the species are very inconstant, and hence the confusion which has arisen. Indeed I find in Sir William Jones' *Botanical Observations on Select Indian Plants*, which appeared in the *Asiatic Researches*, vol. iv, the following statement regarding *Guilandina*: "The species of this genus vary in a singular manner; on several plants, with the oblong leaflets and *double prickles* of the *Bonducella*, I could only see *male* flowers as *Rhecde* has described them; they were yellow, with an aromatic fragrance: others, with similar *leaves* and *prickles*, were clearly *polygamous*."

it to have been one of the kinds of eagle-stone of the ancients. Ainslie identifies it with the *caretti* of Rheede, and describes the seeds as yellow, finely variegated with annular saffron-coloured zones, but these characters are not applicable to the common form, in which the seeds are of a uniform grey, with the annular markings very faint indeed. In Scotland they are often thrown upon the sea-shore, and are there known as molucca-beans. The genus was, according to Paxton, named in honour of Melchior Guilandina, of Prussia, a great traveller, and a Professor of Botany at Padua.

EAGLE-WOOD (*Aquilaria agallocha* Rox.)—It is now pretty generally thought that the far-famed lign-aloes of sacred history was the produce of a tree belonging to the genus *Aquilaria* of the nat. ord. *Aquilariaceæ;* and there are even grounds for supposing it to have been furnished by the *Aquilaria agallocha* of Roxburgh, from which is obtained at least one kind of the precious and fragrant resin known as *calambac;* but, until more accurate and precise information is forthcoming, the uncertainty that has hitherto enshrouded the identity of this delightful and glorious substance can scarcely be removed, or the halo of romance and mystery which hangs around it entirely dispelled.

Aquilaria agallocha is stated by Roxburgh to be a native of the mountainous parts of India, east and south of Silhet, in about the latitude of 24° to 25° north; but, as there is abundant and reliable testimony to show that a fragrant heart-wood, similar in most respects to the produce of that tree, is brought from many other countries, including Malacca, Java, Siam, and Cochin-China, it is quite evident that either the species under consideration, or others possessing like qualities, are pretty widely distributed over the continent and islands of Asia. Indeed, in works on eastern botany two or three different kinds are recognized, but, so far as I can learn, they have never been compared with Roxburgh's *agallocha*, with a view towards ascertaining if they really are specifically distinct.

I have not seen the tree of *Aquilaria agallocha*, but it is stated to be of immense size, and to possess a white, soft, light and inodorous timber, the heart-wood alone being heavy, hard, dark coloured, and highly fragrant. From the latter are extracted the rich essential oil known in India as *ugger*, and the costly resin called *calambac*. Both of these are extensively used as perfumes, and in the manufacture of incense. There are said to be several qualities of eagle-wood, and different kinds of resin procurable from it, which vary in value as in name, but, although I carefully searched the bazaars of Madras, Calcutta, Benares, Delhi, Agra, and other large Indian cities, assisted by an interpreter, I failed in obtaining more than one variety of each, and I could not learn that any others were even known.

The multitude of synonymes, which seem to be the property of eagle-wood and its products, have added, in no small degree, to the confusion which exists regarding it, and the imperfect and often conflicting accounts of travellers have rather increased the mystery than otherwise, and thus have almost nullified the advantage of their researches. On the whole, this interesting subject requires clearing up, and it is to be hoped that, ere long, it will receive the attention it so well deserves.

I cannot credit the statement that the fragrant wood is only found in trees which are diseased and decaying, for all the specimens that I examined were apparently sound and in the most absolute health, with the cells full of the precious and sweet-scented resin. The origin of the scientific names is obvious, but their relevancy is not so clear.

Capsule of the Frangipanni-Flower Tree (*Plumieria alba* Jacq.)—The history of this beautiful tree is very romantically associated with the visit of Columbus to the West India Islands, and with Mercutio Frangipanni, a botanist of the expedition. I find, in *Notes and Queries*, that Frangipanni lived in 1493, was a famous botanist and traveller, and belonged to a noble and celebrated Italian family. When the great explorer's vessel approached Antigua, the sailors observed that a delicious fragrance pervaded the air, and, upon landing, they found the island abounding in plants of *Plumieria alba*, laden with blossoms, and rich in "odours of Paradise." From the circumstance of Mercutio Frangipanni having expressed his great admiration of this lovely plant, it is called, by the inhabitants of Antigua, the Frangipanni-flower, and from it is distilled the famous essence of the same name.

This tree was long ago introduced into India, and it is now very plentiful in that country. At Bangalore, in the Mysore territories, no garden is without it, and, although leafless for a considerable portion of the year, it appeared to me to be never entirely out of bloom. When destitute of its rich and elegant foliage, it is not very attractive, owing to the somewhat peculiar and rather ungraceful growth of the branches; but, about the middle of March, there are few more beautiful objects, and so abundant is the perfume, that it is literally wafted hither and thither by

"— every breeze that roams about."

The flowers are white, fleshy and bell-shaped, with a yellow tube; and the leaves are large, lanceolate and of a dark and glossy green.

The loveliness of the plants themselves, and the rich fragrance of their delightful blossoms, have attracted the attention of all travellers, and Gosse, in his most charming works on Jamaica, has more than once touched upon the beauty of the Spanish jasmines, as the two species, *Plumieria alba et rubra*, which grow there, seem to be called. Bates, in *The Naturalist on the Amazons*, mentions *Plumieria phagedœnica* as one of the most singular ornaments of the campos. *Plumieria acuminata* is called the pagoda-tree in India, and is included, as well as the other species, in the native pharmacopœia. The genus belongs to the nat. ord. *Apocynaceæ*, and was named in honour of Charles Plumier, author of *Plantæ Americanæ*.

Gru-gru Nut (seed of *Acrocomia sclerocarpa*, Martius.)—These nuts, so-called, are the seeds of a noble South American palm, which, owing to its great height and stately growth, is one of the most majestic representatives of the kingly race to which it belongs. The *Journal of Horticulture* says the fruit are about the size of Orleans plums, perfectly globular and smooth, and, when fresh, of an olive-green colour. They have a thin, woody rind, beneath which is a layer of fibrous, gelatinous pulp surrounding the hard stone or gru-gru nut, and this again contains a single seed. The seeds of all the species of this genus contain hard stones, resembling in some degree those under notice; they are polished and carved by the natives of South America, and applied to many ornamental purposes. Both pulp and kernal are said to be eatable—the latter being white and pleasantly tasted. The tree belongs to the nat. ord. *Palmaceæ*, and the generic name is derived from *akros*, top, and *kome*, a tuft.

Seeds of the Perim-Kara Tree (*Elæocarpus oblongus*, Gærtn.)—The Perim-kara is a noble tree, and a great ornament to the forests of the Neilgherries and Southern India, where it grows; especially at the end of the cold season, when the elliptic-oblong leaves assume a most brilliant scarlet-crimson tint before they fall. The blossoms are brown and white, and possess a very unpleasant odour; the fruit is a drupe, not unlike the olive in appearance, only larger, and it contains a rugose nut, which, after being polished, is applied to many ornamental uses. According to Royle, the fruit of at least one species is eaten like olives, and those of other kinds are pickled and used by the natives of India, in their curries. The nuts are strung and employed as sacred beads by the Brahmins, and Royle says they are set in gold, and even sold as ornaments in the shops of Europe. I am unable to trace the origin of the native name, but the generic one is derived from *elaia*, the olive tree, and *karpos*, a fruit, in allusion to the resemblance between the fruits of the Perim-kara and the olive. Nat. ord. *Elæocarpaceæ*.

SEEDS OF THE RED-WOOD TREE (*Adenanthera pavonina*, Linn.)—This is a large tree, and, amongst the natives of India, its timber is known as one of the red sandal-woods. The flowers are small, fragrant, and of a yellowish white; the seeds are scarlet, glossy and hard. Like those of *Abrus precatorius*, the latter are used by the Hindoo jewellers as weights — each one being supposed to be equal to four grains; but, as they vary a good deal in size, they are, of course, not to be depended upon for this purpose. Bruised and beaten up with borax and water, we are informed that a cement is made from them, and their pulp, when mixed with honey, is used medicinally. The timber is very hard, of a deep red colour, and exceedingly durable; it affords a dye, which does not appear to be either very much used or very valuable. The tree was long since introduced from the East into the West Indies, and it has become very abundant there. In Jamaica, according to the *Journal of Horticulture*, the bi-convex seeds are known as Circassian beans, Lady Coote beans, and St. Vincent beans, and they are used for necklaces and other ornaments. Loudon, in his list of synonymes, quotes bastard flower-fence as the property of this tree. It belongs to the nat. ord. *Leguminosæ*, and the seeds are produced in a twisted, sickle-shaped pod, which usually contains about ten or a dozen. The generic name is derived from the fact of the anthers being gland-tipped—from *aden*, a gland, and *anthera*, an anther.

SANDAL-WOOD (*Santalum album*, Linn.)—Sandal-wood, sometimes called Saunders-wood, is the produce of *Santalum album* of the nat. ord. *Santalaceæ*. It is a native of India and other countries of the East, and is a small, handsome tree, with numerous little flowers, which are first straw-coloured, and afterwards of a deep purple. The fruit is a round, black berry. The outer timber is white and almost inodorous—the fragrant portion being only the yellow heart-wood, which is very hard and very handsome. The perfume extracted from sandal-wood is highly prized amongst the Easterns, and it is, perhaps, more extensively used than any other. Medicinal qualities are attributed to the essential oil, as also to the powdered heart-wood. The *Santalum album* is supposed, by some authors, to be identical with the almug or algum trees of Scripture. The name is derived from the Persian word *sandul.*

Indian Shot (*Canna Indica*, Linn.) — This pretty little shrub, with its large leaves and bright scarlet flowers, is very ornamental, and, consequently, cultivated extensively in gardens. It is a native of the tropics in both hemispheres. The seeds are round, black and glossy, resembling shot—hence the English name. The root-stalk of some of the species is edible, and, from one kind at least, is obtained the substance called *tous les mois.* The leaves are used as thatch, and from the seeds is prepared a beautiful purple dye; the roots, seeds, etc., are employed in Hindoo medicine. Loudon says that, in America and the Brazils, the *Canna* is called wild plantain, and that the leaves are used as envelopes for many articles of commerce,—hence, probably, the French name *balisier*—*balija* being Spanish for envelope. Francis Buchanan tells us (*Asiatic Researches*, vol. vi.) that this plant is peculiarly sacred to Bouddha, as it is supposed to have sprung from his blood, when, once on a time, he had cut his foot, by striking it against a stone; and that, therefore, the Burmese value the seeds for rosaries. It belongs to the nat. ord. *Marantaceæ*, and its name is derived from a Celtic word signifying a cane or mat.

Great American Aloe (*Agave Americana*, Linn.)—The romance which made the so-called American Aloe a centennial flower has passed away, and it is now well known that the intervals between its periods of bloom are very much shorter than was supposed, and that they depend, when the plant is under cultivation, pretty much on the mode of treating it. It is a noble and striking object, especially when its long, stately flower-scape towers up to the height of 18 or 20 feet from the centre of its clustre of sword-like, succulent leaves. The various species are applied to many useful purposes in the different parts of the world, where they are naturalized and abundant. They furnish an excellent fibre called *pita*, which is manufactured into a superior and durable rope of great strength and power. This rope is stated to have been subjected to a course of experiments in India, and found to have been stronger than the productions of coir, country-hemp and jute. A bundle of the agave-fibre bore 270 lbs. weight, and that of Russian hemp only 160 lbs. It is a famous hedge-plant, and is much used for that purpose at the Cape of Good Hope and in the East. Loudon informs us that it is either wild or acclimated in Sicily, the south of Spain and in Italy. It is abundant in the West Indies, and Humboldt says that it is common everywhere in equinoctial America, from the plains even to elevations of 10,000 feet.

In Mexico, where it is sometimes called *maguey*, a liquor is obtained from its juice, which, when fermented, is known as *pulque;* and from this is distilled an ardent spirit named *aguardiente de maguey.* The leaves of one kind are, acccording to Mollhausen, baked and eaten under the appellation of *mezcal*, and they are elsewhere used to make paper of, as also an excellent and impenetrable thatch. It is said that the juice possesses strong healing properties, and, in Jamaica, Long tells us that a species of soap is prepared from it.

I have often employed strips of the dried flower-stem—which is a light, pith-like substance—instead of cork for the lining of insect cases; and Bennett records the same use of it in Australia. He also says that, owing to the minute particles of silica which it contains, razor-strops are made of it in that country; and I have possessed and used with great success several that were brought from the West Indies. Chapman, in his poem called *Barbadoes*, speaks of this plant as the May-pole.

> " Here, towering in its pride, the May-pole glows,
> Whose pointed top a bee swarmed circlet shews
> Of waving yellow; whose high-branched stem
> Takes back the rapt thought to Jerusalem,
> Shewing the candlestick that stood of old
> In the first temple, chased in purest gold."

The *Agave* belongs to the nat. ord. *Amaryllidaceæ*, and the name is derived from *agaus*, regal.

Seeds of the Gela (*Entada pursætha*, DeC.)—This is an enormous climbing plant of the nat. ord. *Leguminosæ.* Its stem, which is thick, rope-like and very long, ascends to the highest trees, whence depend its beautiful foliage, small, yellow flowers and immense seed-pods, which Sir Emerson Tennent met with six inches wide and fully five feet in length. He says the Kandyans call it *maha-pus-wael*, meaning great hollow climber, and that probably the mountain region of Pusilawa, which he describes as very beautiful, and one of the finest coffee-districts in Ceylon, takes its name from this plant. The seeds, he adds, which are handsome brown beans of an immense size, furnish the natives of Ceylon with tinder-boxes, which they make by scooping out a portion of the interior. They are also used in medicine and as a detergent. The plant seems widely distributed, and is included in the Cape Flora. The seeds, according to Harvey and Sonder, are the common sword-beans of the East and West Indies, and of the tropical Pacific. The generic name is of Indian origin —*entada* being the Malayalam designation.

NATURAL HISTORY SOCIETY.

MONTHLY MEETINGS.

(*Proceedings from January* 1*st to April* 30*th*, 1870.)

Third monthly meeting, January 31st, 1870; Rev. Dr. De Sola presiding.

DONATIONS TO THE LIBRARY.

Réapparition du Genre Arethusina, Barrande; and Faune Silurienne des Environs de Hof, en Baviere—par Joachim Barrande. From the Author.

Bulletin of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass. (Nos. 9 to 13). From the Trustees.

PROCEEDINGS.

Prof. J. W. Marsh, of Pacific College, Forest Grove, Oregon, was elected a corresponding member of the Society.

The following resolutions, having been moved by Principal Dawson and seconded by Rev. Dr. De Sola, were carried unanimously:—

"That this Society, in presenting its medal to Sir W. E.

Logan, LL.D., F.R.S., &c., although it cannot add appreciably to the many honours which he has received, desires to place on record, not merely on its own behalf, but on that of all the students of Natural Science in Canada, its high estimation of the value of his services in creating, as well as directing, the geological survey of this country, in promoting the development of its mineral resources, in stimulating and aiding the efforts of scientific institutions, and in extending throughout the world the name of Canadian science.

We desire also to express our high appreciation of Sir William's admirable personal qualities, and our hope that he may be spared for many years to Canada and to science, and that the relief from official cares may give him the opportunity to pursue to completion the researches in physical geology in which he is now engaged."

Mr. E. Billings read a paper "On the occurrence of Gasteropoda in the Primordial Zone." He commenced by giving a short account of palæontological discoveries recently made in other countries, and then exhibited a fossil that had been collected during the summer of 1869 by Mr. T. G. Weston, of the Geological survey, in the Primordial slates of St. John, N. B. The specimen was a small species of *Ophileta*, and its geological position was several thousand feet below the lowest beds in which any Gasteropoda had been heretofore found in America. The rocks were of the same age as the Lower Lingula Flags of Wales, the "Menevian group" of the late Mr. Salter. Another species, but of a different genus, has been found by Mr. Murray in Newfoundland, in rocks which appear to be Primordial, but whose age cannot yet be determined with certainty for want of sufficient fossil evidence.

Prof. R. Bell then read a paper "On the Intelligence of Animals." He spoke of the reasoning powers in many of the higher and larger animals as being too well established to require a plea, and devoted the greater part of his paper to the consideration of instances of what might be regarded as intelligence in such small creatures as insects. Many arguments were adduced, based on the organization and development of these creatures, and more especially on their habits, for regarding them as possessed of something more than mere instinct. Amongst other proofs of the possession of a reasoning power, the fact was mentioned, that insects, if baffled in one means of accomplishing their object, will generally try another; and that we find them as prompt and skilful in overcoming exceptional and artificial difficulties, as in performing the ordinary duties of their lives. The habits of insects, like those of the larger and higher animals, appear to be in a great measure the result of the accumulated experience of many generations. The term instinct, the writer said, has too general and vague a signification, and is often used as a convenient way of accounting for what it is found difficult to explain.

After the reading of this paper, a discussion ensued, in which Drs. De Sola and Evans, and Messrs. Billings, Ritchie, Whiteaves and other members took part.

Fourth monthly meeting, February 28th, 1870; Rev. Dr. De Sola in the chair.

DONATIONS TO THE LIBRARY.

Geology of Tennessee, Safford. Presented by Dr. A. Gottingen, State Librarian, Nashville, Tenn.

On the Chemical and Mineralogical composition of the Dhurmsalla Meteoric Stone, by Rev. S. Haughton, M.D., F.R.S., &c. From the Author.

The Principles of Æsthetic Medicine, by Dr. J. B. Catlow. From the Author.

Le Glacier de Boium, en Juillet, 1868, par S. A. Sexe; and two other 4to pamphlets. From the Royal Society of Christiania.

PROCEEDINGS.

Mr. A. S. Ritchie read a paper entitled "Why are insects attracted to artificial light," which will be found entire at page 61 of the present volume.

Prof. R. Bell gave a verbal account of the zoology and botany of the Nipigon country. Principal Dawson made some remarks on this communication, and said that it was much to be regretted that, when parties were sent by the Geological Survey to explore distant and comparatively unknown parts of the Dominion, no competent naturalist formed part of the expedition. Much practical knowledge as to the agricultural capabilities, &c,, of the region explored was thus lost to the community.

Fifth monthly meeting, March 28th, 1870; the President, Rev. Dr. De Sola, in the chair.

DONATIONS TO THE LIBRARY.

North American Oology, by Thomas Brewer, M. D. Part I. Quarto. Plates, uncoloured.

Zoology of H. M. S. *Samarang.* Fishes. By Sir John Richardson. Quarto. Plates. Both from G. Barnston.

PROCEEDINGS.

The two following resolutions, having been moved by Dr. Smallwood, seconded by Dr. Carpenter, (in the absence of Principal Dawson, were unanimously adopted:

1. "That as Mr. Whiteaves has liberally offered to place his private collections of recent shells and British Jurassic fossils in the Museum of the Society, and to make them accessible to members and others, for the purpose of study, so long as he shall remain in Montreal, and under the rules applicable to the collections of the Society, the Treasurer be authorized to expend a sum not exceeding one hundred dollars, in providing the necessary cabinets and materials for mounting and preserving the collections—it being understood that Mr. Whiteaves will himself mount and label the specimens; also, that the Treasurer be authorized and requested to insure this collection for a sum of not less than one thousand dollars, but not to exceed two thousand, so long at it remains within the building of the Society."

2. "That whereas, it is important to the cause of science, and conducive to the interests and reputation of this Dominion, that researches, by dredging, should be prosecuted in the Gulf and River St. Lawrence; in order to ascertain the character of marine life in the greater depths, and at the confluence of the fresh and salt waters of the river; and whereas this Society, and individual members thereof, have so far entered upon such researches as to prove their feasibility and importance, but have not the means of continuing them effectually; it is the opinion of the Society that aid should be afforded to such operations by the Government, in the manner in which this has been done in Great Britain, and other countries, especially by giving, for a short time in summer, facilities on board government vessels, to a party to be furnished and fitted out by this Society, which would undertake to provide observers, and scientific apparatus, and to make reports upon such

results as might be obtained; that Drs. Smallwood and P. P. Carpenter, also Messrs. E. Hartley and J. F. Whiteaves be a committee to correspond with the Dominion government, through the Hon. the Minister of Marine, with the view of effecting the desired results; that Principal Dawson be requested, when in London, to obtain information as to the best methods of making such subsidiary observations on the temperature, chemical constitution, etc., of the waters at great depths, as have been made in the recent dredging operations under the auspices of the British government, and, if possible, to procure specimens of the necessary apparatus."

The two following papers were read by Dr. P. P. Carpenter:

1. On some Peculiarities in Local Faunæ, exhibited in the Dredgings, by Mr. McAndrew, in the Red Sea; by Captain Pedersen, in the Gulf of California, and by Mr. Dall, in Alaska.

2. On the Vital Statistics of Montreal for 1869, with special reference to the great disproportion in death-rate between the French, the Irish, and the English portions of the population.

Sixth monthly meeting, April 25th, 1870; Rev. Dr. De Sola presiding.

DONATIONS TO THE LIBRARY.

Hooker's Icones Plantarum. Octavo. London. Half Morocco. Presented by E. Hartley, Esq.

Reliquiæ Aquitanicæ. Part 10. From the executors of the late Henry Christy, Esq.

Température de la mer entre l'Irlande, l'Ecosse, et la Norvége. Avec cinq cartes, par H. Mohn, Christiania; from the Royal Society of Christiania.

A flora and fauna within living animals, by Joseph Leidy, M.D., 4to, Washington; from G. Barnston, Esq.

PROCEEDINGS.

John Thomas Molson was elected a life member.

Gordon Broome, F.G.S., and James Dakers were elected ordinary members.

Alfred Bell (of London, England) was elected a corresponding member.

The following resolutions having been moved by A. S. Ritchie, and seconded by G. Barnston, were unanimously adopted :—

" That the members of this society regret deeply the resignation of their janitor and taxidermist, Mr. W. Hunter, who has so satisfactorily filled the joint situation for a number of years. They also sympathize with him in his bereavement, and in his continued ill health, the immediate cause of his resignation. It is hereby recommended to the society that steps be taken to present Mr. Hunter with a suitable testimonial in consideration of his long and valuable services."

Messrs. G. Barnston, John B. Goode, and the mover, were appointed a committee to carry out these resolutions.

Dr. Smallwood read a paper "On some phenomena of the Solar Eclipse of August, 1869."

Mr. A. S. Ritchie read an essay entitled: "Aquaria Studies, No. 1." This will be found at page 1 of the present volume.

SOMERVILLE LECTURES.

The six lectures of this course were delivered as follows:—

1. February 10th, 1870. "Explorations in the Nipigon country," by Professor R. Bell, C.E., F.G.S.
2. February 17th. "Recent discoveries in Solar Physics, and the total eclipse of August 7th, 1869," by James Douglas, jr., President of the Literary and Historical Society, Quebec.
3. February 24th. "The chemistry of Iron and Steel," by Dr. T. Sterry Hunt, F.R.S.
4. March 10th. "On Deep Sea Dredging," by Principal Dawson, LL.D., F.R.S.
5. March 17th. "On Gold," by Dr. G. P. Girdwood.
6. March 24th. "On Economic Mineral Deposits," by G. Broome, Esq., F.G.S.

ANNUAL CONVERSAZIONE.

The eighth annual conversazione was held at the rooms on the evening of Wednesday, March 9th, 1870.

The whole of the ground floor was tastefully decorated with evergreens, under the superintendence of Mr. D. McCord. Fine geological maps and sections were kindly lent for the occasion by the officers of the Geological Survey of Canada. Messrs. Theodore Hart and Hugh Allan also kindly contributed bouquets of choice cut flowers from their respective greenhouses. A number of microscopes, with objects, were placed in the library, this department being under the special superintendence of the Montreal Microscopic Club. Mr. J. M. Young sent one of

Powell & Lealand's large binocular instruments, with all the newest accessories. This is probably the finest microscope ever imported into Canada. Other instruments were contributed by Dr. J. B. Edwards, Messrs. James Ferrier, jr., A. S. Ritchie, D. B. Scott, R. McLachlan, and J. F. Whiteaves. Mr. Scott shewed the circulation of the blood in the web of the foot of the Shad Frog, also beautiful living examples of *Vorticella campanularia*, *V. nebulifera*, *Stentor cœruleus*, and other infusoria from his own aquarium. Mr. A. S. Ritchie illustrated details of insect structure, especially elytra of exotic beetles, and wings of tropical butterflies and moths. He also exhibited some good diatom slides, and a photograph, of microscopic animals and plants from a pond at Leytonstone (near London, England) by H. C. Richter. Mr. R. McLachlan shewed German examples of *trichina spiralis*, and Mr. Whiteaves some choice polariscope objects, while Messrs. Young and Ferrier contributed a number of fine slides by English preparers. The string band of the P. C. O. Rifle Brigade was in attendance and performed a choice selection of music during the evening. A little after 8 o'clock, H. R. H. Prince Arthur, attended by Lieut. Picard, entered the building, where he was received by a deputation of tho senior officers of the society. The following address to H. R. H. was then read by the acting president, Rev. Dr. De Sola :—

To His Royal Highness Prince ARTHUR *Patrick William Albert, Knight of the most ancient and most noble order of the Thistle, Knight of the most illustrious order of Saint Patrick, &c., &c.*

MAY IT PLEASE YOUR ROYAL HIGHNESS.

We, the officers and members of the Natural History of Montreal, beg leave to approach your Royal Highness with our most respectful salutations, and to tender you a very cordial welcome on this occasion, when we are honoured with your presence amongst us.

We beg to assure your Royal Highness of the reverence and regard in which we hold the exalted virtues and beneficent rule of Her Most Gracious Majesty the Queen.

Our Society has existed as a corporate body for 38 years, during which time it has ever had as its chief object the advancement of the study of Natural History in this city and throughout Canada. It has erected this building, in which we have collected and arranged a museum which is attaining a magnitude that will bear favorable comparison with ordinary public museums in England, and is essentially valuable for its exhibition of local specimens. It has created the nucleus of a useful library of reference on scientific subjects. It has sought to promote original investigation and to foster a taste for the study of nature by its lectures, its papers regularly read, and by its organ the "Canadian Naturalist" which spreads the best attainable information on the natural productions of Canada, not merely among students in the Dominion, but throughout the scientific world where it is favorably known. We believe that the aims and labors of such an association as ours will enlist the fullest approval of your Royal Highness as they did that of your honoured and lamented father, whose name is revered wherever science is cultivated, as one of its most earnest friends and efficient promoters.

To which His Royal Highness read the following reply:

To the Officers and Members of the Natural History Society of Montreal.

Gentlemen,—It is to me a source of great satisfaction to receive this address of welcome at the hands of a Corporation so learned and distinguished, many of whose members have battled so bravely in the cause of science.

Their achievements in the field of Geology and Organic Chemistry are well-known, not only to Canadians, but to the scientific world at large, and the meritorious literary contributions in other branches of science afford clear indications of the ability and of the attainments of the various members. The establishment of this excellent museum, so full of objects of deep interest, reflects great credit upon this Society. Most praiseworthy are the efforts of the members to popularise the natural sciences, and most sincerely do I offer to them my congratulations on the success that has attended their undertaking.

ARTHUR.

Dr. De Sola said:

May it please your Royal Highness; Ladies and Gentlemen:

The annual conversazione of the Natural History Society, always a gala season for its members, becomes especially so this evening, when we are privileged to welcome to it the honored son of our highly revered and dearly beloved Queen, on whom may God bestow many years of happiness and blessing. On so memorable an occasion in the history of this society, there devolves upon me a duty that could have been more worthily and ably discharged by another—the pleasant duty of extending to you, ladies and gentlemen, on behalf of the society, a very cordial welcome to the entertainment we are enabled to offer you. I beg to assure you that we experience a very high degree of gratification in believing that your presence on this and other occasions is intended to evince your sympathies with the objects of our society. May we be permitted to hope that these sympathies will lead you to become, instead of mere annual visitors, permanent, earnest co-labourers with us. I at least propose in a few remarks on some of the intellectual and utilitarian aspects of the study that engages us here, to show you that we have some warrant for the invitation we give you to labor with us in its great and glorious cause.

In its most extended sense Natural Science means an investigation into the laws governing, and the elements composing, the whole of God's material works; the heavens above, and the earth beneath. The boundlessness of such a field of inquiry, I could not on this occasion, more forcibly and, I trust, more appropriately, impress on you, than by quoting the words of that excellent and lamented Prince, whose like in respect to his extensive attainments in literature and science, and his judicious and successful efforts to promote them, Britain has never yet seen; who, in his life, afforded us a noble illustration of all that dignifies humanity, and in his death, left us a precious example how the time and talents God bestows on us may be most beneficially employed for the best interests of mankind. Need I say I refer to Albert the good? These are his words addressed to the British Association at Aberdeen, in 1859:—

"But in gaining new centres of light from which to direct our researches, and new and powerful means of adding to its ever increasing treasures, science approaches no nearer to the limits of its range, although travelling further and further from its original point of departure. For God's world is infinite, and the boundlessness of the universe, whose confines appear ever to retreat before our finite minds, strikes us no less with awe when, prying into the starry crowd of Heaven, we find new worlds revealed to us by every increase of the telescope, than when the microscope dicloses to us in a drop of water or an atom of dust, new worlds of life and animation, or the remains of such as have passed away."

A society such as ours has to regard Natural Science in its more limited sense. It is only from a few salient points that we can hope to penetrate a field which is not more distinguished by its boundlessness than by its variety. But in its immense variety we discover the more we advance in the study, a prevailing uniformity that speaks of plan and system. And as the astronomer has shown that the slight deviations and perturbations of the spheres in their course are, equally with the regularity of their movements, the result of fixed laws, so the scientific naturalist holds it as one of his highest duties to discover and exhibit the principle governing not merely the uniformity of structure and habits of living nature, but all those deviations from it, that at first sight seem so unaccountable and perplexing. If this be so, then, all persons of all degrees, stations and occupations, should aid in some way or other a Natural History Society. For the scientific naturalist wants facts and results of observations; and he frequently wants those facts which may appear trivial and unimportant, but which he is able by his powers of generalization to show, when connected with other facts already obtained, possess a very great value in connecting what is vague, contradictory or erroneous in his former deductions. And the contributor of these facts need not to be a scientific one. Every one with ordinary powers of observation may make important additions to the stores of scientific knowledge. Some of the most valuable contributions to Natural History have been made by unscientific travellers, who simply but faithfully described what they saw and collected. But we need not go to foreign countries to pursue our investigations; there is quite enough room for them in this Canada of ours. For not to speak of the specially interesting field we have for geological and mineralogical research, there is ample scope for observation and enquiry into the structure and vital actions of even our lowest plants and animals, not by any means thoroughly investigated; and it may be safely promised the diligent collectors among our insects and marine tribes, that their labors will not always remain unrewarded by the discovery of some species hitherto unknown, and thus valuable contributions made to an important department of natural history— the geographical distribution of animals.

The duty of acquiring and imparting knowledge from observation, though a very evident one, inasmuch as it advantages society as well as the individual, is yet one very generally neglected. We have heard of a pedagogue in a small village, who having joined a crowd anxiously engaged in watching an eclipse of the sun, and who having been asked in deference to his superior learning what was the cause of this extraordinary appearance, replied, "It is only a phenomenon." The truth seems too evident to repeat that if, when we behold anything extraordinary in nature, we check our instinctive curiosity by saying to ourselves: "It is only a phenomenon;" we shall not be one step nearer any rational knowledge of the appearance than if we had never observed it. "How many singular phenomena," exclaims the zealous naturalist, in accents of bitter regret, "how many rare and precious fossils have been lost to the world, seen by blind eyes. How many gas lamps might have trembled at sounds before a Lecomte observed under what conditions the ball-room lights responded to the tones of a violoncello."

But the study of Natural History is not merely valuable as a means of cultivating the powers of observation, but of educating all the faculties of the mind. Advancing as it does from the study of the simple to the analysis of the complex it must necessarily bring into play all those mental powers that men are called upon to exercise in all the engagements of life. "The process by which truth is attained" says Mill, "reasoning and observation, have been carried to their greatest known perfection in the physical sciences." Natural History being concerned rather with the knowledge of things than of words, can lay claim to an exactness which is not the least of its merits. Another of its advantages is, that it supplies us with great ideas of natural law and harmonious adjustment. Finally, it bestows on us a general quickness of perception, for the habits of observation it necessitates, gives to the intellect a superior aptitude of understanding and enjoying the thing observed.

Were this the occasion to dwell on the utilitarian aspects of the study, we might refer to the countless blessings it has bestowed on man in the shape of all those things essential to his wants and comforts. We might point to an improved agriculture and horticulture—to the protection of crops from the devastions of insects, to the multiplication of the ores, the coal, the useful and precious stones and metals; we might poinl to the wondrous triumphs of science applied to the arts; to the labour-saving processes which enable all to possess so cheaply the comforts and elegancies of life formerly attainable only by the very few. Especially might we point to these in the mother country, but they are not entirely absent in this Dominion, even with a sparse population of compararatively scant leisure and opportunities. For where first stood the primeval forest in which roamed only savage man and wild beasts, now rise large cities, important centres of commerce, pleasant villages and smiling hamlets; where formerly prevailed unbroken stillness and solitude is now heard the busy hum of industry, the cheerful sound of civilized man's labour in his work shops and in his factories, with his labour saving implements and machines and engines, and his countless devices for multiplying force and velocity, all originating in science and directed by science, the friend of art and the guide of industry. Where the Indian canoe slowly bore its untutored occupant in his short journeys on the bosom of onr noble streams, now rides the majestic steamboat carrying its hundreds of passengers hundreds of miles, even through a night's sleep, on their errands of business, pleasure and duty; where on the banks of these streams could only be seen a few rude wigwams approached by the narrow bridle path or painful trail, now stand thousands of commodious houses and palatial mansions, everywhere connected with broad and easy roads or well furnished railways, along which rushes the mighty locomotive, so fearful in its energy and power, with its freight of human beings, and all that ministers to their wants in distant settlements, speeding on its way through tunnelled hills and mountains, over the marvellous tubular and suspension bridges that hang over gorges of dizzy depths; following the telegraph wire, along which the lightning with its proper rapidity conveys man's messages, wishes and behests; over the canals that science has substituted for rivers not navigable; along rich corn fields and beautiful gardens replete with lovely flowers, luscious fruits and perfumed exotics, all multiplied and improved by scientific culture; such are some of the results which science, applied to the arts, has obtained for us in Canada; and there is not one of her sons or daughters who may not yet aid in further developing these blessed results.

But, it is no mere material, grovelling earthly science that we laud and advocate in this Institution, but a science whose eye alternates between earth and heaven;—below, seeking the advancement and good of humanity; above, finding communion with the Great Creator and Architect of all; acquiring the fuller knowledge of wisdom and design, and adaptation and harmony everywhere displayed.

"To see in part
That all, as in some piece of art,
Is toil co-operant to an end,"

—and that end the elevation and felicity of man. Yes, the benevolence, the wisdom and the omnipotence of Him, who formed all and maintains all, are made more and more manifest to us as we advance step after step in the study of natural science. We hear the voice of God on the mighty waters, when He thundereth and when He flasheth the flames of fire that shiver the mighty cedars. We raise our eyes and we see his infinite and unapproachable wisdom displayed in the delicate adjustments and felicitous arrangements of the varied forces that astronomy reveals. We see it in the mechanical, chemical and physical properties of the atmosphere, in the effects of light and heat, in developing and fostering all the varied beautiful animal and vegetable life; in the production of cooling winds and fructifying showers. We read this testimony in the towering rocks and giant trees as in the grains of sand and petals of the flowers; in the nerves and veins and arteries which permeate this wondrous frame of ours, as in the vessels that convey the sap from the root to the leaf in the vegetable world, in short in all the countless adaptations and modifications everywhere visible, everywhere needed. And when we pass from the known to the unknown; from the revealed to the unrevealed; from the study of the stupendous and inimitable organisms, it is given us to understand, to the contemplation of the mysterious powers and qualities and forces in nature which seem almost for ever destined to baffle man's puny efforts to resolve them, we cannot fail to carry away a sentiment of the most profound humility, a deep seated conviction of the utter weakness and insignificance of our powers. Yes, from the study of nature, from this house in which it is specially cultivated, we should and we must carry into the active occupations of our lives, in our daily intercourse with our fellow beings, an earnest desire to emulate, as far as we may, the attributes of the Creator, as revealed to us by nature; to select the most comprehensive of these attributes,—benevolence, as the main spring of all our thoughts and actions; so that we may look upon all men, no matter what their origin, color or creed, as equally the objects of the one Creator's care and the one Creator's love and so that we may learn to practice that toleration for each other's cherished opinions, political or religious, that shall ever banish from amongst us the bitter wrangling of dogmatism and the rancour of sectarian strife, and shall secure among us the rule of that harmony everywhere prevalent in nature, and everywhere taught by her,—the harmony that shall prove

> " The chain of love,
> Combining all below and all above."

Principal Dawson, in a short address, rapidly epitomized the work done by the Society since its establishment, more than thirty years ago, in gathering and recording facts in Canadian natural history; also in promoting the origination of the Geological Survey, and, incidentally, in being instrumental in the founding of the Somerville course of lectures. He also pointed out in detail the peculiar functions of the Society as being, to compare small things with great, in one respect at least, somewhat analogous to those of the British association,—at least, in so far as either of them might urge on the attention of the public and the Government any opening of new paths of scientific local enquiry. It gathered facts and preserved a record of them in the " Canadian Naturalist,"—facts which would otherwise have been lost, or retained no scientific value. It had one of the most important museums in the city; and outside of its more proper sphere, it had lent its countenance and assistance to obtaining the passage of the Act for the protection of insectivorous birds, to the promotion of city sanitary effort, and to the formation of the Society for the Prevention of Cruelty to Animals. It was, however, to be regretted that Canada did not show herself more disposed to take part amongst the nations in some departments of scientific investigation; likewise, that competent zoologists and botanists were not invited to accompany the expeditions sent out by the Geological Survey, as they might do with great advantage and at a light expense.

The Chairman called on Dr. J. Baker Edwards, F.C.S., to make some remarks on

APPLIED SCIENCE, AS ILLUSTRATED IN THE USEFUL PRODUCTS OBTAINED FROM COAL.

Dr. Edwards stated that the direction of his remarks would not be towards a chemical demonstration of the miscellaneous products derived from coal, but, by the enumeration of their character and importance, to derive an encouragement for the spread of scientific knowledge throughout all classes of the community. Canada, being a country full of mineral wealth, might look to the education of the industrious classes as one of the great sources of her future wealth and importance; and although coal was not one of her mineral treasures, yet we should not fail to see that we are as much interested as consumers of its products, as if we were producers of it as a mineral. The different varieties of coal—anthracite, cannel, albertite, &c.,—were then described, and the production of coal-gas illustrated by a large diagram showing the interior of a gas works. The first product of coal, illuminating gas, being illustrated by a photometer, by which the Montreal gas was declared to be equal to 21 sperm candles, which, he believed, was superior to any in Canada, and equal to most of the large towns of the north of England, the "applied science" was to be found in the choice of suitable admixtures of coal to form the best coke as well as the best and purest gas. The use of gas as fuel, by Siemann's Regenerative Furnaces, was next described; and this mode was recommended as the most economical for any coal containing much gas; by its aid a new process for the production of soda ash was now being worked with much success in Liverpool. In the necessary purification of gas for illuminating purposes, quantities of tar and ammoniacal liquor are produced; and by the chemical treatment of the tar especially, new and valuable products are obtained. The benzole so largely employed for the solution and manufacture of rubber compounds is derived from this source, as also the asphalt of our pavements, roofing and tarpaulings. In cookery and perfumery we meet with nitro-benzole under the name of almond flavour, from which is derived aniline, the base of that beautiful series of colours well known as the aniline dyes. Important as these are in a commercial point of view, they are surpassed in social importance by the production of carbolic acid, which now stands at the head of our disinfecting agents. From this substance is also obtained a yellow dye, picric acid, which is said to possess explosive properties rivalling gun-cotton and nitro-glycerine. Finally, from the ammonia and sulphur recovered from the process, we have valuable fertilizing agents which, when returned to the soil, complete the great cycle of vegetable existence. From this brief review of the value of applied science to coal, Dr. Edwards urged the importance of the establishment of schools of technical science to supply an existing want in this community, and to enable the coming generation to develop the immense mineral resources of this rich country.

Illustrations of the luminous and chromatic properties of flame were shown after the lecture by the aid of the photometer, the electric light, the sodium light, &c.; also, the process of dyeing silk by Aniline colours.

His Royal Highness then proceeded to examine with some care the various objects in the museum, the curator pointing out any of special interest. He paid particular attention to the collection of mammals and birds, also to the series of Canadian insects, the study of entomology, particularly of the lepidoptera, seeming to have had special attractions to His Royal Highness. The company separated a little after eleven o'clock. J. F. W.

ABSTRACTS OF THE PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF LONDON.

At a recent meeting of the Geological Society of London, the following communications were made, of which we present abstracts to our readers:

"Notes on some specimens of Lower-Silurian Trilobites." By E. Billings, Esq., F.G.S., Palæontologist of the Geological Survey of Canada.

The author first described a specimen of *Asaphus platycephalus*, in which the hypostome was not only preserved *in situ*, but also the remains (more or less well preserved) of eight pairs of legs, corresponding with the eight segments of the thorax, to the underside of which they had been attached. The appendages take their rise close to the central axis of each segment, and all curve forwards, and are thus most probably ambulatory rather than natatory feet. They appear to have had four or five articulations in each leg.

Three small ovate tubercles on the pygidium may, perhaps, indicate the processes by which the respiratory feet were attached.

Mr. Billings referred to the large number of Trilobites which have been examined, and expressed his belief that only the most perfectly preserved specimens are likely to have the organs on the underside preserved.

Mr. Billings next described the doublure or pleura in the Trilobites, comparing it to that of *Limulus*. He then proceeded to describe a row of small scars and tubercles on the underside of the pleuræ, to which both Dr. Volborth and Dr. Eichwald believed soft swimming feet or hard horny legs had been attached. As these were first seen by Dr. Pander in a Russian Trilobite, Mr. Billings has called them "Panderian organs." He thinks, soft natatory appendages may have been attached to these scars.

Mr. Billings directed attention to the *Protichnites* and *Climactichnites*, which he thinks may now be referred to *Crustacea*, belonging to the division *Trilobita*.

Finally, Mr. Billings described a section of a rolled-up *Cymene senaria*, the interior cavity of which appears to be full of minute ovate bodies, from 1-80th to 1-100th of an inch in diameter.—These small ovate bodies the author believes to be eggs.

"Note on the palpus and other appendages of *Asaphus*, from the Trenton Limestone, in the British Museum." By Henry Woodward, Esq., F.G.S., F.Z.S.

Mr. Woodward, when comparing the Trilobite sent over by Mr. Billings with specimens in the British Museum, presented by Dr. J. J. Bigsby, F.R.S., discovered upon the eroded upper surfaec of one of these, not only the hypostome exposed to view, but also three pairs of appendages, and what he believes to be the palpus of one of the maxillæ. This furnishes an additional fact to Mr. Billings's most interesting discovery, besides confirming its correctness.

Mr. Woodward considers the so-called "Panderian organs" to be only the fulcral points upon which the pleuræ move, and showed that such structures exist in most recent Crustacea.

He considered that the evidence tended to place the Trilobita near to, if not in, the Isopoda Normalia.

He remarked that the prominence of the hypostome reminded one strongly of that organ in *Apus*, and suggested that we might fairly expect to find that the Trilobita represented a more generalized type of structure than their representatives at the present day, the modern Isopoda.

Discussion.

Mr. Woodward had carefully examined Mr. Billings's specimen, and agreed with him in considering that there was undoubted evidence of the presence of walking-appendages under the thorax.

The presence of such limbs might *à priori* have been expected; and the nature of the test suggested that Trilobites were walking rather than swimming forms of Isopods. The branchiæ had probably been under the telson; and this would account for its large development. It was not more surprising to find highly organized Trilobites than it was to find such highly organized crustaceans as *Pterygotus*, *Eurypterus* and *Slimonia* in the same beds.

Prof. Rupert Jones, Principal Dawson, and Sir Wm. Logan made some remarks, more especially on Protichnites and Climactichnites, the latter having been explained as galleries of Crustacea by Prof. Jones, when first exhibited in England.

"Notes on the Geology of Arisaig, Nova Scotia." By the Rev. D. Honeyman, D.C.L., F.G.S.

The author referred to a previous paper on the Upper Silurian Rocks of Nova Scotia, which he stated appeared to him now to be generally repetitions of his Arisaig series. He noticed the occurrence of fossils in one of the beds previously supposed to be almost destitute of organic remains, and described the occurrence, in Arisaig township, of a band of crystalline rocks which appeared to contain *Eozoon* and were probably of Laurentian age. A note from Prof. Rupert Jones, giving an account of the fossils referred to by Dr. Honeyman, was also read.

Discussion.

Sir W. Logan said that Dr. Hunt had seen the specimens of serpentinous limestone, and considered that they might be Laurentian. Sections of them appeared to Dr. Dawson to show tubulation rather different from that found in Laurentian *Eozoon*. They might, therefore, belong to a different age.

The following among other specimens were exhibited to the Meeting:—

Specimens of *Sigillariæ*, Calamites, etc.; exhibited by Principal Dawson.

Specimens of Trilobites; exhibited by E. Billings, Esq.

REVIEWS AND NOTICES OF BOOKS.

Disinfectants and Disinfection, by R. A. Smith, Ph.D., F.R.S.—(*Continued from No. 2, page 228.*)—A large portion of the experimental and original investigations of our author were made by Royal Commission, in conjunction with Professor Crookes, F.R.S., in an enquiry into the nature of and remedy for the Cattle Plague of 1865-66.

A subject of so great national and world-wide importance demanded the closest scientific scrutiny ;—and whilst, on the one hand, the microscope was made the instrument of valuable information as to the cause of the disease, (viz : the existence of organic spores in the atmosphere which attended the outbreak and marked the duration of the disease) ; the materials of disinfection which proved most valuable, after a long series of experiments, were, as already indicated, the Tar Acids—in the form of Carbolic Acid, and as Carbolate of Lime.*

In referring to tar and its accompanying products, our author treats us to a very learned and interesting historic review, (pp. 8-17) and enters into the chemical history of "tar acids," (page 59). By the distillation of wood tar, we obtain *creosote* and *acetic acid* (vinegar). By the distillation of coal tar, we produce *carbolic* and *cresylic acids.*

Of *creosote* we know—that it kills and preserves from decay, insects, fishes, and animals, that it stops the flow of blood in man, and preserves flesh from decay.

In the *coal tar acids*—we find some differences. Carbolic acid is poisonous, but less so than creosote. It coagulates, but does not stop bleeding. It exercises preserving and antiputrescent powers in wonderfully dilute solutions. The action of the tar acids our author thus explains (page 62) :—" There is neither " life nor decay without motion. Tar acids arrest that motion " which takes place in decay. They are, therefore, antiseptic— " they antisept. As soon as the decay ceases, the putrid gases " cease to arise. The acids are, therefore, disinfectant. They

* Misprinted "Carbonic Acid" and "Carbonate of Lime" in the former notice.

" prevent oxidation of organic, but not of inorganic substances; " they will not prevent iron from rusting."

Pettenkofer states that "they arrest, but do not destroy fermentation." This seems, however, to depend greatly on the strength of the acids used, and the conclusion drawn by the author is that all vital action may be destroyed by strong acids, and that in various degrees of dilution they are more or less potent on the lower organisms—both animal and vegetable. Experiments made by Mr. Crookes showed that a solution containing 1 per cent of carbolic acid:—1° preserved meat with fresh odour; 2° preserved gut skin, size, and glue; 3° stopped the fermentation of yeast in a saccharine solution; 4° killed cheese-mites, infusoria fish, caterpillars, beetles, and gnats.

Cresylic acid, which accompanies carbolic acid, is also a powerful antiseptic, and has much less coagulating power over albumen, than carbolic acid. It has a stronger smell, bears greater dilution, and is probably a more powerful disinfectant than carbolic acid, and better adapted for injection into the veins of diseased animals—a process which was found of great service during the Cattle Plague.

" Petroleum is a very poor disinfectant compared to tar acids. " Probably it contains a little either of carbolic acid or of some " allied compound, to which it owes all its disinfecting power. " Tar oils which most resemble petroleum have also a weak disin- " fecting power; but, when the acids are washed out by water, " there is no disinfecting power remaining."

Lime is a good disinfectant, but very weak. As it is, however, cheap and abundant, it is an excellent auxilliary, especially applied as lime-wash to the walls of buildings. It is, certainly, greatly raised in value by admixture with carbolic acid, which is thus retained in contact with large surfaces of air which it completely disinfects. The process, however, needs frequent repetition, if the generation of air poisons be continuous, as in stables, cattle sheds, or slaughter-houses.

After consideration of the several metallic salts, which have been recommended as disinfectants, (of which our author forms a less favourable opinion than of the tar acids,) attention is called to the necessary removal of manure and refuse by water-closets and sewers, earth closets and middens. Of the first he says:— " The water-closet system is a great luxury, unquestionably, but " like all other luxuries, it is taxed. * * * It is the very

" symbol of abundance and extravagance. The mechanism must " be very excellent, and, with the best, a little chemical assistance " from disinfectants is often needful. Water-closets which are " not carefully attended to are unsafe. It is an immense advance " upon the old cess-pools, which were found after much loss of " life to be manufactures of disease of the most active nature. " But unless we get good sewers, we have similar evils from the " water system. 'There are sewers and sewers.' The liquid " matter, when neither removed rapidly, nor disinfected, is our " old enemy, the cess-pool, with a territory extending miles long " instead of feet. The midden is better than the bad sewer. I " believe we shall never see the extinction of either middens or " water-closets; we may remedy some of the evils. To allow " bad air to form in the sewers, and then draw it into the houses, " or permit it to rush into the streets, is bad engineering. The " sewers may be ventilated, and filtered through charcoal; or the " formation of bad air may be prevented by a proper use of disin- " fectants." On the earth closet question, our author remarks :— " One may very correctly look upon the soil as the greatest agent " for purifying and disinfecting. Disinfection by its means is per- " fect so long as the decomposing matter can be perfectly dried " up by it; but, should moisture be in excess, a dangerous " condition of malaria is apt to ensue." Admitting the conditions which Mr. Moule lays down, viz., two cwt. of dry earth per week for six persons, he says :—" Nobody can doubt the disinfecting " power of the soil, and certainly, Mr. Moule has found a mode " of applying it in many cases."

The author's treatise is rendered especially valuable by a series of original experiments on the comparative power of disinfectants, which are expressed in a tabular form, for which our space is too limited. The objects of the experiments, however, may be thus stated :—

1st. To show the amount of gas evolved when the disinfectants act on organic substances in water.

2nd. To show the amount of certain disinfectants required to prevent the evolution of sulphuretted hydrogen.

3rd. Amount of certain disinfectants required to remove putrid smells.

4th. Influence of volatile substances in preventing putrefaction.

5th. Comparative power of antiseptics in preserving meat.

6th. The antiseptic effects of certain gases on flesh.

The value of air and water are then considered, as the great natural disinfectants. Air, especially ozonized air, is a most powerful disinfectant; and the use of water in the bath is advocated and lauded in the following quotation from Martial, "The Joys of a Life in the Water":

> "Baiæ, the prince of watering-places,
> Somehow the weather's always fine;
> The light is long, and the day's decline
> Is very slow, and 'going away'
> Are words one never thinks to say.
> Rocks with all beauties there abound
> Cut out of many a distant ground;
> Warm breathing onyx fat and fine,
> And various-coloured serpentine.
> If hot Laconian vapours please,
> Here lie, though melting, at your ease;
> Two streams supply you all you crave,
> The Virgo and the Marcian wave,
> Water so bright and clear and fair,
> You think no liquid can be there."

The comparative value of disinfectants to *prevent decomposition* of organic matter, *i.e.*, as antiseptics, is thus given:

		COST.
100″	Common Salt..........................	1.0
7″	Cresylic Acid......................	4.9
23″.2	Chloride of Lime......................	7.0
9″.3	Carbolic Acid..........................	14.0

Special directions are given for the best mode of preserving cattle skins, horn tips, salted and dry cattle-gut, melted tallow in casks, cows' hair, pigs' bristles, sheep's wool, fresh bones, skins and guts, raw flesh, wagons, platforms, cattle-pens, and ships.

On the general subject of disinfection our author wisely remarks:—"It is a very complicated problem. Disinfection is "not a magic act, performed by a small piece of a substance, "which removes all evils at once. There are many evils in various "conditions, and each must be attacked in its own peculiar mode. "People must use their reason. Everyone must pick out the "cheapest and most convenient disinfectant, according to the "circumstances of the case. Chloride of lime destroys smells "rapidly; Condy's fluid, ditto, and is itself without smell. Tar "acids (carbolic and cresylic) are good for continuous action, "especially for closets and the open air. Burnett's fluid, for "preserving moist bodies long."—(pp. 133-134).

The work is eminently practical and suggestive. Perhaps it would be more acceptable to the public if it had been more dogmatic and positive in its generalizations. It is a valuable accumulation of facts carefully chronicled, and we may hope that some Liebig will arise to give us the great deductions which are involved in this most important subject—which are still "desiderata." J. B. E.

PROTOPLASM; OR, LIFE, MATTER, AND MIND. By Lionel S. Beale, M.D., F.R.S. 2nd Edition. London: Churchill, 1870. —We have only to state in reference to this the second edition of Dr. Beale's interesting book, that it is much enlarged and contains a new section on the Mind. It is an able display of the author's well-known views in reference to the early development of the tissues, and embraces an attempt to apply these views to some of the problems, half physical, half metaphysical, which of late years have attracted the attention of thinking biologist. Whatever opinions may be held as to the dispute between Dr. Beale and Mr. Huxley, it is certain that the volume itself is full of interest both to the microscopist and the ordinary educated man.—*Monthly Microscopical Journal.*

THE CELL-DOCTRINE: ITS HISTORY AND PRESENT STATE, *&c.* Jy James Tyson, M.D., Lecturer on Microscopy in the University of Pennsylvania. Philadelphia: Lyndsay & Blakiston, 1870.—It is surprising how very little is known by medical men generally of the arguments for and against the cell-doctrine of Schwann and Schleiden. Notwithstanding the admirable essay published by Professor Huxley many years since in the 'Medico-Chirurgical Review,' and the numerous fine memoirs which Dr. Beale has given from time to time, it is still a fact that very few know how the question as to the mode of origin of the tissues now stands. It was to meet this want, and, at the same time, to help to promulgate Dr. Beale's views, that the author of the present volume prepared this treatise.—*Monthly Micro. Journal.*

GEOLOGY AND MINERALOGY.

At a meeting of the Geological Society of London, held December 22nd, 1869, the following papers were read:

NOTES ON THE STRUCTURE OF SIGILLARIA, by Principal Dawson, F.R.S., F.G.S., Montreal.—In this paper the author criticised the statements of Mr. Carruthers on the structure of Sigillaria (see Q. J. G. S. xxv. p. 248). He remarked that Sigillaria, as evidenced by his specimens, is not coniferous; that the coniferous trunks found in the coal-formation of Nova Scotia do not present discigerous tissue of the same type as that of Sigillaria; that no Conifer has a slender woody axis surrounded by an enormously thick bark; that Calamodendron was probably a Gymnosperm, and allied to Sigillaria; that although Stigmaria may not always show medullary rays, the distinct separation of the wood into wedges is an evidence of their having existed; that the difference in minute structure between Sigillaria and Stigmaria involves no serious difficulty if the former be regarded as allied to Cycadaceæ; and further, that we do not know how many of the Stigmariæ belong to Sigillaria proper, or Favularia, or to such forms as Clathraria and Leioderma, which may have been more nearly allied to Lepidophloios; that the fruit figured by Goldenberg as that of Sigillaria is more probably that of Lepidophloios, or may be a male catkin with pollen; and that he has found Trigonocarpa scattered around the trunks of Sigillariæ, and on the surface of the soil on which they grew. He agreed with Mr. Carruthers in regarding Mr. Binney's *Sigillaria vascularis* as allied to Lepidodendron.

Discussion.—Professor Morris thought that Clathraria and Lepidophloios ought to be discriminated from the Sigillariæ, as being rather more nearly allied with cycadaceous plants, especially the former. He pointed out the maner in which certain vascular bundles communicating between the centre of the stem of Sigillaria and allied genera and their bark might be mistaken for medullary rays.

NOTE ON SOME NEW ANIMAL REMAINS FROM THE CARBONIFEROUS AND DEVONIAN OF CANADA, by Principal Dawson, F.R.S., F.G.S., Montreal.—The author described the characters presented by the lower jaw of an Amphibian, of which a cast had occurred in the coarse sandstone of the coal-formation between Ragged Reef and the Joggins Coal-mine. It measured 6 inches in length; its surface was marked on the lower and posterior part with a network of ridges inclosing rounded depressions. The anterior part of the jaw had contained about 16 teeth, some of which remained in the matrix. These were stout, conical, and blunt, with large pulp-cavities, and about 32 longitudinal striæ, corresponding to the same number of folds of dentine. The author stated that this jaw resembled most closely those of Baphetes and Dendrerpeton, but more especially the former. He regarded it as distinct from *Baphetes planiceps*, and proposed for it the name of *B. minor*. If distinct, this raises the number of species of Amphibia from the Coal-measure of Nova Scotia to nine. The author also noticed some insect remains found by him in slabs containing Sphenophyllum. They were referred by Mr. Scudder to the Blattariæ. From the Devonian beds of Gaspé the author stated that he had obtained a small species of Cephalaspis, the first yet detected in America. With it were spines of Machairacanthus and remains of some other fishes. At Gaspé he had also obtained a new species or variety of Psilophyton, several trunks of Prototaxites, and a species of Cyclostigma.

Discussion.—The president objected to the term Reptiles being applied to Amphibia, from which they were totally distinct. He questioned the safety of attributing the jaw to Baphetes, of which no lower jaw had been previously found. Mr. Etheridge remarked that the Cephalaspis differed materially in its proportions from any in either the Russian or British rocks.

BOTANY AND ZOOLOGY.

North American Laminariaceæ.—At a late meeting of the Nova Scotian Institute, Prof. Lawson read a short paper on this group of sea weeds, of which we give an abstract. He commenced by stating that although many subjects interesting to science had been the objects of study to members of the Institute, yet that the Laminariaceæ of our coast and harbors had been entirely neglected; and he expressed a hope that some of them would qualify to supply the omission. The study had long engaged the earnest attention of celebrated naturalists. He enumerated the following species, which are fully described in Dr. Harvey's Nereis Boreali-Americana.

Alaria esculenta—On rocks about low water mark, extending south to Cape Cod.

A. Pylaii.—On rocks near low water mark, Newfoundland.

Laminaria Fascia.—A very small and delicate plant, only a few inches in length, found in Halifax harbor, on rocks and stones near low water mark by Prof. Harvey—widely distributed—occurring not only at Halifax and on the New York coast, but also on the Atlantic and Mediterranean shores of Europe, and at the Falkland Islands. Specimens of the allied *L. debilis* were shown from Kutzing.

L. lorea.—Shores of Newfoundland.

L. dermatodea.—On rocks at and below low water mark, Newfoundland.

L. saccharina.—At and below low water mark. Harvey gives it as common on rocky shores from Greenland to New York, and cast up from deeper water on the New Jersey coast. Prof. Lawson has a specimen collected by Dr. Rae at Montreal Island.

L. longicruris.—Abundant below low water mark along the shores of Halifax harbor, at Point Pleasant and around the wharves at the city. The species abounds along the shores from Greenland to Cape Cod, and occurs in Newfoundland. It occurs likewise in Europe, but there the range is quite northern as it scarcely extends beyond the limits of the Arctic Sea, whence ragged fragments are sometimes drifted upon the Northern coasts of Scotland and Ireland. Its reported occurrence in the Bahama Islands is probably a mistake.

L. trilaminata.—Found floating near Narragansett, Rhode Island; it is probably an abnormal form of *L. saccharina.*

L. digitata.—On rocks at and below low water mark, common as far as Cape Cod. Dr. Harvey's impression that possibly more than one species is confounded under this name should induce observers to examine the numerous forms with much care.

Agarum Turneri.—The species of Agarum differ notably from Laminaria in the flat frond being pierced throughout with holes, hence the common name, Sea Colander, by which they are known. This species grows below low water mark, and is thrown up in quantities by southern gales at Point Pleasant. It extends from Greenland to Cape Cod, and has likewise been collected on the coast of Russian America, but it is unknown on the European shores.

A. pertusum.—Newfoundland. This plant is distinguished by its less regularly shaped and smaller and fewer perforations..

Chorda filum.—The frond is of great length attached by a small disc and very slender at the base, thickening towards the middle, and again attenuating. It is often so long that when taken out of the water it ressembles a fishing line. It occurs between tide marks and extends into deep water, and is often abundant.

C. lomentaria.—Extends from our coast south to Charleston, S. C.

Dr. Lawson, in conclusion, read a letter from Dr. A. F. Le-Jolis, of Cherbourg, France, in which he states—that he is engaged in a monograph of the whole group of the Laminariaceæ, that for such a study materials are never too numerous, and that he would be happy to receive a fresh supply of specimens from North America. He asks Dr. Lawson's help, and that he would interest his friends in his favour. It is not necessary that the specimens be prepared for the herbarium. On the contrary, he had rather they were coarsely dried, without being washed in fresh water or compressed. The parcels may be addressed to him, and sent by any vessel sailing for France, or, if convenient, through the steam packets from New York to Hamburg, which stop at Cherbourg on their return from America.—*Newspaper Report.*

THE DIFFUSION OF PLANTS.—Prof. Delpino, of Florence, has published some interesting researches on the relation between the diffusion of plants and animals. The life of every plant has three principal objects: its nourishment, its reproduction and the distribution of its seeds; for each of these three objects special bio logical conditions being requisite. The fertilisation of many plants can be effected only by some particular animal: as *Arum italicum*, *Aristolochia*, and *Asarum*, by gnats; the fig tribe by different species of *Cynips* (or gall-fly); *Arum dracunculus*, *Stapelia*, and *Rafflesia*, by blue-bottle flies; many others by different kinds of flies or bee-like insects (*Hymenoptera*), and some even by small birds belonging to the family of *Trochilidæ*, or humming-birds; *Rosa*, *Pœonia*, and *Magnolia, grandiflora*, by beetles of the chafer tribe; others again by small slugs. If in any particular locality the animal necessary for the fertilisation of a particular plant is absent, it is certain that the plant cannot spread; and thus the conditions for the diffusion of plants are dependent on the geographical distribution of animals. A remarkable illustration is furnished by two plants belonging to the same genus, grown in the botanic gardens in Italy, *Lobelia syphilitica* and *L. fulgens;* the flowers of the former are abundantly visited by *Bombris terrestris* and *italicus*, and freely produce seeds; the latter, notwithstanding its beauty and its great store of honey, is never visited by insects in the neighbourhood of Florence, and never bears seeds spontaneously, but can be readily fertilized by artificial impregnation. Prof. Delpino conjectures that it is naturally fertilised by humming-birds. He believes that the scarlet colour of the corolla, so common in the tropics, but comparatively rare with us, is especially attractive to small birds, but offensive rather than otherwise to *Hymenoptera*. As a rule, scarlet flowers are large, bag-like in form, horizontal in position, and with the nectar completely separated, which would of itself perfectly prevent their fertilisation by insects. The largest European flowers, such as the pæony and large bird-weed (*Convolvulus sepium*) are fertilised by sphinxes and rose-chafers.—*Botanishe Zeitung.*

National Museum of Bohemia, Nov. 24, 1869.—M. T. Palacky explained his views of the botanical geography of Asia. M. Grisebach has recently divided Asia into four botanical provinces: (1) Western, or that of the Steppes; (2) Eastern, or Chinese; (3) Boreal, or Siberian; and (4) Southern, or that of India. M. Palachy admits only two provinces—the one Southern, the other Boreal—including in the latter the whole of Asia beyond the Himalayas, because the first three provinces of M. Grisebach do not appear to him to differ more from one another in regard to their flora than the sub-provinces of each do. The author lays special stress upon the tropical species inhabiting China—where they are not arrested by the steppes—as far north as Pekin, and even as the Amoor. According to M. Palachy, the existing flora of Central Asia is an invasion of the Mediterranean flora which took place after the elevation of the Turcoman plateau in place of the ancient post-tertiary sea between Europe and Asia. The principal obstacle in the way of researches connected with botanical geography, is the diversity of the views adopted by various botanists; one species of Hooker, Wallich and others being equivalent to at least twenty-five species of Maximowicz, Ruprecht and most of the German botanists.—*Nature*, No. 9.

NOTES ON CANADIAN BIRDS.—The occurrence of the following rare birds in Lower Canada deserves placing on record.

Falco Candicans, Gmelin. The American Jer Falcon.—The Rev. D. Anderson, M.A., of Point Levis, an acute ornithologist, informs the writer that he has in his collection an adult specimen of this rare species, which was shot on the north shore of the St. Lawrence, near the Bay of Seven Islands.

Mr. Hancock has shewn that there are two species of Gyr-falcon, both of which are now included in the list of American birds. It is just possible that the specimens described by the late Dr. Hall as *Falco Dawsonis* (this Journal, Vol. 7, page 62), are the young of the American Jer falcon.

Nyctale albifrons, Shaw. The White-fronted or Kirtland's Owl.—A specimen of this scarce species was procured by the Rev. D. Anderson, which was shot at a place called Breakey's Mills, about six miles from the mouth of the Chaudiere river, near Quebec.

Cardinalis Virginianus, Bonaparte. The Summer Red Bird. —In the early part of June, 1862, Mr. W. Hunter saw two individuals of this species on Montreal mountain, one of which is now in his possession. It seems to be of rare occurrence, at least in Lower Canada. J. F. W.

LOWER CANADIAN LAND AND FRESH WATER MOLLUSCA. —Since the publication of my paper on the above subject, a few additional species have been found in Lower Canada, as follows:

Bithinia tentaculata, Linn. This common European species has been found *living* in the Lachine canal, by Mr. G. T. Kennedy. According to Mr. G. W. Binney, this shell has been taken in Greenland.

Helix Morsei (?), Tryon. Montreal mountain. Mr. R. J. Fowler.

Helix (*Pseudohyalina*) *exigua*, Stimpson. West Farnham, P. Q. Mr. R. J. Fowler.

Helix (*Punctum*) *minutissimum*, Lea. Same locality and collector as for the preceding species.

Notes on other Species.—*Valvata humeralis* (?), Say. (*Can. Nat.*, Vol. 8, page 102.) Though this may not be the true *Humeralis* of Say, in my judgment the shells in question are perfectly distinct from any varieties of *V. tricarinata*, or of *V. sincera*. Mr. Binney refers them to the former, and the late Dr. Gould, to whom I sent specimens, to the latter species. Dr. Lea referred them doubtfully to *V. humeralis*. Our shells are covered with a thickish olivaceous epidermis, and are strongly transversely ribbed.

Planorbis macrostomus. Probably it would be better to unite this form, together with the Pl. trivolvis, lentus and corpulentus of Say, under the general name of Pl. trivolvis, Say.

Helix exoleta, Say, so far as I am aware, does not occur in Lower Canada. Prof. Bell's specimens, said by him to have been determined by Mr. Binney, are all *H. dentifera*, Binney.

Pupa simplex, Gould. The shells catalogued under this name, are all *Pupa badia*, C. B. Adams. J. F. W.

Lower Canadian Marine Mollusca.—Since the appearance of my paper on dredging in Gaspé, in vol. iv., p. 270 of the new series of this journal, a few species of shells, which I had no means of identifying in Montreal, have been sent to Mr. J. G. Jeffreys, F.R.S., etc., for identification. Having been compared with specimens named by Moller, Mr. Jeffreys recognizes the following species, which must now be added to our list of Lower Canadian marine molluscs :—

Utriculus turritus, Moller.	*Bela Pingelii*, Moller.
Rissoa scrobiculata, Moller.	*Bela impressa*, Beck.

The shell supposed by me to be *Philine lineolata*, Gouth., Mr. Jeffreys informs me, is *Philine lima*, Brown. In like manner, the Margarita I referred to Gould's *M. argentata*, is *M. Glauca*, Moller, sp. ; and the species queried as *Diaphana debilis*, Gould, is probably *Utriculus hyalinus*. J. F. W.

Swiss Mammalia.—M. Fatio gives the number of mammals inhabiting Switzerland in the wild state—that is, excluding the cat, dog, horse, ass, ox, sheep, and goat—as fifty-eight, or as sixty-one, if the rabbit (which is not indigenous, but has been imported of late years) be reckoned, and the two minute forms, *Sorex pygmæus* and *Mus minutus*, which have been said to occur, but which M. Fatio has not himself succeeded in finding. This list does not include the ibex, the stag, or the *Mus agrarius*, which have become extinct. Some mammals which occur in adjoining countries are remarkable for their absence in Switzerland: thus, the two bats, *Rhinolophus clivosus* and *R. Euryale*, which occur in Lombardy, *Mus agrarius*, occurring near the Rhine on the north, and by Como to the south, *Arvicola subterraneus*, also found near the Rhine, and *A. Savii*, found in Lombardy, are not met with in Switzerland.

M. Fatio has increased the catalogue of Swiss mammals, as given by some of his predecessors, by the addition of nine species of bats, two insectivora, and four rodents, one of which is considered a new species altogether.

This new species of M. Fatio, is a little black mouse, very much like the common house mouse (*Mus musculus*). but having a very dark black-coloured fur; the two presenting much the same contrast as do the *Mus rattus* and *Mus Alexandrinus*, which M. Fatio agrees with M. Arthur de l'Isle in considering one and the same species. The new mouse, however, which is called *Mus Poschiavinus*, from the locality where it was observed, presents more important differences when compared with *Mus musculus* than those of colour and proportion only. The palatine ridges in *M. Poschiavinus* are *four* in number, in place of *five* in the common species, and the anterior simple ridges are of a different form.

The strange thing about this little black mouse, which is found at Poschiavo in the Grisons, is that it lives on tobacco. It was first noticed in a tobacco-factory, and was found to make great ravages among the stores of the nicotian weed. When first caught, M. Fatio thought he had possibly got hold of young specimens of the black rat, but subsequently he obtained specimens bearing evident signs of maturity. It does not appear to have suggested itself to M. Fatio's mind, that his *Mus Poschiavinus* may be only a sample of the deleterious effect of indulgence in the noxious herb to which these rodents are addicted. What if this new black mouse is but a stunted race of the black rat? It would furnish an invaluable argument to the anti-tobacconists.

A very pretty coloured plate, representing two Poschiavinian mice helping themselves to cigars, illustrates the description of this species. It is not a little remarkable that an animal should normally feed on tobacco. Monkeys, as is well known to the frequenters of menageries, are exceedingly fond of the end of a cigar, and an elephant has been seen gravely to accept such an offering; but one would have supposed that the amount of nicotine in a pinch of snuff was enough to make a mouse unwell. The indifference of these mice to the toxic action of tobacco, calls to mind the similar indifference on the part of pigeons (rodents are like birds in many things) to the toxic action of opium in the largest doses, as lately noticed by Dr. Weir Michell.

Among the rarer and more interesting forms noticed by M. Fatio as still existing, or as having existed—for he notices the contents of the quaternary deposits in Switzerland—are the Bear (*Ursus arctos*), the Wolf (*Canis lupus*), the Wild Cat (*Felis catus*), the Lynx (*Felis lynx*), the Bouquetin or Ibex (*Capra ibex*), the Chamois (*Capella rufricapra*), and the Stag (*Cervus elaphus*). With regard to this last, it appears that, eighty years since, very fine specimens inhabited the Swiss valleys; now it only appears when driven from the German forests lying to the north; its remains are found in quaternary deposits. The fallow-deer is represented neither in the present nor in the quaternary fauna; the Roebuck, or Chevreuil, is the only cervine species still inhabiting the country. Wolves, lynxes, and wild cats are not uncommon in the forests of the Jura; but the lynx has not been found in the quaternary deposits, which is noteworthy, since Dr. Ransom, of Nottingham, has found it in England in snch beds.

The bear is commonest in the Grisons; every year there is some bear-hunting to be done in these wild and elevated valleys. The ibex, though no longer found in the Swiss Alps, occurs in the immediately adjacent territory of Lombardy; where, however, it is now strictly preserved. The ibex of the Alps, of the Pyrenees, of Siberia, and of Crete, each have very distinctive characters, in the direction and length of their horns, but are hardly to be considered as distinct species. Some naturalists, however, distinguish a second species in Spain, as *Ægyceros Hispanicus*, occurring farther south than the so-called *Ægyceros Pyrenaicus*. The domesticated *Capra hircus*, has no doubt largely taken the place of the indigenous ibex; natural hybrids between the two are not uncommon. The industrious Swiss have sometimes exhibited to curious tourists an eccentric specimen of the common goat as a living idex. M. Fatio mentions such an instance, which may put naturalist travellers on their guard. A specimen presented by the King of Italy may be seen in the Zoological Gardens, Regent's Park. The chamois are still very numerous in Switzerland, though the large herds of eighty and a hundred, which used to be seen in past times, are not now met with. A certain amount of care is exercised now in regard to the time of hunting, and the animals are allowed to breed in security, so that they are on the increase in localities where they had become scarce. M. Fatio mentions an old hunter who boasted of having killed as many as 3,000 chamois.

The Alpine marmot, which is so common and so well known to Alpine tourists, is not the mammal which attains the highest elevation of habitat in Switzerland; another little rodent, the *Arvicola nivalis*, has that distinguished honour, living at a greater altitude than any other European mammal.

Both this species and the marmot live among tho oases of rock and herbage which stand out amidst the vast masses of mountain ice. The Bobac marmot does not occur in Switzerland, being confined to the north-eastern districts of Europe. The Alpine marmot inhabits the Carpathians and the Pyrenees, as well as the Alps.—*From a Review of Dr. V. Fatio's Faune des Vertebres de la Suisse. Part I. Mammals. By Dr. E. Ray Lankester, in "Nature."*

The Use of Birds and Worms.—Worms and birds are great friends to grass-turf. Where there are plenty of blackbirds and thrushes you will generally find the grass to thrive. No doubt the reason is that these cheerful creatures, like other cheerful creatures, have a desire to be useful. They know they cannot live upon song, and they cannot live by singing, for no one ever thinks of paying them for their merry minstrelsy; so they work for their crust, and on the grass find wireworms, slugs, snails and leather-jackets; the last named being the destructive grub, or the "Daddy Long-legs," the most outrageous destroyer of grass in the world. As to earth-worms, if you drive them out of your lawn, you must expect the grass to die. They are the cultivators of it. For any other crop we dig and manure constantly. For grass, we, as a rule, do neither. But we cut down a crop of it now and then, and carry it away. Now the worms dig and manure; that is to say, they bore holes and throw up common soil in little heaps, and in time will reverse the order of all the articles of the top crust.—*Gardener's Magazine*.

Uses of the Cockchafer.—"Through the columns of the *Moniteur Scientifique* we learn that nothing can be better to grease machinery with, and prepare salad, than cockchafer oil. In Prussia the people have reached the advanced stage of making cockchafer flour, which, at present, is only used for the purpose of making cakes for young pheasants, partridges, and quails. In this country (France) an attempt has been made to introduce the white worm or larva of the cockchafer into the kitchen, as a substitute for the snail; but gentlemen who are voracious when *Helix pomatia* is concerned, turn up their noses at the grub of *Melolontha vulgaris*. A servant of the name of Jonglet, proposes to extract from the cockchafer colouring matter, which, it is said, will make rapid strides in industry, and create a small revolution in the commercial world. He states that he can get yellow out of the obnoxious insect of a colour between chromium and gold,—and that each insect yields a few centigrammes. Several specimens of silk, dyed with this new colour, have been exhibited and much admired. Taken all in all, the cockchafer, what with the amount of manure he furnishes when slain in proper quantities, and the uses above mentioned, stands a fair chance of being classed as a valuable insect, and some day we may hear philanthropic persons calling out against its wanton destruction."—*Land and Water*.

The *Melolontha vulgaris* of Europe is represented in Canada by *Lachnosterna fusca*, commonly called the May bug. In reference to the appearance of this creature, we may state, that it occurs in immense numbers every three years; at least, such is our experience since 1855. The years 1858, 1861, 1864, and 1867, are those when this insect appeared in greatest numbers, and in 1870 we shall probably have another visitation of cockchafers. It must not be inferred from the above statement that no examples of these insects occurred in the intervening years, for it is always a common species in Canada. But there are years when certain species prevail in such numbers as to be noticed by everybody. One reason why the cockchafer should be tri-yearly may be owing to the circumstance that it remains in the larva state for three years. Here, then, an opportunity occurs for testing some of the alleged practical uses to which these insects may be put. A. S. R.

TOMATO-WORMS NOT POISONOUS.—The Tomato-worm belongs to an extensive group (the *Sphinx* family), almost all of which have a stiff pointed horn growing out of their tails—a merely ornamental appendage, such as those which are distributed in considerable numbers over the body of another magnificent larva which we illustrated some time since. Why or wherefore it is impossible to say, but this poor unfortunate Tomato-worm has been selected by the popular voice, out of about fifty others belonging to the same family, and found within the limits of the United States—all of which have a similar horn growing out of their tails,—to be falsely accused of using this horn as a sting. The Tomato-worm and the Tobacco-worm are as like as two peas, and produce moths which resemble each other so closely, that entomologists for a long time confounded them together. Each has exactly the same kind of horn growing on the hinder extremity of its body; yet while the Tomato-worm is generally accused of stinging folks with his horn, nobody, so far as we are aware, ever yet said that the Tobacco-worm would or could do so. The real truth of the matter is that neither of them can sting, either with his tail or with his head, or with any part of its body. Yet not a season elapses but the newspapers publish horrible accounts of people being stung to death by Tomato-worms, and earnestly recommended those who gather tomatoes to wear heavy buckskin gloves. These stories, however, have been contradicted so flatly and so often, that latterly the penny-a-liners have struck off upon another tack. Tomato-worms, it appears, do not sting with the horn that grows on their tails, but they "eject with great violence a green caustic fluid from their mouths to a distance of from 3 to 15 in."! Now, what is the real truth about this matter? Tomato-worms do really discharge from their mouths, when roughly handled, a greenish fluid, and so do the larva of almost all moths, and so does every species of grasshopper with which we are acquainted, and so do many different kinds of beetles. But it is not true that they can spit out this fluid even to the distance of a quarter of an inch, much less to the distance of 15 or even of 3 in.; and especially it is not true that the fluid is poisonous. If it were so, we should have been in our graves long ago; for we have had it repeatedly daubed over our fingers, but without the least ill effects therefrom, and so have scores of other entomologists in this country. The strangest thing of all is, that of two worms almost exactly alike, one of which eats tomato-leaves, and the other eats tobacco-leaves, the tomato-chewer should be accused of spitting, and the tobacco-chewer should be held to be guiltless of this offensive practice. Now, then, gentlemen of the public press, if tomato-worms neither sting nor spit, what is the next charge that you are going to bring against them? Why not assert that they can leap a distance of from 10 to 20 ft., having taken deadly aim at the human eyes, which they forthwith proceed to gouge out with their rough rasp-like pro-legs? Of course you would follow this up by recommending everybody never to go near a tomato patch, without a large pair of green goggles to protect the eyes from being destroyed.—*American Entomologist.*

CHEMISTRY AND PHYSICS.

Hydrogenium.—The last researches of the late lamented Prof. Graham, the Master of the Mint, were devoted to the study of a new condition of hydrogen antithecal to that of oxygen in the form of ozone; and to this condition of the element he gave the name of Hydrogenium. By all analogy the new substance should be considered metallic, but like ozone, it has not been isolated. The details of Prof. Graham's researches, communicated to the Royal Society, were devoted to the relations of hydrogen to palladium. He had also observed hydrogenium in meteoric iron. Concluding an account of his researches to the Royal Society, Prof. Graham thus remarks on the chemical properties of hydrogenium which distinguish it from ordinary hydrogen:—

"The palladium alloy precipitates mercury and calomel from a solution of the chloride of mercury without anydisengagement of hydrogen; that is, hydrogenium decomposes chloride of mercury, while hydrogen does not. This explains why Mr. Stanislas Meunier failed in discovering the occluded hydrogen of meteoric iron, by dissolving the latter in a solution of chloride of mercury; for the hydrogen would be consumed, like the iron itself, in precipitating mercury. Hydrogen (associated with palladium) unites with chlorine and iodine in the dark, reduces a persalt of iron to the state of protosalt, converts red prussiate of potash into yellow prussiate, and has considerable deoxidizing powers. It appears to be the active form of hydrogen, as ozone is of oxygen.

"The general conclusions which appear to flow from this inquiry are, that in palladium fully charged with hydrogen, as in the portion of palladium wire now submitted to the Royal Society, there exists a compound of palladium and hydrogen in a proportion which may approach to equal equivalents.* That both substances are solid, metallic, and of a white aspect. That the alloy contains about 20 volumes of palladium united with a volume of hydrogenium; and that the density of the latter is about 2, a little higher than magnesium, to which hydrogenium may be supposed to bear some analogy. That hydrogenium has a certain amount of tenacity, and possesses the electrical conductivity of a metal. And finally, that hydrogenium takes its place among magnetic metals. The latter fact may have its bearing upon the appearance of hydrogenium in meteoric iron, in association with certain other magnetic elements."

Metallic Hydrogen.—At a recent meeting of the Lyceum of Natural History in New York, a paper was read by Dr. Loew, Assistant in the College of New York, "On the Preparation of Hydrogen Amalgam." The researches of Graham went to show that hydrogen could be alloyed with palladium, and that it was also contained in meteoric iron. He condensed the hydrogen in the palladium, and came nearer proving its metallic character than any other person had done. Schoenbein, in his search for ozone, found a method for making the peroxide of hydrogen which brought him to the very threshold of discovering hydrogenium. Schoenbein's experiment was this:—An amalgam of zinc and mercury is violently agitated in water; the water is then filtered, and, on being examined with iodide of starch and protosulphate of iron, will be found to contain peroxide of hydrogen or oxygenated water. Dr. Leow has carried the investigation further, and has, instead of oxidizing the hydrogen, succeeded in combining it with the mercury.

He takes an amalgam composed of no more than three or four per cent. of zinc, and shakes it with a solution of bichloride of platinum; the liquid becomes black, and a dark powder settles to the bottom. The contents of the flask are then thrown into

* Proceedings of the Royal Society, 1868, p. 425.

water, and hydrochloric acid added to dissolve the excess of zinc. The amalgam of hydrogen and mercury at once forms in a brilliant voluminous mass, resembling in every way the well-known ammonium amalgam. It is soft and spongy, and rapidly decomposes, but without any smell of ammonia. The hydrogen escapes, and soon nothing but pure mercury is left in the dish. The experiment appears to show conclusively that an amalgam of hydrogen and mercury can be formed, and that hydrogen is really a metal. It would also throw some doubt upon the existence of the amalgam of ammonium and mercury, and offer an explanation of that compound on the basis of its being the same amalgam of hydrogen and mercury that is prepared in the way now pointed out by Dr. Loew. The smell of escaping ammonia must be traced to some other source than the existence of that radical in combinrtion with mercury.—'*Scientific American.*'

ARTIFICIAL PRODUCTION OF ICE. By P. H. Vander Weyde, M.D. *Calculation of the amount which can be produced from a given amount of coal in the modern ice machine.* —The amount of ice produced by an ice machine, worked by means of an exhaust or condensing air-pump, driven by steam power, is easily determined, theoretically, from the amount of coal burned in the furnace of the steam boiler. It has been proved that the combustion of one pound of anthracite coal produces, in round numbers, 14,000 units of heat, and that in order to freeze water of 72° Fahr., it is necessary to abstract, besides 40° of sensible heat, 140° of latent heat—together 180—which for one pound of water is, of course, equivalent to 180 units of heat. As this number of the units is the eightieth part of the 14,000 units produced by the combustion of one pound of coal, it is clear that the heat produced by the combustion of one ton of coal is equivalent to the heat to be abstracted from 80 tons of water of 72°, in order to change it into ice.

But in practice we find here exactly the same state of affairs as is the case with the steam engine. Theoretically, a steam engine ought to produce at least 700 units of force (foot-pounds) for every unit of heat consumed; in practice, good machinery only produces from about 70 to 100 foot-pounds, from about one-tenth to one-seventh part of the theoretical amount. In the best ice machines thus far constructed, instead of freezing 80 tons of water for every ton of coal consumed, only from about 8 to 11 tons of ice are produced also, from one-tenth to one-seventh part of the theoretical amount, proving, thus, the remarkable fact, that in both the steam engine and the ice machine, exactly the same relation exists between the theoretically calculated effects and the practical results.

As, however, all the best ice machines accomplish the conversion of the heat of the fuel into the freezing operation by the intervention of a steam engine, the fact that they practically produce only from one-tenth to one-seventh of the amount of the cold they theoretically should produce, is solely due to the other fact, that the steam engine itself practically produces only from one-tenth to one-seventh of the amount of power which would be strictly equivalent to the number of heat units consumed. It must not be lost sight of that it is only the power of the steam engine which generates the cold in the freezing machines, and that, therefore, improvements in the steam engine, which bring its practical results nearer to the theoretical standard, will at once exert their influence on the amount of ice the ice machines can produce, and, consequently, also on the cost of the ice manufactured in these machines.

Moreover, it appears that the kind of freezing machines in question, which convert power into cold, notwithstanding they are yet in their infancy, have already attained such a degree of excellence, that they are ahead of that class of machines which convert heat into power, either by steam, hot air, or any other possible means, as it is proved that they produce the full theoretical equivalent of cold (negative heat) for the number of foot-pounds employed; namely, cooling one pound of water one degree for a power equivalent to 700 pounds, descending one foot, which, expressed in the adopted scientific manner, is one unit of negative heat for every 700 foot-pounds consumed.—*Scientific American.*

Pins pointed by Electricity.—A recent discovery has been made by M. Cadery, telegraph inspector on the Western Swiss railroad, and is now applied with success at Aix la Chapelle (Belgium), whence needles and pins are shipped to all parts of the world. On passing a metallic wire (brass, copper, iron or steel), connected with the negative pole of a Bunsen's battery, through the bottom of a glass tube, closed in such a way as to hold an acidulated liquid, and leading the other wire of the positive pole through the superior opening of the glass tube, closed in such a way as to allow the positive wire to plunge into this acidulated liquid, taking care to leave a small interval between the extremities of the wires; the electric current thus established through the acidulated fluid as a conductor, produces the following phenomena. Very soon the extremity of the positive wire takes a conical point of more or less sharpness, depending on the free distance existing between the two wires plunging into the acidulated liquid. During this phenomenon, which takes from 5 to 15 minutes, according to the acid used, its strength, the composition of the wire, its degree of thickness, and also the intensity of the electric current, very fine sections of the wire are seen to separate from the wire. Water, acidulated with sulphuric acid, appears to be more efficacious, especially for iron and steel wires. Nitric acid is used in preference for brass and copper wires. The same effect will take place if to the positive pole (superior) an indefinite number of wires are tied together and dipped in the acidulated water, instead of the single wire, care being always to keep this positive wire at a little distance from the negative wire. I have seen a hundred brass wires after having been submitted to this operation, present points as sharp as the best English pins, although the electric current was produced by a very small Bunsen's battery. It appears to me very desirable that this new method should receive proper encouragement, and everything should be tried to bring it into general use. The operation of making the points of needles and pins in their manufacture is a dangerous and costly one. Medical men in large manufacturing cities have long recognized the dangerous effects produced by the fine metallic dust resulting from it, on the health of the workmen. The remedies for this evil are very imperfect, little used, and very impracticable; inhaling apparatus communicating with the outside air has been tried, but every danger would be suppressed by the method above described.—*Scientific American.*

Another New Dye.—The aniline dyes, it seems, have now a rival which not only vies with them in brilliancy and variety, but is of a less fleeting or more fixing character. The new colouring matter, according to the *Mechanics' Magazine*, is a purely vegetable extract, the plant from which it is obtained being imported from the western part of Africa, and also from the West Indies. The colouring matter is variously treated, according to the colours required and the dyes to be prepared from it. The process of production is carried on with machinery of a special character, which has been designed by the patentees, Messrs. Walker & Co., for this manufacture.—*Builder*.

CHEMICAL ANALYSIS OF A SAMPLE OF EXTRACT OF MEAT.—An analysis of extract of meat by Herr Reichardt is given in *Dingler's Polyteckniscfies Journal*. The sample was prepared by a private firm, and yielded, on analysis, the following results:—Portion soluble in alcohol (of 83 per cent. strength), 80-76 per cent.; water, 16 per cent.; fatty matter, 0-2 per cent.; nitrogen, 9-99 per cent.; ash, 21-36 per cent. (containing potassa, 9-0 per cent.;) soda, 2-3 per cent.; phosphoric acid, 6-1 per cent. These results, as compared with Liebig's and the Fra Bentos extracts, are stated by the author to be in favour of the extract tested by him for MM. Buschenthal & Co.

MICROSCOPY.

BUTTERFLY PARASITE.—In the March number of this Journal, attention was drawn to the existence of a vegetable *parasite* on the legs of the dark Swallow-tail Butterfly (*Papilio asterias*). The facts are as follows:—

At a meeting of the Montreal Microscopic Club some time ago, the subject for illustration and examination was "Parasite—Animal and Vegetable."

Looking over my collection previous to the meeting, for example of the subject, I had occasion to open a small box containing four specimens of *Papilio asterias*, and observing something attached to the legs of one of the butterflies, it was subjected to microscopic examination, and I concluded it would suit the subject for investigation at the meeting of the club.

One leg with the *parasite* was mounted in balsam—the cover being secured with sealing wax varish, a very useful cement when an object is wanted for immediate use, as it dries quickly.

Members differed in opinion as to the objects—the general impression that it was a *vegetable parasite*, fungoid in its nature, remained. Not being thoroughly persuaded in my own mind as to its nature, from the peculiar situation of the organism—it being attached not to the leg, but impaled on the spines of the *tibiæ* and *turise*, also on the tips of the *imgues*,—it appeared to me as if the creature, in feeding or flying over some plant, had brushed off something like seeds or flowers, or some fungoid growth. With a view to find out its real character, I sent a mounted slide to Mr. M. C. Cooke, the Editor of *Science Gossip*, and author of "An account of the British Fungi," also of "Microscopic Fungi," for his opinion. He very kindly returned me the following answer in the pages of the *Science Gossip*: "The supposed fungus on the legs of *Papilio asterias* is not a fungus at all, but pollen masses from some species of Orchis."

Before receiving this answer, however, I had determined for myself what the supposed fungus was. A friend having remarked that he had captured some large flies with their legs covered with a peculiar looking substance, I desired him to let me have a few specimens, together with a specimen of the plant on which he had taken them. The latter proved to be the milk weed, or wild cotton *Axlepias cornuti.* On examination, I found the pollen masses to be identical with those on the legs of the butterfly, and that they (the pollen masses) belong to a species of the genus *Axlepias*, and not to a member of the family *Orchidaceae.*

This is another instance of the uses of insects as fertilizers of plants. A. S. R.

Microscopic Examination of Dust.—An ingenious apparatus is figured in the monthly *Microscopic Journal* for collecting atmospheric particles, contrived by Dr. Maddox; the results are also figured from micro-photographs. Dr. Maddox says:—

"Dr. Tyndall has shown us that organic matter may escape destruction to a great extent when air is drawn somewhat slowly 'over fragments of glass, wetted with concentrated sulphuric acid,' also 'over fragments of marble, wetted with a strong solution of caustic potash,' or when 'permitted to bubble through the liquid acid and through the solution of potash,' and likewise when rapidly passed through a red-hot platinum tube, containing a roll of platinum gauze Valuable as these observations are in themselves, we are but little nearer the chief question, which is left open as to the vitality of such organic particles, or their relation to disease.

"It is not pretended that this form is the only useful one or the most convenient that can be adopted, but as it has now been in use some days, I find it answers its chief purpose very well, and is exceedingly easy to manipulate. The advantages claimed are, ready application at any spot, the collection of the atmospheric particles *into a small space* in such a manner as to be at once microscopically examined with a $\frac{1}{16}$th or $\frac{1}{20}$th objective, placed on a growing slide, or some form of cultivating apparatus for further observation, or mounted permanently. The difficulty is to select the best cultivating medium. Hitherto I have found besides (*débris*) organic and mineral matters, pollen grains, minute germs of various fungi or protophytes, and excessively minute bodies, 'molecules,' 'globules,' &c.; none were seen in motion. All seem to vary in abundance with the force of the wind and dryness of the ground.

"This apparatus is deficient as regards crucial tests, but for general use it is efficient, and may, by continued employment, be of service, If any doubt exist as to the medium furnishing the spores, it can be treated as though it had been exposed; hence thus far we have fairness in the results.

"I believe it will be only by constant, varied, and multiplied research, we shall ever obtain any answer to the important question of 'dust and disease;' hence my excuse for trespassing on the pages of this Journal, in the hope others may be induced to give the apparatus a fair trial or suggest something more useful.

"The examination of the collections made over forty days has shown that in this immediate locality, at this period, the air cannot be considered as *loaded* with microscopic germs; the largest number visible and counted as such on one cover being twenty-one (not including bacteroid bodies). A few only have germinated; they are under observation."

THE AMERICAN MICROSCOPICAL SOCIETY.—At the last annual meeting of the American Microspical Society the following officers were elected:—President, Dr. J. H. Hinton; 1st vice-president, Mr. Robert Dinwiddie; 2nd vice president, Mr. T. F. Harrison; corresponding secretary, Dr. S. G. Perry; recording secretary, Dr. J. S. Latimer; treasurer, Mr. E. C. Bogert; librarian, Dr. John Frey; curator, Mr. S. Jackson. Committee on nominations:—Dr. D. H. Goodwillie; Mr. R. A. Witthaus, Mr. J. W. S. Arnold.

A New American Natural History and Microscopical Society.—There has just been started in the city of Baltimore a society of fifty members, called the "Maryland Academy of Sciences." It is intended to pay special attention to microscopy. The following list of the officers may be useful to those societies which desire to correspond with the new Academy:—Philip T. Tyson, President; John G. Morris, D.D., Vive-President; Edwin A. Dalrymple, D.D., Corresponding Secretary.

MISCELLANEOUS.

Prof. Bell on the Nipigon Territory.—The Canadian shore of Lake Superior simply varied according to its geological structure, and the prevalence of Laurentian rocks and gneiss of of Huronian rocks. Not only the shore of Lake Superior varied in respect to its physical character, but the country behind it varied also in the same respect. The whole of the Canadian side of Lake Superior could not be called the North Shore, for we had an east side as well; but at the present time the North Shore was the most important. The basin of Lake Superior was eituated a thousand miles from the sea, its surface being six hundred feet above the sea level, or a hundred feet lower than the Montreal mountain. The bottom of the lake was four hundred feet below the sea level, its depth being four times the height of an ordinary church spire. The waters of this basin were kept from flowing over by a rocky rim which enclosed them; but in speaking of this basin, that of Lake Nipigon should be included at the same time. The Nipigon river was a feeder of Lake Superior, but could not be classified with the smaller feeders of the lake, for it was vastly larger than the other tributaries, and was the only clear water river entering it, and proceeding from a lake which deserved to be considered one of the great lakes, being supplied by sixteen tributaries. The party had left Fort William on the 4th of July last year, and in two or three days arrived at Red Rock at the mouth of the Nipigon River; and in four days and a half reached the lake, the distance being about 30 miles, in which there were seven portages, some of them about a mile long. The scenery along the Nipigon River was very fine; Red Rock, at its mouth, being thought by some to be one of the prettiest places in Canada, the river itself being unrivalled for trout fishing. Steamboats might pass up the river as far as about ten miles from its mouth, but above that point its navigation was interrupted by rapids. On arriving at the lake, the view was found to be very grand. Owing to the existence of magnetic rocks the surveying party could make but litlle use of their compasses; the angles, however, were taken and its distances measured by a micrometer; the latitudes were also taken by various observations of the sun and polesstar, and meridian lines were also laid down. Lake Nipigon lies directly north of the northern extremity of Lake Superior, and is more than half the size of Lake Ontarió; its general outline is elliptical. Its area was 3,700 square miles, or about four-sevenths of the size of Lake Ontario; its length 70, and its breadth 50 miles. As an illustration of the size of Lake Nipigon, there are nine lakes in Canada—amongst them, Lake St. John, Lake Metapedia, Lake Temiscouta, Lake Megantic, Lake St. Francis and Lake Memphremagog—but Lake Nipigon is four times as large as the whole nine put together. Lake Nipigon is by far the most beautiful of all the great lakes, and is studded throughout its whole extent by islands, large and small, and high and low, some rocky and some thickly wooded. They could not, of course, survey the whole of these during one season; but, in connection with their triangulations of the coast, they managed to located 460 of these with tolerable accuracy, and more roughly over 100 others. Some of these islands were large enough to form whole townships. One of them was eight miles in diameter, several were from five to six miles across, while those from two to three miles in breath were quite common. They were all covered with good soil and well timbered, and some day will, no doubt, be converted into well-cultivated farms. The coast line of the lake measures 580 miles, or, perhaps, considerably more than the coast line of Lake Ontario, and, therefore, a great deal of the country round the lake is accessible from the water. Sixteen rivers, with unpronounceable Indian names, flow into the lake, and the average size of these streams is as large as the Grand River of Ontario. The Gull River is much larger. As far as these rivers were examined, the country through which they flow was found to be level, with clayey soil, and a light surface of sand. Like all rivers flowing through level countries, the feeders are very crooked, and when the water is low they resemble great winding ditches with muddy banks. On one river which they ascended they met no rapids for ten miles up, and that was but a small one. Some distance up this same river they found an open margin, very fertile and covered with an abundance of good grass. He did not mean by this "beaver hay," but a very superior kind of grass, which was found by experience to be very valuable as fodder for cattle and horses. The country is very free from rocks, and at one place they could not find stones large enough to sink the lower edge of their net. There is evidence in the Nipigon country, as well as in the Thunder Bay region, that the forests have been frequently swept by fires in past times, and the Indians told him that these fires often originated from lightning. It was likely that prairies were formed in this way. He believed there was a tradition among the Indians that the prairies once extended eastward as far as Lake Nipigon, but all the country east of the Lake of the Woods has since been overgrown with forest. They sometimes left the stores and struck away into the woods and generally found the country level. Although the soil was good the trees were small, and stood so far apart that the party could carry their canoe without underbrushing a road anywhere. After having prosecuted their survey for seven weeks, they arrived at the Nipigon House, a Hudson Bay post, on the north-west shore of the Lake. This was one of the three posts maintained by the Company on the lake shore. The Nipigon House is surrounded with a farm and garden, which have been cultivated for about 100 years. During the early part of the present century the station was called Fort Duncan, and then, as now, it supplied the neighbouring country. The appearence of the field and garden crops indicated that the soil was well suited for agricultural purposes. The latitude of that part of the country was about the same as at the mouth of the St. Lawrence—between 49° and 50° north latitude, but it was well known that in that part of the country the isothermal lines bend to the North-West. The survey revealed the encouraging fact that we have an easy route for the construction of a railway to the North West.—*Gazette.*

American Association for the Advancement of Science.—The next meeting will be held at Troy, (N. Y.), on the 17th August next. Members desiring the usual facilities for travel, &c., will obtain the required information on application to H. B. Nason, Esq., Correspondent Secretary, Troy, N. Y.

THE

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ON RECENT SPECTROSCOPIC OBSERVATIONS OF THE SUN, AND THE TOTAL ECLIPSES OF 1868 AND 1869.

By James Douglas, Jr.

Astronomy is no longer a purely mathematical science, treating of the distances and magnitudes of the celestial bodies; nor is the telescope the only instrument by means of which the condition of these far-distant worlds can be studied. The spectroscope now enables the astronomer to determine of what the sun and many of the fixed stars are composed; whether they possess an atmosphere, and what elements exist in it; whether they are self-luminous or only reflect borrowed light; what burns in the flaming tail of the comet, and what those mysterious clouds of light—the nebulæ—are.

Until the year before last the spectroscope had revealed little else respecting the physical constitution of the sun than that it possesses a gaseous envelope or atmosphere of glowing gases and metallic vapours, in which certain known and many unknown substances existed. But a solar atmosphere had been predicated on other grounds. Looking at the sun in the full blaze of day-light, one sees a fiery orb with sharply-defined circumference; but when the sun is eclipsed, by the passage of the moon between it and the observer, the surface of the sun is seen to be broken, not like that of the moon, by rugged mountain peaks and deep valleys, but by stupendous masses of burning gas, which are whirled up by storms raging over the surface of the sun, as are the pillars of sand by the sirocco of the African desert. These flames are visible beyond the disc of the moon after it has hid the luminous body of the sun. Such mountains of glowing gas have been noted during every eclipse of which we possess a scientific record; and it was observed that they sprung from a ring of rosy-colored light which enveloped the dark orb of the moon. Outside them, and extending at places for a degree beyond the the sun, there was always observed an irregular halo of white light. For a long time, through the most perverse reasoning, these phenomena were supposed to be appendages of the moon; but the observations made during the eclipse of 1842, and the photographs made during that of 1860, left no doubt that these protuberances or prominences belong to a solar atmosphere, less luminous than the body of the sun.

It was after the eclipse of 1860 that the value of the spectroscope, in the investigation of solar physics, became evident; and, therefore, the next eclipse was looked forward to with eagerness as likely to enable the spectroscopist to determine, beyond a doubt, the nature and composition of the protuberances and the corona. Consequently, a number of expeditions left Europe to observe, at different points along its central line, the eclipse of August, 1868, which began in Africa, crossed the Red Sea to Aden, and then traversed the Indian Ocean, India and Malacca. A Prussian expedition, under Dr. Vogel, stationed itself at Aden, where totality occurred soon after daylight. M. Janssen, an eminent French astronomer, made his observations at Gondoor, in India, and M. Rayet in the Peninsula of Malacca. Several English parties were organized, foremost among which were those under Major Tennant and Lieut. Herschel, both of whom took up positions in India. Dr. Vogel and Major Tennant aimed chiefly at obtaining photographs of the eclipse. During this eclipse there were observed several large protuberances and a corona. The rosy-coloured banks of cloud from whence these protuberances sprang were brightest about the equator. One very prominent protuberance retained the same position, and underwent very little alteration in shape during the period of the eclipse. The interest of the eclipse centred in the spectroscopic observations of the protuberances. Upon the whole, the reports of the different observers accorded. They all found the protuberances to give bright lines, and, therefore, the question of their gaseous constitution was settled. There was not quite such identity in the opinion as to the number and position of the bright lines. All the observers, except Lieut. Herschel, observed two of the hydrogen lines. The blue line which he lays down corresponds, however, so nearly to the hydrogen line, F, which the others are sure they detected, that we may consider them the same. All likewise agree in having seen a line in the yellow, near the double D line of sodium; and M. Rayet noted lines indicating the presence of iron and manganese. He distinctly observed nine lines in one protuberance, and only eight in another. "Hence," he remarks, "all the protuberances do not emit identical light." The observations on the corona were more discordant. M. Rayet, with his powerful instrument, could not detect the faintest spectrum, whereas Major Tennant positively reports a continuous spectrum.

Capt. Branfell, of the same party, reports "the protuberances unpolarized, and the corona strongly polarized, everywhere in a plane passing through the centre of the sun." There is the usual disagreement with regard to the color of the protuberances, Major Tennant pronouncing them white, but all others assigning to them some shade of red.

Such are the principal results of the memorable eclipse of 1868; but they were immediately thrown into the shade, and rendered well nigh superfluous, by a discovery made almost simultaneously by M. Janssen in India, and Mr. Norman Lockyer in England, by which the spectroscopic phenomena of the protuberances may be viewed any day without the interposition of the moon.

The coincidence in time of the same discovery by two men, at the antipodes, ranks among the curiosities of science with the simultaneous discovery of Neptune by Adams and Leverrier.

More than three years ago Mr. Lockyer conceived the idea of viewing the protuberances in full sun-light by passing a spectroscope with great dispersive power around the sun's disc. His instrument being unsuitable, one of a peculiar construction was ordered in 1867, but only finished in the autumn of 1868. His anticipations were realized by his first observation. In broad daylight he was enabled to trace the position and shape of the protuberances upon the sun's disc, by means of the bright lines which their spectrum gave. A few days after the publication of these important results, and a few minutes after their communication to M. Delaunay, of the French Academy, there was received by that gentleman a letter from M. Janssen, stating that during the progress of the eclipse he had conceived the possibility of attaining the same end by the same means as Mr. Lockyer was at that very time independently working at, and that on the following day he had experimentally confirmed his idea, and drawn the altered outline of one, the same protuberance he had observed the day before during the eclipse. Since then these astronomers and other spectroscopists—notably Father Secchi, of Rome—have worked in the same field, and vastly enlarged our knowledge of solar physics. I can but briefly enumerate the conclusions arrived at. It is now determined, with tolerable certainty, that there is a very attenuated atmosphere of burning hydrogen enveloping the sun at every point, measuring, in average height, about 5,000 miles; but at certain points, and chiefly near the equator, upheaved by internal volcanic forces within the sun into masses twenty times that height, and then wafted about by solar whirlwinds. Then, from the protuberances or prominences seen during an eclipse, the expulsive force is so violent that it displaces not only the light hydrogen which forms the outermost layer of atmosphere, but also projects from a deeper stratum the heavier vapours of iron and other metals into the base of the hydrogen flames. This outer layer has been called the chromosphere, from its giving a spectrum of bright-coloured lines. Here and there, as some of the photographs taken during the three last eclipses show, and as spectroscopic observations verify, clouds of hydrogen, and even of magnesium, are carried away, burning, into space, quite detached from the visible solar atmosphere, though probably within the limits of the real atmosphere, as certain of the hydrogen lines in the spectra of the protuberance extend faintly beyond the others, and indicate the extension of the atmosphere far beyond its more perceptible bounds.

Lockyer's description of a chromosphere is quite picturesque: "In different parts the outline varies. Here, it is undulating and billowy; there, it is rugged to a degree; flames, as it were, darting out of the general surface, and forming a rugged, fleecy, interwoven outline, which, at places, is nearly even for some distances, and then, like the billowy surface, becomes excessively uneven in the neighbourhood of a prominence. Here one is reminded of the fleecy, infinitely delicate cloud-films of an English hedgerow, with luxuriant elms; there, of a densely intertwined tropical forest, the intimately interwoven branches spreading in all directions, the prominences generally expanding as they mount upwards, and changing slowly, almost imperceptibly."

Intermediate between the chromosphere, yielding its spectrum of bright lines, and the body of the sun—which gives a continuous spectrum with dark lines, Father Secchi says—may, under favourable conditions of our atmosphere, be detected a continuous spectrum. The explanation of this is not very easy, but the following is suggested: If we suppose the body of the sun to be liquid, the metals which compose it are in a state of fusion at a white heat, and, therefore, emit white light; if we suppose it gaseous, the mass of glowing vapor is too dense to be transparent, and, therefore, may act in the same manner as if it were liquid; but immediately outside this liquid, or gaseous nucleus, there is a layer of ignited gases and vapors, situated so near the thin outer limb of the orb as to be transparent, in which the vapors of so many metals are burning, that their combined bright lines will yield a continuous spectrum, or what may appear such.

Another explanation, and a more probable one, because corroborated by experiment, has been offered. A continuous spectrum, according to Frankland and Lockyer, is given by gases when undergoing condensation. Judging from what takes place in our own atmosphere, we may suppose, as Storey has pointed out, a rapid condensation of certain of its constituents upon the surface of the sun. Such a permanent gas as hydrogen would undergo no change, and, therefore, continue burning beyond the limits of the area of condensation. This area of condensation would form a cloudy envelope, radiating back most of its heat to the sun, and serving other purposes in the solar economy. Would the reversion of the bright lines take place in this area?

There is not perfect unanimity of opinion as to the condition of the body of the sun. The old idea of a solid nucleus is now generally abandoned, and the opinion that it is liquid is yielding to the views of those who conceive that at such a high temperature, as all admit, prevails, it must be gaseous. There are other reasons still for believing it to be gaseous. In this latter case there can be no well-defined atmosphere; but the term may be applied to the hydrogen or outer stratum of gas, and so much of the deeper stratum as contains the vapors necessary to give the Frauenhofer lines. The chromosphere in this view is that layer in which the reversion of the bright lines takes place, unless there be an area of condensation, as proposed above. The interior has been called the photosphere.

Whether the chromosphere, or the chromosphere and photosphere are alone gaseous, and the nucleus liquid, or whether there are not successive rings of simple or mixed gases, of decreasing density, from the centre to the circumference, will probably be determined by more extended observations on the spectra of solar spots. These spots, as you are aware, have been the subject of much controversy, and the spectroscope has not set it at rest. It is assumed by some that there is a relation between the spots, the protuberances, and the feculæ, which are generally observed in the neighbourhood of the spots. When a spot is visible on the edge of the sun's disc, a protuberance may often be detected in the neighbourhood, as, for instance, in the following observation by Mr. Lockyer:—

"On the 21st April there was a spot very near the limb which I was enabled to observe continuously for some time. At 7.30 a.m. there was a prominence visible in the field of view, in which tremendous action was evidently going on, for the C. D. and F. lines were magnificently bright in the ordinary spectrum itself; and as the spot-spectrum was also visible, it was seen that the prominence was in advance of the spot. The injection into the chromosphere surpassed everything I had seen before, for there was a magnesium cloud quite separated from the limb, and high up in the prominence itself. By 8.30 the action had quieted down, but at 9.30 another throb was observed, and the new prominence was moving away with tremendous velocity. While this was going on, the hydrogen lines suddenly became bright on the other side (the earth's side) of the spot, and widened out considerably—indeed, to such an extent that I attributed their action to a cyclone, although, as you know, this was a doubtful case. Now, what said the photographic record? The sun was photographed at 10h. 55m. a.m., and I hope you will be able to see on the screen how the sun's surface was disturbed near the spot. A subsequent photograph at 4h. 1m. p.m. on the same day shows the limb to be actually broken in that particular place; the photosphere seems to have been actually torn away behind the spot, exactly when the spectroscope had afforded me possible evidence of a cyclone."

Another instance is noted by D. Curtis in his report. He observes, of one of the most striking of the prominences in the last eclipse—the corn-ear protuberance—that while its peculiar shape has all the appearance of having been impressed upon it by a cyclone, it is in the neighbourhood of a larger sun-spot and a group of feculæ. As, however, this is the only instance in which he observed any relation between sun-spots and protuberances, he considers their vicinity to one another accidental. Lockyer, however, justly remarks that though there may be spots visible in one region without prominences, and prominences without spots, it does not follow that a spot is not accompanied by a prominence at some stage of its life, or that the spot and prominence do not originate through one and the same action.

Prof. Young, of Hanover, N.H., who is making daily observations on the spots and protuberances, does not admit so intimate a relation between them. From his observations he considers it evident that the spots and prominences obey nearly the same laws in respect to their distribution on the solar surface; but the prominences, which are far more numerous than the spots, approach nearer to the poles, and are more frequently found on the equator. He has never yet been able to watch a spot in its passage round the limb, so as to observe its effect on the chromosphere; but his present impression is that certain depressions. observed from time to time in the chromosphere, are due to spots directly under them. In only one case has he found a prominence very near a spot, and then only a small one. Whether the prominences are connected with the feculæ, he thinks, is a different question, and more likely to receive an affirmative answer.

Dr. Curtis remarks that his photographs show abundance of feculæ, and prove that there must have been an almost continuous line of thin objects along the portion of the circumference of a great circle of a solar sphere occupied by the protuberances.

What appears in the telescope as ripples on the surface of the sun—the feculæ—generally occur near a spot, and reveal their presence to the spectroscope by a decided reduction in the intensity of the dark hydrogen lines, and sometimes their conversion into bright lines, even upon the surface of the sun.

The spectroscopic phenomena of the spot itself are very curious. Of course, deductions have been drawn from them; but it would be premature to put implicit reliance on them until more extended experiments on gases at different temperatures, and under varying pressure, have enabled the conditions existing on the surface of the sun to be imitated and watched in the laboratory. Mr. Lockyer detects the presence of a spot by a general darkening of the spectrum and the widening of certain of the Frauenhofer lines—phenomena which he attributes to a local increase in the general and selective absorption of the chromosphere. The Frauenhofer lines put on a sudden blackness and width in the case of a spot with steep sides, but expand gradually in a shelving one. This thickening of the absorption lines Lockyer and Frankland have proved, by experiments, to be due to varying pressure; and this variation in pressure they attribute to convection currents in the chromosphere: "Suppose a hydrogen flame to be suddenly projected from the sun in the direction of the earth, the waves of light will be shortened, and the hydrogen lines of the spectrum be shifted nearer the violet. If the flame travels from the earth the waves will be lengthened, and the lines shifted nearer to the red end of the spectrum. The line F undergoes strong contortions when seen near the centre of the sun's disc. It is seen, in fact, stopping short in one of the small spots, swelling out prior to disappearance, invisible in a fecula between two small spots, changed into a bright line, and widened out two or three times in the very small spots, becoming bright near a spot, and expanding over it on both sides, and so on. The Frauenhofer lines may thus be looked upon as so many milestones, telling the rapidity of the approach and downrush. Thanks to Angstrom's map of the wave-length of the different parts of the spectrum, it is known that the shifting of the F line the ten-millionth part of a millemeter nearer the violet, means a velocity of uprush to the eye of 38 miles per second. The observed alterations of wave-length is such that twenty miles a second is very common."

From this, I presume, we are to gather that Lockyer considers that the same cyclone which whirls the chromosphere up into space projects the heavier vapors of the photosphere into the chromosphere, and thereby leaves a cavity in the photosphere itself. This is filled by a downrush of the chromosphere, which is, consequently, there much thicker than in the surrounding region, and, therefore, more absorbent.

Father Secchi's observations agree, in the main, with the above. He remarks that when the slit of the spectroscope is carried across a solar spot, the relative intensity, as well as the length of the spectral lines, changes. The spectrum is never really interrupted; it is merely darkened through the narrowing of the bright interspaces by reason of the bulging of the dark rays and the formation of a number of cloudy lines. Many of these cloudy lines correspond with those observed in the spectrum of the sun, when on the horizon; and certain lines in the red orange space are identical with those produced by a cirrus cloud crossing the field of view, and, therefore, indicate the existence of watery vapor. A careful comparison of their spectra has led Father Secchi to the conclusion, that, as the spectra of the red orange stars and the spectra of the solar spots are identical, the sun, stripped of its chromosphere, would resemble Alpha in Orion, or Omicron in the Whale; as it is, it is a variable star. The layer of absorbing vapor, which, by its varying thickness and density, produces this variation, is denser on the spots. The questions then arise: is it piled up at such points above the average level of the chromosphere?—or, does it fill cavities in the photosphere? The Rev. Father inclines to the latter opinion. He finds, moreover, that in the spectrum of the spot, the iron and calcium lines are more strongly marked than the magnesium and sodium; hence, he concludes that the former metals, existing at the bottom of the cavity, mark the dark nucleus of the spot: the latter are within the region of the penumbra. Remark that this opinion differs materially from the old view, which supposed the dark nucleus to be the dark body of the sun—the penumbra to be the sides of the cavity. It approaches nearly the old notion that the spots are caused by a downrush of a cool, absorbing atmosphere upon the visible body of the sun,—only, according to recent observations, the downrush fills cavities in the gaseous body of the sun. This gaseous body, under such pressure as exists there, emits white light, which is more largely absorbed in the spot than elsewhere, because there the absorbing medium—viz., the vapors and gases which fill the cavity—forms a deeper and denser layer than elsewhere.

As I said before, the subject requires further elucidation; and in its further investigation, Capt. Ashe's theory of falling asteroids being elements in the disturbance which takes place in the region of a spot, is certainly worthy of consideration; for, although the theory requires remodelling to suit new facts, some of the data on which it rests cannot be overlooked.

The old cavity theory, which he long ago showed the absurdity of, has been abandoned by all, and the new cavity theory, which is being put in its place, by no means explains all the facts of the case. At the same time, it is not easy to reconcile Capt. Ashe's hypothesis with the laws of physics and chemistry. Were the spots caused by melting asteroids floating on the chromosphere, these incandescent masses of metal would give continuous spectra, whereas the spots give the very reverse; but one cannot conceive how a mass of heavy metal could float for days and months upon an ocean of light hydrogen, while undergoing fusion and then volatilization; nor in a sea of burning hydrogen would there probably be formed the dross which the Captain supposes the penumbra of the spot to be. For all that, the correspondence between the zone to which spots are confined and that within which asteroids would fall upon the sun's surface, and the fact that there is a maximum and minimum period in the occurrence of sun-spots, give strong probability to the supposition that there is a relation between sun-spots and intra-mercurial asteroids.

Lockyer and Janssen's discovery has greatly detracted from the interest which attends a total eclipse, as the most remarkable phenomena of the eclipse—the chromosphere and its protuberances—may be observed at any time. This may be the reason why no European party crossed the Atlantic to witness the eclipse of the 7th of August last. A further reason, doubtless, was, that it was known it would be so carefully observed by American astronomers as to make any assistance from them almost superfluous. It is, nevertheless, to be regretted that some European astronomers, who witnessed the eclipses of 1842, 1860, and 1868, did not bring their experience to the observation of the last. The scientific results, however, of the eclipse have been by no means insignificant. All the parties of observation have not yet published their reports; but from such as have appeared, the following summary is gathered:

The eclipse was total at sunrise in Siberia; it crossed the north Pacific a little south of Behring Straits, and thence pursued a south-east course across the continent, terminating at sun-set off the coast of North Carolina. It was observed by two United States Government parties in the Pacific, whose reports have not yet been published; by Mr. Gilman, of New York, at Sioux city, on the Missouri; by Capt. Ashe, at Jefferson City, Iowa; at Des Moines, about fifty miles south-east of Jefferson, by Dr. Curtis, of the U.S. Army Medical Museum, and a party from the U.S. Naval Observatory; as well as by Prof. Rogers, and some of the officers of the U.S. Coast Survey; by three divisions of a party under charge of Dr. Morton, of Philadelphia, stationed —one at Burlington, another at Otumwa, and the third at Mount Pleasant, Iowa. Prof. Alexander and others took up a position at Springfield, Illinois; and the Harvard University sent their observers to Selbyville, Kentucky. Many other colleges and scientific bodies sent their representatives to these or other stations along the line of totality.

The general phenomena of the eclipse did not differ from what had been observed on previous occasions. The darkness was not so great that print of moderate size could not be read during totality; and it was not till totality had almost occurred that the decrease in light became to the eye very manifest. Prof. Eastman found the light during totality to be about equal to that after sunset. The moon moved majestically and calmly across the surface of the sun, till it had almost extinguished it: when, quickly, as if by an effort, it totally eclipsed it. The shadow of the moon, as it rushed through the air, and enveloped the earth in sudden darkness, struck observers with more awe than perhaps any other of the many almost perternatural appearances of the eclipse—an awe that was dissipated only by the equally sudden return of light, as the sun blazed forth from behind the jet-black orb of the moon. The planets Mercury, Venus, and Saturn, and one or two stars of the first magnitude, burst forth at the commencement of totality, and were visible for a few seconds afterwards. The sky is described (for, having been shut up in my photographic room, I saw nothing, and speak, therefore, from hearsay) as presenting a very unusual appearance. Immediately outside the sun, beyond the corona, it was of an inky black; yet, even here there were no stars visible, only the planets; while further towards the zenith, and beyond it, to the east, the color changed to an indigo blue; and all around the horizon, but particularly to the west, it was of a bright orange. At the moment of totality, there shone forth a halo of light from all sides of the dark moon; but so much more strongly from the equator than the poles, that it more resembled a nimbus, lozenge-shaped, with rays of unequal length, than a regular crown of light. Some of the rays were over 1° in length. Within the corona there appeared, on the eastern limb of the sun, or rather moon, a rugged line of rosy red light, rising in several places into larger masses. As the moon advanced and covered the eastern limb and this range, as it were, of burning mountains, it uncovered a similar range, with its high peaks, on the western limb, and brought into better view a like phenomenon on its lower limb. This band of red light, with its remarkable excrescences, is probably the chromosphere and its protuberances.

Thermometrical observations were made by Prof. Pickering, with the following results: "Shortly before the eclipse the thermometer rose, attaining its maximum at the instant of contact, so that when three digits of 14 per cent. of the sun's disc was obscured, the temperature was about the same as before the eclipse. Again, the thermometer began to rise after the eclipse was over. These anomalies, Prof. Pickering thinks, are explained by the photographs taken at the same time. The increased brightness which they show along the moon's limb, proves, he supposes, that the latter augmented the active power of those parts of the sun's disc nearest to it, and thus renders the increase of heat very probable. This is, at least, another contribution to the many explanations of this knotty point.

The photographers' delineations of the eclipse are many, and very beautiful. Photographs were taken during totality by Dr. Curtis, at DesMoines; by Mr. Willard, at Burlington; by Messrs. Brown and Baker, at Ottumwa; by Messrs. James Clifford, Curbutt, and other gentlemen, at Mount Pleasant; by Mr. Black, of Boston, at Springfield, Ill.; by Mr. Whipple, at Selbyville, Kentucky; and by ourselves, at Jefferson. Prof. Davidson took photographic apparatus to Alaska; but we have not heard what use he made of it. Several other observers, whose telescopes were not provided with clock-work, took pictures during partial obscuration only.

At DesMoines 120 pictures were taken during the partial, and 2 during the total eclipse. They are all faultless. The pictures, before and after totality, were taken at regular intervals, and carefully timed, so as to assist in the correction of nautical tables. The two pictures of totality are probably the grandest photographs of an eclipse ever taken. They are 5½ inches in diameter, and were exposed 120 and 40 seconds respectively. Owing to this lengthy exposure the first picture exhibits the chromosphere all round, and shows, combined in one picture, passing phases which were not visible at any one moment. Scientifically, this is a disadvantage. It shows the most exquisite detail in the structure of the chromosphere, especially in a group of fantastic forms in the eastern limb, which, throwing out long tongues of light, have the appearance of delicate flickering flames, in many cases disconnected from the surface of the sun. In the second picture the chromosphere is visible only on the western limb, and is less brilliant than that on the eastern.

By the three parties under Prof. Morton thirteen pictures in all were taken during totality, with exposures varying from 5 to 16 seconds, all more or less successful. All display the chromosphere and protuberances, and one of them, taken the instant before totality, shows the limb of the sun cut into bright dots by the mountainous edge of the moon, settling, Professor Morton thinks, conclusively, the question of the origin of Bailey's beads. The exposure in all cases was too short to secure the corona; but this was most admirably done by Mr. Whipple at Selbyville, who exposed a plate in the principal focus for 40 seconds. Even in this picture the chromosphere may be detected as a very bright ring within the crown of light, but all detail is smothered; for, so actinic is the light issuing from the chromosphere, that probably no picture was exposed briefly enough to catch all the detail in its structure and that of the protuberances, which the photographic plate is capable of delineating. If any attempts are made to photograph the eclipse which will occur in China this year, the aim should be by very short exposure—say one second in the principal focus—to secure the utmost possible definition in the chromosphere. As these protuberances are ever in motion, reliable deductions as to their structure can be drawn only from pictures taken with a very short exposure. From the rapidity which my plates—exposed only ten seconds—developed, I am satisfied a well-defined image of a protuberance can be taken in one or two seconds. So short an exposure would only give the larger masses of the chromosphere, whose light, from the great accumulation of light-giving material burning in them, is very strong; but it should suffice for giving the most minute detail in these masses—detail which is obliterated or blurred in pictures with a longer exposure.

During totality we took four pictures, of one inch diameter, in the principal focus of the large telescope of the Quebec Observatory, which Capt. Ashe had the courage to take with him, and the skill to pack, mount, and re-pack without accident. Our instrument was a nine-foot equatorial, made by Alvan Clarke, of Cambridge, Mass. Our pictures received an exposure of ten seconds each, and were taken at equal distances of time from the beginning to the end of the totality. They exhibit the protuberances and parts of the chromosphere well, but do not show a trace of the corona.

It is not easy to distinguish the protuberances in all cases from the chromosphere whence they spring. Our photographs, and a drawing made by Mr. Vail, of Philadelphia, who rendered us the greatest assistance in our preparations, and carefully noted the passing phenomena of the eclipse through a Dolland 40-inch telescope, agree in laying down five protuberances. Mr. Falconer, of London, who likewise joined our party, distinguished only five protuberances. Professor Morton, on the other hand, finds nine in his pictures. Some that he and we consider as such only differ by being isolated from the neighbouring banks of light. Flames are strongly marked in pictures taken to the east of us, of which the rudiments only are visible in ours; and the large protuberance on the lower limb, which, in our pictures, grows from a bright dot in picture I. to a high flame in picture III., burns down in picture IV. to one-half its former height, and commences to assume the flattened form which it has in all the pictures taken to the east of us. This remarkable protuberance was seen by Capt. Ashe, and the other members of our party, to blaze up rapidly after the exposure of the second picture; then the top of the flame was wafted away to the east, as if by a strong current in the upper atmosphere of the sun, and the body of the flame gradually burned down, assuming the forms it bears in pictures III. and IV.

Mr. Vail described the protuberances, and especially the large one, as follows:—

"But the most remarkable appearance of all, and that which attracted the attention of every one who witnessed the eclipse, whether seen with the naked eye or with the telescope, were the red protuberances that shot up immediately on the disappearance of the sun from various places on the edge of the moon. Their position your photographs will fix better than I can describe. The largest was on the lower edge of the moon, and was, by my estimate, when highest, not less than two minutes in altitude from the edge of the moon, or about 55,000 miles.

"Its color was a bright *pinkish red*; its outlines were perfectly well defined, and were not curves, but rather irregularly broken straight lines; and, throughout, it seemed marked by similar lines.

"It reminded me of the appearance one sometimes sees on the face of a cliff where the rock is broken by horizontal and vertical lines. The same, or nearly the same appearance would be presented if one were to view columnar basaltic rocks from a point where the rocks in the rear would rise above those in front. I would, therefore, suggest whether these lines may not have a similar origin, and each be the outline of a vast column of luminous matter thrown up above the atmosphere of the sun."

Capt. Ashe has made accurate drawings of the structure of the protuberances from our magnified photographs. No semblance of a spiral structure, such as was thought to be discernible in the Indian pictures, exists; but dark lines cut the flame longitudinally and transversely, giving it the appearance—as described by Mr. Vail—of being built of huge blocks, laid in irregular rows. The same structure may be recognized in the lower protuberance on the western limb. The outline of these flames, as delineated in the photographs, is not sharp, especially on their western side, where a hazy band, like a shadow, is very manifest. The bright band of light, broken into flickering flames, which surrounds the eastern limb, exactly corresponds to Lockyer's description of the chromosphere. It presents, however, a different structure on the western limb, where it forms two concentric bands of light, extending round the sun, from the large protuberance on the lower limb, for about 90°. Between the bright bands is a dark space. Within the rings are enclosed three protuberances. The axes of all these protuberances are parallel to one another, and the chromosphere is crossed by numberless lines parallel with one another and the protuberances, and not radiating from the sun's centre, but at right angles to its axis. It would be presumptuous to offer any explanation of these appearances before comparing our pictures with others, as even photographs are liable to so many sources of error.

But justice has not been done our pictures in England, whither they were sent last autumn to the care of M. De La Rue. He faintly praised pictures I. and II., but unhesitatingly pronounced pictures III. and IV. to be worthless, as the telescope must have moved or followed irregularly. He questions the fact of the large protuberance having been seen to shoot up and then burn down, and disregards the minute structure of the protuberances and the chromosphere, considering them photographic blemishes. Mr. Airy concurs in the opinion, which is strengthened, in his mind, by the difference between our pictures III. and IV. and the pictures taken by the American parties to the east of us. This last reason is palpably fallacious. Had any other party photographed the sun at the same moment as ourselves, and our pictures differed, one or other would have been faulty; but the eclipsed sun was neither observed nor photographed by others during the period of totality at Jefferson. Mr. Gilman observed it at Sioux City before totality occurred, and Dr. Curtis photographed it at Des Moines after totality at Jefferson. I saw nothing of the total eclipse, but I heard, in my dark room, the strong expressions of wonder uttered by all at the striking changes in form the protuberance was undergoing, and the very vehement language Capt. Ashe was using toward me on account of the delay in passing him plates when he wanted to catch the strange phase of the dissolving view, as the top of the protuberance was being blown away to the east. There are probably periods of greater or less activity in the life of the prominences, and, considering that but a few prominences are visible for a few hours during a total eclipse, what wonder that a prominence in activity should rarely be seen? Our pictures so closely correspond with the descriptions of the various appearances given independently by intelligent observers on the spot, especially in the structure of the great protuberance, as to afford *prima facie* evidence of their correctness; but Capt. Ashe, in his report to Government, gives geometrical proof to the same effect, by showing that the rings of the chromosphere (if such it be) in picture IV. are perfectly concentric, and that if the independent protuberances which the English astronomers pretended are duplicates of one and the same, be duplicates, the telescope must have moved in opposite directions.

The chromosphere appears to be heaped up most densely about the equator, though the largest protuberances in each of the late eclipses was isolated and at a distance from the equator.

All the prominences in our own and others' pictures seem to eat into the moon; and the same appearance is presented by the more elevated portions of the chromosphere. Captain Ashe conjectures that this is due to reflections from the moon's surface. This is clearly proved, he thinks, by the following facts, viz.: that the limb of the moon is distinctly seen as a dividing line between the protuberance and its reflection, and that the inner is a similar and inverted image of the outer figure. The same explanation of this puzzling phenomenon has been given independently by Dr. Gould. But Dr. Curtis believes this appearance to be due to excessive deposition of silver in the photographic plate from vicinity to the bright protuberance. His experiments in proof of this would be conclusive had not the appearance been noticed by the most uninitiated observer when watching the eclipse. A carpenter asked Capt. Ashe what the notches (not a bad expression) in the moon were.

SPECTROSCOPIC OBSERVATIONS.

Spectroscopic observations were made by Professor Young, who was stationed at Burlington, Iowa. He observed nine bright lines, the number noted by M. Rayet at the previous eclipse, though they do not correspond in position. Two, if not three, of the lines are indisputably those of hydrogen, and several others nearly correspond with iron lines. In the following table I give a list of the lines observed, and Professor Young's remarks. The middle column I am responsible for.

Lines Observed by Prof. Young.	Coincidences and Nearest Correspondence.	Remarks-
C.	A hydrogen line	Dazzling in brightness.
1017.5	Near double D—Sodium	Bright, but not equal to C.
1250.2	1250.4.—Iron	Very faint; position only estimated, and extending apparently beyond the protuberance, and thought to be a coronal line.
1350.2	1351.1.—Iron	Like the preceding.
1474	1473.9.—Iron	A little below E; conspicuous, but not half as bright as 1017.5. Like the two preceding, supposed to extend into the corona.
F.	Hydrogen	Next to C in brightness.
2602.2	2601.7.—Iron	A little fainter than 1474; position determined by micrometrical reference to the next.
2796	Hydrogen?	A little below H δ; in brightness, between 1017.5 and 1474.
H δ	Hydrogen	Somewhat brighter than 1474.
B.		Supposed to have been overlooked.

Prof. Harkness, at Des Moines, had taken every precaution to ensure accuracy in the record of his observations. He noted six lines in the protuberances, and one of the same lines in the corona. As might be expected, while he found the different protuberances to possess essentially the same constitution, he detected more lines in one than in another, and found different metals to occur at different altitudes in the prominences. This is not difficult of explanation ; for, supposing the protuberance to be caused by violent convulsions, which displace the gaseous envelope of the sun, while the lighter hydrogen which composes the outermost layer will occupy the top of the flame, the heavier metallic vapors will be lifted out of their appropriate strata, and be detected about the base of the protuberance. Suppose, further, that a protuberance on the eastern limb of the sun is examined at the instant of totality, the heavier vapors of the base and the lighter gases of the summit will both be uncovered, and give their respective spectra ; whereas, if a protuberance on the opposite limb be observed, as it is being uncovered, only the summit will be visible, and the hydrogen spectrum alone be obtained, till just before totality finishes, when the base of the protuberance comes into view.

The following Table summarises the result :—

1	2	3^1	3^2	4	Corona.	Mean.	Kirchoff Scale.	Wave length.	Wave length of chemical elements.
46.0	37.0	36.5	36.0	35.0	...	36 3	693	656.9	656.8 Hydrogen—C.
50.0	50.5	....	50.0	50.0	....	50 1	1007	589.4	587.9 (Sodium—D.) un-
67.5	67 0	67.0	66.5	67.5	66 5	67 0	1497	530.0	530.7 Iron. [known.
....	....	...	70.5	.....	....	70 5	1611	520.1	518.7 Magnesium.
85.0	...	....	84.0	84.5	....	84.5	2069	487.5	486.5 Hydrogen—F.
....	....	....	114.0	114.5	....	114.2	2770	435.9	435.1 Hydrogen—Hy.

Columns 1, 2, 4 give the lines detected in three different protuberances; columns 3^1 and 3^2 those detected in a fourth protuberance during the observations taken at an interval of some seconds.

There still remain, therefore, to be detected in the protuberances many lines whose position in the chromosphere Mr. Lockyer has determined, though the only metal, whose presence in the chromosphere Mr. Lockyer is certain of, which has not yet been found during an eclipse observation, is "Barium."

THE CORONA.

The corona, such as it appeared to an observer, as previously stated, has been brought out in only one photograph, which was taken by Mr. Whipple. It is a very remarkable picture. In it the corona resembles what it appeared to the naked eye, an irregular, somewhat oval-shaped halo of light, lowest at the poles, but at the equator one-fourth of the sun's diameter in height; diminishing in intensity from within outwards. The rays, which to the eye seemed distinct and in constant motion, like cilia, form in the photograph, of necessity, from the length of exposure, an unbroken sheet of light. Prof. Hume describes the structure of the corona as "fibrous, slightly crooked, or twisted, somewhat like a cirrous cloud, and of silvery whiteness." The dim haze seen round the moon in other photographs is probably also produced by the corona, as the chromosphere would give a better defined outline.

We saw that the Indian observers disagreed as to the spectroscopic character of its light, M. Rayet finding no spectrum, and Major Tennant a continuous one. Prof. Young thinks it gave a faint, continuous spectrum, and that three of the lines, viz.: 1250, 1350 and 1470, which he found in the protuberance spectrum, extend into the corona, and that these three are the lines which Prof. Winlock detected in the spectrum of the aurora borealis. Prof. Young is, however, not confident of the accuracy of his observation, and thinks it possible that the three lines in question may extend only beyond the more visible parts of the protuberance into that hazy region which the photographs dimly reveal, as if it were a shadow thrown by the flame. These three lines are not exactly coincident with any known lines, though they vary very little from three iron lines.

Prof. Harkness is not doubtful of the accuracy of his observation. He found the corona to yield a faint continuous spectrum, with one bright line, whose position is given in the table above. He remarks:—"The brightness of the continuous portion was about equal to—perhaps slightly less than—that of the spectrum which I get from the moon in the same instrument; and I am perfectly convinced that there was no absorption lines. I looked particularly for them, and the light was sufficiently intense, and the slit sufficiently narrow, for me to have seen them if they had been present. The bright line was tolerably conspicuous, but it did not stand out so glaringly as the bright line in the prominences. So far as a single observation can be depended upon, it seems to me that this one tends to prove that the corona is a highly-rarified, self-luminous atmosphere surrounding the sun, and that it is composed principally of iron in the state of incandescent vapor. Probably the selective absorption of the continuous portion of the spectrum is not sufficiently strong to do more than slightly dim, without actually reversing, the bright lines of the chromosphere. But with the bright line at 67.0 divisions of my scale the case is different. If I have rightly identified its wave-length, *it does reverse the solar spectrum*, for the rays whose wave-lengths are 530.7 and 528.8 are respectively identical with the dark lines at 1487.7 and 1508.6 of Kirchoff's maps.

What is the corona, and of what does it consist? If Prof. Young is correct, do the three bright lines which he observed, belong to some unknown element—a gas lighter than hydrogen, and which, like the hypothetical ether, fills space? We can hardly suppose such intense action as exists on the surface of the sun to be unaccompanied by electricity, which, in the auroral light of our own heavens and the corona of the sun, may render this hypothetical gas luminous. Storey, years ago, discussed the likelihood of such an extra-atmospheric medium. If Prof. Young's observations are corroborated by those of others, there may be found some probable proof for such a supposition.

Are the corona and the zodiacal light identical? Major, in his essay, "The Dynamics of the Heavens," offers an explanation of the zodiacal light, as follows:—

"As cosmical masses stream from all sides in immense numbers towards the sun, it follows that they must become more and more crowded as they approach thereto. The conjecture at once suggests itself, that the zodiacal light, the nebulous light of vast dimensions which surrounds the sun, owes its origin to such closely-packed asteroids. However it may be, this much is certain, the phenomenon is caused by matter which moves according to the same laws as the planets, round the sun; and it consequently follows that the whole mass which originates the zodiacal light is continually approaching the sun and falling into it. This light does not surround the sun uniformly on all sides—that is to say, it has not the form of a sphere, but that of a thin convex lens, the greater diameter of which is in the plane of the solar equator; and, consequently, it has, to an observer on our globe, a pyramidal form. Such lenticular distribution of the masses in the universe is repeated in a remarkable manner in the distribution of the planets and the fixed stars." * May, then, the zodiacal and coronal light be one and the same? Supposing the above hypothesis to be correct, would not the asteroids, falling in

* Page 272 of Youman's "Collection of Essays on the Correlation and Conservation of Forces."

a shower towards the sun by their attrition produce a sheet of light resembling the corona? Moreover, as the meteors which fall upon our earth are composed almost entirely of iron, we may suppose those reaching the sun to contain that metal as a predominant element. Although the spectroscopic observations of the corona differ—Professor Young having detected several bright lines, and Professor Harkness only one—by both the presence of iron is rendered highly probable.

POLARISCOPIC OBSERVATIONS.

Prof. Pickering entirely disagrees with the observers of the Indian eclipse as to the polariscopic condition of the coronal light. He says:—"The form of polariscope used was that adopted by Arago in his experiments on sky polarization. It consists of a tube about twenty inches long and two inches in diameter, one end of which is closed by a double-image prism of Iceland spar, and the other by a plate of quartz. Looking through the former, we see two images of the latter, which, when the light is polarized, assume complementary tints. If, now, the corona was polarized in planes passing through the centre of the sun, (as is generally admitted,) when viewed through the polariscope, in one image the upper and lower parts should have appeared blue, and those on the right and left yellow, while in the second image these colours would be reversed,—the yellow being alone below, and the blue on the sides. In reality the two images were precisely alike, and both pure white; but one was on a blue, and the other on a yellow back-ground. From this we infer that the corona was unpolarized, or, at least, that the polarization was too slight to be perceptible." Prof. Pickering adds, that "although this does not prove that it shines by its own light, since polarization is produced only by specula, and not by diffused reflection, yet these observations, and those by the spectroscope, seem to render it probable. This view is also strengthened by the fact, that as the most distant portions are but about 100 parts the distance of the earth, they receive about 10,000 times as much heat per square foot. The coloured background mentioned above shows that the sky, close to the corona, is strongly polarized; and, since the tint is uniform on all sides of the sun, the plane of polarization is independent of the position of the latter—that is, the same on the sides that it is above and below it. The most probable explanation of this most unexpected result is, that the earth beyond the limits of the shadow being strongly illuminated, acts as an independent source of light, and this being reflected by the air, becomes polarized in planes perpendicular to the horizon." These results are so diametrically opposed to those previously obtained, that their accuracy is sure to be called in question.

The discrepancies in opinion of the different observers of the corona, in the late eclipses, are in striking contrast to the accordance of their observations of the protuberances. To the corona attention must chiefly be directed in future, the main points as to the constitution of the protuberances having been determined. No means of examining it, except during an eclipse, have yet been proposed; so that unless some method of doing so is devised in the interim, we must wait for the intervention of the moon before we can be sure what that beautiful crown of light is—whether it is composed merely of the rays which issue from behind the moon as we see them radiate from behind a cloud when it obscures the sun; or whether they emanate from some metal known or unknown, forming an extremely attenuated atmosphere beyond the hydrogen envelope; or whether they are identical with the auroral or the zodiacal light, whatever they may be.

CANADIAN DIATOMACEÆ.

By William Osler,

[Of the Toronto School of Medicine.]

Among the many beautiful objects which the microscope has revealed to us, none, perhaps, are such general favourites, (especially with the younger microscopists,) as the Diatomaceæ. Their almost universal distribution — the number of species — and above all, the singular beauty and regularity of their markings — have all tended to make them objects of special interest and study. In the following paper I propose to give, briefly, the principal points connected with their life, history, and structure, together with a list of those species I have met with in Canada.

Standing, as they do, upon the very border-land between the animal and vegetable kingdoms, it is not to be wondered at that the earlier observers, unable to free their minds from the idea of motion being a special characteristic of animal life, claimed for them a place with the former; stricter investigations, aided with better instruments, have proved most conclusively that their real position is among the Protophytæ.

A Diatom consists, essentially, of a single cell, and only differs from the other unicellular plants in the ultimate structure of its cell wall, which is impregnated with silex — this impregnation always following a definite and distinct pattern in each organism, and forming a most valuable means of determining the species. — I need hardly observe that this secretion of silex is by no means peculiar to the Diatomaceæ; parallel instances are found in the Equisteæ, and many other plants. On examining a living frustule the cell-contents are clearly seen, consisting of a bright central nucleus (not always visible,) and a yellowish brown-coloured substance called Endochrome, dispersed throughout the frustule; this is sometimes seen to exhibit the phenomenon of cyclosis, moving freely from one portion of the cell to the other. In addition, several oil-globules are usually present. These, at certain seasons, become very abundant; so much so, as almost to take the place of the Endochrome. At the apices and sides of the frustule a clear or slightly granular substance exists, which, as we shall see, Prof. Schultze believes to be the chief agent in producing the movements of this family. A curious motion of granules is to be observed in some diatoms, which is very similar to, and probably owes it origin to the same cause as the "swarming of the Desmids."

The siliceous envelope is composed of two valves of the most perfect symmetry, which are at first in close proximity to one another, and enclose between them the cell-contents; but as the process of self-division goes on, the valves separate from each other, and a hoop or connecting membrane is formed, usually containing less silex, and not often presenting the beautiful markings so well seen on the valves. The connecting membrane generally separates from the valve on the application of strong heat, or on boiling the frustules with nitric acid.

When the connecting membrane is turned towards the observer, it is said to be the "front view;" when the valves are turned, the "side view." It is on the valves principally that the markings so characteristic of the Diatomaceæ, and about which so much discussion has taken place, occur. Until recently, great uncertainty prevailed as to the true nature of these markings, especially in the genus Pleurosigma,—some maintaining that they were depressions, others regarding them as elevations. The Rev. Mr. Reade has at last, I believe, settled this vexed question by means of a very simple little piece of apparatus, which he calls a "Diatom prism." With this he clearly demonstrates that the dots into which the striæ are resolvable in the Pleurosigma and allied genera are elevations, and he aptly compares them to a "field of haycocks," or a "plate of marbles." Through the kindness of Prof. Bovell, I have been enabled to use the prism, and certainly the appearances produced strongly favour this view. The large cellular markings of some of the marine genera, Isthmia for example, are undoubtedly depressions, while in the beautiful genus Pinnularia, the striæ are continuous, and have been called by Mr. Thwaites, "costæ."

Minute apertures exist along the line of suture, and at the apices, through which the cell is nourished; these, in some genera, communicate with the interior by means of channels (canaliculi) hollowed out between the valve and primordial utricle. Nodules of silex are present at the centre and extremities of the valves, in many species. These, by Ehrenberg and others, were supposed to be apertures; but they probably only serve to give additional strength and firmness to the valves.

Increase in the Diatomaceæ takes place in several ways, namely—by division — by conjugation — and, most likely, by the formation of gonidia. The first of these methods is, as Mr. Thwaites observes, rather an act of generation than of reproduction. It is thus described by Messrs. Griffith and Henfrey — "The primordial utricle, enclosing the contents, divides into two portions, which separate from one another in a plane parallel with the sides of the undivided frustule; the two halves of the parent cell gradually separate from one another, remaining connected by the simultaneous gradual widening of the hoop. In the space thus afforded the two segments of contents secrete each a new layer of membrane (ultimately silicified) over the surfaces where they are in contact, which layers of membrane constitute the two new half frustules, back to back, corresponding to and conjoining with the two half frustules of the parent, to form new individuals." In the free species, when the self-division is completed, the hoop drops off — and it is not until that occurs, that the two new half frustules become perfectly silicified; but in the filamentous species the hoop is persistent, and forms the connecting band between the frustules. The true act of reproduction is, comparatively speaking, rare among the Diatomaceæ, and probably only occurs when conditions become unfavourable to the process of self-division.—In this act two frustules approach one another — their concave surfaces being in apposition; from each of these surfaces two conical projections of the Endochrome are seen — these coalescing become developed into sporangial frustules, which are considerably larger than the parent ones, but exhibit similar markings. Varieties of this mode occur in several genera; in some (Himantidium) the product of the united Endochrome is a single sporangial frustule, while in others (Cocconeis, etc.) the Endochrome of a single frustule escaping, may develop into a sporangium. During the act both old and developing frustules are enclosed in a thick layer of mucous. The subsequent history of the sporangia is as yet very imperfectly understood; but it is probable that their contents break up into gonidia, and these becoming encysted, develop into several individuals — though some believe that the sporangia undergo self-division, to a limited extent, before breaking up into the gonidia.

The movements of the living frustule are of a most peculiar kind, and are generally described as a "series of successive jerks in a straight line, and a return, after a slight pause, upon the same path." To explain this motion various hypotheses have been advanced, from time to time. Some observers supposed that cilia were the active agents in producing it, and even went so far as to publish woodcuts of the Diatoms, with the cilia at either end. These have been proved, by Mr. Wenham, to have been "optical delusions." It is true, however, that hair-like processes, uniformly arranged, and bearing a striking resemblance to cilia, are very often seen attached to Diatoms — (this seems especially the case in Nitzshia sigmoidæa, though it not uncommonly happens that the Diatoms of a whole gathering have them) — but these are never seen in motion, and appear to impede rather than assist the movements. They are, in all probability, of fungoid origin. Nageli's hypothesis, namely — that the movements are produced by endosmotic and exosmotic currents, is one which has met with considerable favour. It was advocated by the late Prof. Smith, and still is, I believe, by Dr. Carpenter. Prof. Max Schultze, of Bonn, has recently advanced a view, which certainly appears reasonable, if borne out by facts. It is this: He supposes that the clear, or slightly granular protoplasmic fluid, which extends underneath the valves, along the raphe to the apices, and in which a movement is sometimes seen, is in connection, by means of excessively minute pores in the raphe, with a similar, clear external layer; and in this way the movements of the protoplasm are communicated through the pores to the external layer, enabling the frustule, when in contact with smooth surfaces, to glide along, with undulating motion, not unlike a snail.

Below is given a list of one hundred and ten species, comprised in thirty-one genera. Many more, no doubt, will be found, as the number of practical microscopists increase in the country.

In conclusion, I beg to acknowledge the many obligations I am under to Prof. Bovell, of Trinity College, and the Rev. W. A. Johnson, of Weston, Ont.; from both these gentlemen I have received much valuable assistance, especially in the use of books and microscopical apparatus.

EPITHEMIA, KUTZ.

E. turgida, Sm.—Common. Grenadier Pond; Sandy Cove.

E. granulata, Kutz.—Rare. Grenadier Pond.

E. zebra, Kutz.—Rare. Desjardin Canal.

E. gibba, Kutz.—Common. Humber Ponds.

E. ventricosa, Kutz.—Not uncommon. Kempenfelt Bay.

E. argus, Sm.—Rare. Desjardin Marsh; Burlington Bay.

E. ocellata, Kutz.—Rare. Grenadier Pond.

E. sorex, Kutz.—Rare. Ditch at Ancaster; Don River.

E. proboscidea, Kutz.—Numerous. Stream near London.

EUNOTIA, EHR.

E. arcus, Sm.—Numerous. Cedar Swamp, Weston; Humber Bay.

E. tetrodon, Ehr.—Rare. Desjardin Canal.

CYMBELLA, AG.

C. Ehrenbergii, Kutz.—Not uncommon. Grenadier Pond; Desjardin Canal; Don River.

C. maculata, Kutz.—Rare. Stream at Niagara Falls.

C. Scotica, Sm.—Rare. Grenadier Pond.

AMPHORA, EHR.

A. ovalis, Kutz.—Common. Grenadier Pond; Sandy Cove; Lake Simcoe.

A. minutissima, Sm.—Rare. Sunken boat at mouth of River Humber.

COCCONEIS, EHR.

C. Thwaitesii, Sm.—Common. Grenadier Pond.

C. pediculus, Ehr.—Very common. Constantly attached to Cladophora glomerata in the fall. Wharves at Toronto.

C. Placentula, Ehr.—Rare. Wharf at Orillia.

CYCLOTELLA, KUTZ.

C. Kutzingiana, Thw.—Frequent. Stream at London; Desjardin Canal; Grenadier Pond.

C. operculata, Kutz.—Rare. Sandy Cove; Lake Simcoe.

C. rotula, Kutz.—Rare. Pond Mills; London.

SURIRELLA, TURP.

S. splendida, Kutz.—Common. Pond near Clifton House, Niagara Falls, (numerous); Grenadier Pond; London.

S. nobilis, Sm.—Rare. Sandy Cove; Lake Simcoe.

S. minuta, De Breb.—Rare. University Pond, Toronto; Stream near Weston, (Rev. W. A. Johnson.)

S. biseriata, De Breb.—Rare. Burlington Bay.

S. craticula, Ehr.—Very rare. Sandy Cove; Lake Simcoe.

S. linearis, Sm.—Not uncommon; Grenadier Pond.

TRYBLIONELLA, SM.

T. angustata, Sm.—Rare. Marsh at Dundas.

CYMATOPLEURA, SM.

C. solea, Sm.—Common. Don River; Grenadier Pond.

C. elliptica, Sm.—Uncommon. Mouth of the Humber.

C. apiculata, Sm.—Common, with *C. solea*.

NITZSCHIA, HASS.

N. sigmoidea, Sm.—Not uncommon. Humber Ponds; Burlington Bay.

N. Brebissoni, Sm.—Rare. Barrie; Don River.

N. amphioxys, Sm.—Not uncommon; Island Ponds, Toronto.

N. acicularis, Sm.—Rare. Niagara Falls.

N. tenuis, Sm.—Rare. Wharf at Orillia.

N. minutissima, Sm.—Common. Mono Mills; Island Ponds, Toronto.

AMPHIPLEURA, KUTZ.

A. pellucida, Kutz.—Rare. Grenadier Pond.

NAVICULA, BORY.

N. cuspidata, Kutz.—Common. Sandy Cove; Niagara Falls.

N. lanceolata, Kutz.—Common. Desjardin Canal; Humber Ponds; Don Marsh.

N. ovalis, Sm.—Rare. River Thames, London.

N. amphirhynchus, Ehr.—Rare. Desjardin Canal.

N. rhomboides, Ehr.—Common. Burlington Beach.

N. affinis, Ehr.—Common. Sandy Cove; Grenadier Pond.

N. tumida, Sm.—Rare. Toronto Bay.

N. crassinervia, Ehr.—Rare. Sandy Cove; Pond at Ancaster.

N. sphærophora, Kutz.—Rare. Niagara Falls.

N. ambigua, Ehr.—Not uncommon. Don River; Kempenfelt Bay; Welland Canal.

N. amphisbæna, Bory.—Common. Niagara River, above the Falls.

N. producta, Sm.—Rare. Pond at Dundas.

PINNULARIA, EHR.

P. major, Sm.—Common. Sandy Cove; Humber Ponds.

P. gibba, Ehr.—Common. Clifton; Mono Mills; Don River.

P. stauroneiformis, Sm.—Rare. Grenadier Pond.

P. nobilis, Ehr.—Not uncommon. Grenadier Pond; Desjardin Canal.

P. acuta, Sm.—Rare. Stream at London.

P. viridis, Sm.—Common. Humber Ponds; Burlington Bay.

P. mesolepta, Ehr.—Rare. Grenadier Pond.

P. acuminata, Sm.—Rare. Sunken boat at mouth of Humber.

P. oblonga, Sm.—Common. Grenadier Pond; Oakville.

P. acrosphæria, Sm.—Common. Humber Ponds; Thames, London.

STAURONEIS, EHR.

S. Phœnicenteron, Ehr.—Not uncommon. Grenadier Pond.

S. acuta, Sm.—Rare. Sandy Cove; River Don.

S. dilatata, Sm.—Rare. Burlington Bay.

S. gracilis, Ehr.—Common. Island Ponds, Toronto; Humber Ponds.

S. punctata, Kutz.—Rare. River Don.

S. linearis, Ehr.—Very rare. Pond near Niagara Falls.

S. anceps, Ehs.—Common. Desjardin Canal; Kempenfelt Bay.

PLUROSIGMA, SM.

P. attenatum, Sm.—Not uncommon. Outlet of Grenadier Pond; Don Marsh; Burlington Beach.

P. Spencerii, Sm.—Rare. Mr. Saunders' farm, London; Desjardin Canal.

SYNEDRA, EHR.

S. lunaris, Ehr.—Rare. Humber Bay; Stream at Barrie.

S. minutissima, Kutz.—Common. River Thames, London.

S. radians, Sm.—Very common. Streams at Dundas, Weston, Paris, London, etc.

S. capitata, Ehr.—Common. Sandy Cove; Grenadier Pond.

S. ulna, Ehr.—Not uncommon. Niagara Falls; Humber Bay.

S. longissima, Sm.—Rare. Sunken boat, Humber River.

S. fasciculata, Kutz.—Common. Stream at London.

COCCONEMA, EHR.

C. lanceolatum, Ehr.—Common. Grenadier Pond; Desjardin Canal.

C. parvum, Sm.—Rare. Pond at Ancaster.

C. cistula, Ehr.—Not uncommon. Sandy Cove; Humber Bay.

GOMPHONEMA, AG.

G. geminatum, Ag.—Common. On *Cladophora glomerata*, in swiftly running streams, and on wharves.

G. olivaceum, Ehr.—Common. Trinity College stream, and streams at Weston.

G. acuminatum, Ehr.—Not uncommon. Grenadier Pond.

G. cristatum, Ralfs.—Rare. Mouth of the Humber.

G. dichotomum, Kutz.—Common. Wharves, Toronto; Grenadier Pond; St. Lawrence, at Prescott, (Rev. W. A. Johnson.)

G. curvatum.—Not uncommon. Grenadier Pond; Desjardin Canal.

MERIDION, AG.

M. circulare, Ag.—Common. Cedar swamp, Weston; streams at Weston, Dundas, and Toronto.

M. constrictum, Ralfs.—Rare. Island Pond, Toronto.

HIMANTIDIUM, EHR.

H. arcus, Sm.—Not uncommon. Burlington Bay, Humber Ponds.

H. pectinale, Kutz.—Common. Grenadier Pond; stream at Paris.

H. majus, Sm.—Rare. Kempenfelt Bay.

ODONTIDIUM, KUTZ.

O. mutabile, Sm.—Common. Sandy Cove; Lake Simcoe; stream at London.

O. Tabellaria, Sm.—Rare. Mouth of Desjardin Canal.

O. parasiticum, Sm.—Rare. Sandy Cove; Lake Simcoe.

O. Harrisonii, Sm.—Frequent. Kempenfelt Bay; stream at Dundas.

O. anomalum, Sm.—Not uncommon. Don Marsh; Grenadier Pond.

FRAGILARIA, LYNG.

F. capucina, Desm.—Common. Streams at Dundas, Toronto, London, and Oakville.

F. virescens, Ralfs.—Not uncommon. Desjardin Canal.

ACHNANTHES, BORY.

A. exilis, Kutz.—Not uncommon. Stream at Hamilton; Humber Ponds.

DIATOMA, DEC.

D. vulgare, Bory.—Very common. Grenadier Pond and elsewhere.

D. elongatum, Ag.—Common. Desjardin Canal; stream at Orillia.

TABELLARIA, EHR.

T. flocculosa, Kutz.—Frequent. Humber Ponds; Burlington Bay; Cedar Swamp, Weston.

T. fenestrata, Kutz.—Common. River Thames, London.

MELOSIRA, AG.

M. varians, Ag.—Common. Stream near Dundas; wharves at Toronto.

ORTHOSIRA, THWAITES.

O. orichalcea, Sm.—Rare. Sandy Cove; Lake Simcoe.

O. spinosa, Sm.—Rare. Buoy in Burlington Bay.

ENCYONEMA, KUTZ.

E. prostratum, Ralfs.—Common. Wharves at Toronto; water trough near Dundas.

COLLETONEMA, BRIB.

C. vulgare, Thw.—Rare. Mill-stream, Dundas.

C. neglectum, Thw.—Not uncommon. River Don; Toronto Island; Kempenfelt Bay.

NOTES ON THE BIRDS OF NEWFOUNDLAND.

By Henry Reeks, F.L.S., &c.

(*Continued from page 47.*)

Picidæ. The Woodpeckers.

Hairy Woodpecker, or *Sapsucker* (Picus villosus, *Linn.*)—Tolerably common, and does not migrate. Newfoundland specimens appear to agree with Professor Baird's variety—*medius.*

Downy Woodpecker, or *Sapsucker* (P. pubescens, *Linn.*)—Very common, and, like the preceding species, is non-migratory.

Black-backed Three-toed Woodpecker (Picoides arcticus, *Swains.*)—This fine species is tolerably common in Newfoundland throughout the year; and, often when the snow is drifting through these dreary forests, no other sign of animal life is noticeable than the "Woodpecker tapping" in search of the larvæ of several fine species of Sirex which abound there.

Banded Three-toed Woodpecker (Picoides hirsutus, *Vieill.*)—Scarcely so common as the preceding species, but, like that, is a resident throughout the year. I shot several males, but had a difficulty in getting a female, though I succeeded at last in killing one specimen. It is a rather darker bird than the male, and is without the yellow patch on the crown, having that part spotted with white. The transverse bands on the back are similar to those on the male.

Black Woodcock, or *Logcock* (Hylotomus pileatus, *Linn.*)—This is the "great black Woodpecker" of the Newfoundland settlers, and appears to be rather rare, as I did not meet with it during my stay there. It is probably a summer migrant.

Flicker (Colaptes auratus, *Linn.*)—This species is a summer visitor to Newfoundland, where it is called the "English Woodpecker," and is tolerably common. It has a peculiar note, which bears a fancied resemblance to that of the green Woodpecker (*Picus viridis ;*) hence the name bestowed on it by the settlers.

Three other species of Woodpecker probably occur in Newfoundland, but I did not meet with them, viz., *Sphyrapicus varius*, Linn.; *Centurus Carolinus*, Linn.; and *Melanerpes erythrocephalus*, Linn.

Cypselidæ. The Swifts.

American Chimney Swallow (Chætura pelasgia, *Linn.*)—apparently rare, at least at Cow Head. I only examined one specimen, shot in June, 1868. It is, of course, a summer migrant.

American Night Hawk (Chordeiles popetue, *Vieill.*)—Well known to the settlers as the "Night Hawk," but I did not meet with a specimen. It is a summer migrant.

Alcedinidæ. The Kingfishers.

Belted Kingfisher (Ceryle alcyon, *Linn.*)—Tolerably common during the summer months, and, like the British species of Kingfisher, builds in banks, often at a considerable depth, and lays five or six white eggs. I have always found the belted Kingfisher a very shy bird, and difficult to get a shot at.

Tyrannidæ. The Tyrant Flycatchers.

King Bird, or *Bee Martin* (Tyrannus Carolinensis, *Linn.*)—Visits Newfoundland for nidification, and is tolerably abundant. I have shot them after the first fall of snow in the autumn.

Pewee (Sayornis fuscus, *Gmelin.*)—A summer migrant, but not common.

Wood Pewee (Contopus virens, *Linn.*)—A summer migrant, arriving in May. Not common.

Least Flycatcher (Empidonax minimus, *Baird.*)—A single specimen, obtained in the month of June, 1868. It is a summer migrant.

Green-crested Flycatcher (Empidonax Acadicus, *Gmelin.*)—Not very common. Frequents woods in the neighbourhood of houses, and is a summer migrant.

Yellow-bellied Flycatcher (Empidonax flaviventris, *Baird.*)—Apparently a common summer migrant, arriving in May.

TURDIDÆ. The Thrushes.

Hermit Thrush (T. Pallasi, *Cabanis.*)—A common summer visitor, and tolerably good songster. Arrives about the middle of May.

Wilson's Thrush (T. fuscescens, *Stephens.*)—A summer migrant, but not so common as the preceding species. One specimen, obtained in May, 1868.

Olive-backed Thrush (T. Swainsoni, *Cab.*)—A summer migrant, but scarcely so common as *T. Pallasi.*

Migratory Thrush, or *American Robin* (T. migratorius, *Linn.*)—A summer migrant, and by far the commonest of all the Turdidæ. Arrives in April, and soon commences building. I have taken the eggs early in May. This bird is called the "Robin" by the English settlers, evidently from its redbreast and familiarity; it is, however, about the size of the Fieldfare (*T. pilaris,*) and much resembles that bird in habits. The eggs are not quite so large, and of an unspotted blue. A pair of these birds occupied the same nest at Cow Head for six consecutive years. Considering the vast number of "Robins" which annually breed in Newfoundland, this habit may account for the scarcity of old nests, so apparent in passing through the thick fir woods.

Blue Bird (Sialia sialis, *Linn.*)—A summer migrant, and said, by the settlers, to be occasionally common. I did not, however, meet with it.

Ruby-crowned Wren (Regulus calendula, *Linn.*)—Not uncommon. Arrives in Newfoundland in May.

[*Hydrobata Mexicana,* Bonap.—Has this species really occurred in Nova Scotia? *Vide* Downs on the "Land Birds of Nova Scotia."]

SYLVICOLIDÆ. The Warblers.

American Tit Lark (Anthus Ludovicianus, *Gmelin.*)—I do not think this bird breeds in Newfoundland, as I have only seen it in August, or during the autumnal migration.

Black and White Creeper (Mniotilta varia, *Linn.*)—Apparently a common summer migrant.

Maryland Yellowthroat (Geothlypis trichas, *Linn.*)—A summer migrant. Common.

Nashville Warbler (Helminthophaga ruficapilla, *Wilson.*)—A summer migrant, but apparently rare. One specimen, obtained in June, 1868.

Oven Bird, or *Golden-crowned Thrush* (Seiurus Aurocapillus, *Linn.*)—A summer migrant, but not common.

Black-throated Green Warbler (Dendroica virens, *Gmelin.*)—A summer migrant, and tolerably common, arriving towards the latter end of May.

Yellow-rumped Warbler (D. coronata *Linn.*)—A common summer migrant, arriving early in May.

Bay-breasted Warbler (D. castanea, *Wilson.*)—Tolerably common. Arrives in Newfoundland early in June.

Chestnut-sided Warbler (D. Pennsylvanica, *Linn.*)—Tolerably common throughout the summer.

Black-poll Warbler (D. striata, *Forster.*)—Apparently not uncommon in summer.

Yellow Warbler (D. æstiva, *Gmelin.*)—A common summer migrant, and called, by the settlers, "Yellow-hammer." It makes a pretty little nest in low bushes, somewhat resembling that of our English Goldfinch.

Yellow Red-poll Warbler (D. palmarum, *Gmelin.*)—One of the arliest spring migrants, and tolerably common.

Black and Yellow Warbler (D. maculosa, *Gmelin.*)—Arrives in May, and is tolerably common.

Green Black-cap Flycatcher (Myiodioctes pusillus, *Wilson.*)—A summer migrant. Arrives in June, but is not very common.

Canada Flycatcher (M. Canadensis, *Linn.*)—Arrives in June, but not common.

American Redstart (Setophaga ruticilla, *Linn.*)—A summer migrant, but rare in the north of Newfoundland. It is called "Goldfinch" by the English settlers. Arrives about the middle of May.

HIRUNDINIDÆ. The Swallows.

Barn Swallow (Hirundo horreorum, *Barton.*)—A rare summer migrant at Cow Head.

Cliff Swallow (H. lunifrons, *Say.*)—An equally rare summer migrant with the preceding species.

White-bellied Swallow (H. bicolor, *Vieill.*)—A summer migrant, and very common at Cow Head; in fact, the only species of swallow to be seen there throughout the summer.

Bank Swallow, or *Sand Martin* (Cotyle riparia, *Linn.*)—Very rare at Cow Head, but said to be very common about the Bay of St. George, and further south.

Purple Martin (Progne purpurea, *Linn.*)—This beautiful species appears rare in Newfoundland; at least I only obtained one specimen, shot at Daniels' Harbour in June, 1868. The settlers did not seem to be acquainted with the bird, or know anything of its breeding habits.

[*Note.*—Of the Bombycillidæ, Ampelis cedrorum, *Baird*, be looked for in Newfoundland.]

Laniidæ. The Shrikes.

Great Northern Shrike, or *American Butcher Bird* (Collyrio borealis, *Vieill.*)—Visits Newfoundland in its periodical migrations, but appears rare. Perhaps a few remain to breed on the island, although I have no evidence at present to prove it.

Yellow-throated Flycatcher (Vireo flavifrons, *Vieill.*)—A summer migrant, and appeared tolerably common in 1868 arriving in June at Cow Head.

Liotrichidæ.

Winter Wren (Troglodytes hyemalis, *Vieill.*)—Common, and resident throughout the year.

Certhidæ.

American Creeper (Certhia Americana, *Bonap.*)—Apparently a summer migrant, but not very common. I am inclined to think this bird may not migrate, although I did not observe it in the depth of winter.

Red-bellied Nuthatch (Sitta Canadensis, *Linn.*)—Perhaps a resident on the island. The only one obtained was in April, 1868. It is certainly a rare bird at Cow Head.

Paridæ.

Black-cap Titmouse (Paris atricapillus, *Linn.*)—Common, and resident throughout the year. Breeds in holes in trees; sometimes adopts deserted holes made by *Picus pubescens*.

Hudsonian Tit. (P. Hudsonicus, *Forster.*)—Common, and non-migratory. Breeds in holes in trees, and associates with the preceding species in winter, at which season the juvenile Newfoundlanders frequently amuse themselves by calling these little birds around them and knocking them off the boughs with a stick, or even the ramrods of their guns. My specimens were obtained for me in this manner.

Fringillidæ.

American Pine Grosbeak (Pinicola Canadensis, *Briss.*)—Common throughout the year, but apparently more abundant in winter, when they get together in small flocks of about two broods. They feed on the *buds only* of Pinus, Abies, Larix, &c., and are very tame, being often killed with sticks. Provincial name, "Mope."

Yellow Bird, or *Thistle Bird* (Chrysomitris tristis, *Linn.*)—A common summer migrant.

Pine Finch (C. pinus, *Wilson.*)—A summer migrant, but apparently not so common as the preceding species.

From my short residence in Newfoundland the observations on the distribution of some of the smaller species belonging to the *Fringillidæ*, *Sylvicolidæ*, &c., may not be of much value—*e. g.*, it is very probable that some birds, especially of these families, which are not uncommon, and even generally distributed over the island, may have altogether escaped my notice, while, on the other hand, some rare, or otherwise not regular migrants, may have fallen to my gun on more than one occasion during the summers of 1867 and 1868. In such cases I have naturally stated the birds to be frequent, or common, as the evidence may tend to show.

American Crossbill (Curvirostra Americana, *Wilson.*)—Common throughout the year, and an early breeder. Feeds on the seeds of *Coniferæ*, and is called by the settlers the "large spruce bird," to distinguish it from the following species.

White-winged Crossbill (C. leucoptera, *Gmelin.*)—These pretty little birds are common throughout the year, but more abundant during winter, when they congregate in small flocks of from five to twenty individuals, feeding principally on the cones of the White Spruce (*Abies alba.*) When feeding these birds are usually very tame, and easily approached. I kept an old "Joe Manton," loaded with small shot, in the house, for the purpose of shooting Crossbills and other small birds, and remember, on one occasion, snapping three percussion caps at a small flock of *C leucoptera*, within fifteen yards of me, without causing them sufficient alarm to take wing. They have a very pleasing note, much resembling the song of the canary. The provincial name is "Spruce Bird."

Mealy Redpole (Ægiothus linaria, *Linn.*)—Very common, and does not migrate. Breeds early, and generally in alder bushes; hence its provincial name of "Alder Bird." Feeds on the buds of *Coniferæ*, &c., when the ground is covered with snow.

Snow Bunting (Plectrophanes nivalis, *Linn.*)—Very common in its periodical migrations, but, I scarcely think, breeds on the island, although I saw a good many there in June last (1868.) Provincial name, "Snow Bird."

I did not meet with *P. lapponicus*, Linn., but it is probably seen in some parts of the island.

Savannah Sparrow (Passerculus Savanna, *Wilson.*—Abundant throughout the summer. Frequents grassy places, building its nest on the ground. Provincial name, "Grass Bird."

White-crowned Sparrow (Zonotrichia leucophrys, *Forster.*)—A common summer migrant, arriving in May.

White-throated Sparrow (Z. albicollis, *Gmelin.*)—A summer migrant, and equally common with the preceding species. Arrive in May, usually towards the latter end of the month.

Snow Bird (Junco hyemalis, *Linn.*)—A summer migrant, arriving about the last of May, and tolerably common throughout the summer.

Chipping Sparrow (Spizella socialis, *Wilson.*)—A common summer migrant.

Fox-coloured Sparrow (Passerella iliaca, *Merrem.*)—This fine species of Sparrow is a summer migrant, and very common. It is called the "Hedge Sparrow" by the settlers, and is very troublesome in gardens, scratching up fine seeds. Breeds sometimes on the ground, at others in low bushes.

Icteridæ.

Rusty Blackbird (Scolecophagus ferrugineus, *Gmelin.*)—A regular and common summer migrant, remaining generally until after the first fall of snow.

Crow Blackbird (Quiscalus versicolor, *Linn.*)—A summer migrant, but rare; at least I only saw one specimen at Parson's Pond, about twelve miles north-east of Cow Head.

Corvidæ.

American Raven (Corvus carnivorus, *Bartram.*)—Common throughout the year. I think Wilson and Audubon were right in not separating this bird from the European *C. Corax*. I cannot see the least difference—at least, not more than would be found in examining a quantity of either species, if they are distinct. The more slender bill is more individual than typical of the American bird. The eggs certainly cannot be separated, but this is also the case with several of the *Corvidæ*, which are otherwise well marked and well-known species.

American Crow (C. Americanus, *Audubon.*)—A common summer migrant to Newfoundland, arriving in April. Frequents the sea coast, breeds in trees, and lays four or five eggs much resembling those of *C. frugilegus*. It is called the "Otter Crow" by the settlers.

Pica Hudsonica, *Sabine*—May reasonably be expected to occur in Newfoundland, but I am inclined to think it does so only as a straggler.

Blue Jay (Cyanura cristata, *Linn.*)—A summer migrant, but not common. Breeds in Newfoundland, and is called the "Silken Jay" by the settlers.

Canada Jay (Perisoreus Canadensis, *Linn.*)—Common, and remains throughout the year. In some of its habits, and especially its familiarity, this bird much reminds the English sportsman of Robin Redbreast at home. When camping in the woods, miles back in the country, the Canada Jay, or, as it is often called, "Whiskey Jack," was ever my constant, and, frequently, only feathered companion. Like others of its tribe it appears very partial to raw meat for food, although, when in the vicinity of houses, it becomes almost omnivorous, eating bread, fish, potatoes &c., with an evident relish. It is said to collect and store away large quantities of cranberries for winter use. I have never met with any of these "stores," but have often noticed the Jays picking the berries, especially in the spring of the year, where the snow has disappeared in patches in the open marshes. In a state of nature I think the Canada Jay is even tamer than the Robin. I remember on one occasion, particularly when deer-hunting in the country, I had the hearts of three caribou hanging to the "tilt," or camp, within four feet of my head, and, although unable to leave the "tilt" for the whole day, from bad weather, the Jays managed to eat all the fat from the hearts, notwithstanding I continually drove them away, but, like vultures and carrion crows, with every re-appearance there seemed a re-inforcement, until at last, to save my venison, I had to amuse myself by firing balls at them from my rifle as they sat on and picked a fine fat quarter of caribou only a few yards distant from the camp. My specimens were obtained by tying a piece of meat to the pan of a rat-gin and retiring a few yards from the trap: they were invariably caught by the bill. The settlers, strange to say, cannot succeed in keeping this bird alive in confinement.

I did not meet with any of the *Columbidæ* in Newfoundland. *Ectopistes migratoria*, Linn., may prove an occasional straggler there.

(*To be continued.*)

ON THE ORIGIN AND CLASSIFICATION OF ORIGINAL OR CRYSTALLINE ROCKS.

By Thomas Macfarlane.

(*Continued from March Number.*)

III.—TEXTURE OF ORIGINAL ROCKS.

In adverting to the origin of rocks, those which have been called original were described as analogous in nature to furnace scoriæ. This may seem a forced comparison, and it may be supposed that crystalline rocks are not likely to be influenced by heat; but the truth is that nearly every one of them have been shewn, experimentally, by Hall, Bischof, Delesse, and Sorby, to be fusible, and to be reduced by a high temperature to the same condition as furnace scoriæ. But while the latter generally exhibit, on cooling, a homogeneous mass, original or compound crystalline rocks are most frequently seen to be composed of various and different minerals. While the furnace slags, in rapid cooling, had no time during which their chemical constitutents could arrange themselves into different compounds, the greater number of original rocks, having solidified in enormous masses, and, doubtless, during long periods of time, their constituents had opportunity for arranging themselves in such a manner as their chemical affinities suggested. The minerals, which were the result of this re-arrangement of the chemical elements, are not, however, always readily recognized in rocks. The latter have in some rare cases solidified so hurriedly that they present merely the appearance of natural glass. Others have had time to lay aside the vitreous character and assume a stony appearance, but they appear so homogeneous and fine-grained that their compound nature would scarcely be suspected. This is, for instance, the case with basalt, which, on this account, was at one time regarded as a simple mineral. On grinding it to powder and washing it, however, Cordier found it to consist of several minerals with distinct physical characters. A good many other rocks are seen, on examination, to be distinctly compound, but their constituent minerals are developed in such minute grains that their determination becomes a matter of very great difficulty. It is only in the coarser and large grained rocks that the constituent minerals can be readily recognized by the student, and their physical and chemical properties easily tested.

These variations in the size of the constituent minerals are accompanied by differences in their form and position, and, both together, give rise to what is called the texture of crystalline rocks,—difference in which may easily and at once be detected by the student. Coarse and fine grained, schistose and slaty, vitreous, porous, and other such names, are used for characterizing peculiarities of texture, which are not at all to be regarded as merely trifling accidents in the history of rocks, but which really possess a deeper meaning than we are inclined at first to imagine. Although neither the furnace nor the volcano can give us any conception of the magnitude of the scale upon which the earlier original, or, as they have been named, the plutonic rocks, were erupted, still, they furnish us with hints which we cannot afford to neglect. To the metallurgist, it is an every day occurrence to observe that the same scoriæ yields either a vitreous slag or a stony mass, accordingly as it has been quickly or slowly cooled. Slag cakes, a few inches in diameter, are found to be impalpable or glassy on the outside, while on breaking them, the interior is found to be porcelain-like or crystalline. Bischof made some interesting experiments on this matter at the iron-works of Mägdesprung in the Hartz. He allowed common iron furnace slag to run into cold water, where it disengaged sulphuretted hydrogen, and yielded a white, easily friable pumice stone. He next allowed the slag to solidify upon cold, somewhat moist, sand. This gave a harder pumice, still retaining some of the original color of the slag. In the next experiment the slag was allowed to cool on a completely dry bottom of sand, and the result was a brownish-green transparent glass. Under a protecting cover of dry sand, the solidified slag was found to contain crystalline quadratic prisms in considerable numbers, and between them lay spherical concretions, consisting of regular radiating fibres, extending from the middle point in every direction. In the last experiment the slag was exposed to slow cooling in a basin lined with a warm mixture of charcoal powder and clay. When broken, after cooling, it did not exhibit a trace of vitreous substance nor any quadratic prisms, but a fine radiated texture had spread itself equally throughout the whole mass. The experiments of Sir James Hall have often been mentioned in connection with this subject. Nearly seventy years ago he applied experiment, for the first time, to the elucidation of geological phenomena. It occurred to him to melt a small piece of basalt, and the result was a dark vitreous substance. But on fusing a much larger quantity, and allowing it to cool slowly, he obtained a crystalline mass. Since that time geologists gradually became accustomed to look upon the original rocks of a glossy appearance, which occur in nature, as the products of rapid, and those of a granular texture as the products of slow, cooling. Nor are there wanting instances to show that other physical causes have influenced the structure of such artificial silicates as slags. At the Eglinton iron-works in Scotland, and those of Bethlehem, Pennsylvania, the writer observed that there is frequently developed in the slags, as they flow from the furnace, streaked bands of different colors, not at all unlike those developed in many slate rocks. Then again, when the workmen, at the establishment first named, tap off the iron and cool the small amount of scoriæ which follows after it with a plentiful supply of water, the slag froths up and solidifies to a porous cellular substance, the exact parallel of which is to be found in the pumice stone of volcanoes. In observing the slags of copper furnaces, nothing is more common than to see those which are allowed to flow over damp ground rise up into porous scoria, while those which run over wet portions of the smelting-house floor, boil up into loose pieces, or throw themselves about in the form of little volcanic bombs and lapilli. Similar phenomena are observed in the lava streams of active and extinct volcanoes. Those of Alta Vista, in Teneriffe, consist, on the surface, of glittering, transparent bottle-glass-like obsidian, which, towards the interior, changes into a less glittering pitchstone-like mass, which is so filled with crystals as to resemble a crystalline rock. These instances have been given in order to show that, in studying the varying textures of original rocks, it is well to bear in mind that such textures are, in all likelihood, the result of the influence of the physical conditions under which their respective rocks solidified, and of the temperature and plasticity of the mass from which they were produced.

The following modifications in the texture of original rocks may here be distinguished:—

1st. The constituent minerals are of a comparatively large size, ranging from several inches to one eighth of an inch in diameter, generally large enough to be easily tested as to hardness, cleavage, and other physical characters. The mode of their arrangement is altogether irregular, and, although the individual minerals may sometimes have a greater length than thickness, no parallelism of their larger axes can be noticed. Granite, syenite, and diorite are examples of this order of texture, which may be called the *coarse and small grained.*

2nd. The constituent minerals are of a size varying from the smallest individuals to those of an inch in diameter. One or more of them have their longest axes arranged in the same direction and parallel with each other, there being thus developed a fibrous or laminated texture. This may be called the *schistose* order, to which gneiss and hornblende schist belong.

3rd. The constituent minerals are finer grained than in the preceding order, and more difficult of determination. A similar parallel structure, however, is visible, which occasions an easie fracture of the rock along a particular plane, or what is called a slaty cleavage. Common roofing slate may be regarded as the type of this *slaty* order of texture.

4th. The next order of texture to be distinguished is the *porphyritic.* Large individuals, or crystals of one or several minerals, are enclosed in a fine-grained or impalpable matrix. Augitic, syenitic and felsitic porphyry are examples of this order of texture, the rocks of which are distinguished from each other as well by variations in the nature of their matrices as in the compositions of the crystals developed in it.

5th. The next order may be called the *variolitic*, and regarded as incipient porphyritic texture. In a fine-grained matrix, small rounded concretions are developed, without, however, being sharply separated from it. These concretions sometimes possess a fibrous structure in the interior, the fibres radiating from the centre, and their existence is frequently betrayed by the weathering of the rock.

6th. The minerals are here of a much smaller size than in the coarse-grained order, so as to be in most cases difficult of determination. This texture is the same as that often possessed by the matrices of porphyries, and, being destitute of parallel structure, bears the same relation to the coarsely schistose texture. Trap and felsite belong to this order, which may be called the *fine-grained.*

7th. In a small or fine-grained matrix, rounded cavities have been formed, and afterwards partly or wholly filled up with various minerals. On account of the resemblance between the long drawn and flattened shape of these mineral aggregations and almonds, this texture has been called the *amygdaloidal.* Trappean amygdaloid and the spilite of French lithologists may be cited as examples.

8th. The next order of texture includes certain fine-grained and globular rocks, characterized by their containing very appreciable quantities of water. The globular texture resembles the variolitic, but the concretions, instead of possessing a radiated structure, are composed of concentric layers. Pearlstone is the type of this species of rock, which is intimately connected, geologically, with pitchstone and other impalpable rocks belonging to this order. Phonolite and basalt are examples of the fine-grained members of the order, which, as above-mentioned, are distinguished from the fine-grained order already mentioned by their containing a considerable percentage of water. It may, therefore, be called the *fine-grained and hydrated.*

9th. This order may be denominated the *trachytic*, and, although its rocks have frequently a porphyritic development, they are distinguished from those of that class, in having a rough porous, sometimes even cellular, matrix, and felspar crystals developed in it of a vitreous appearance and full of small fissures. The same rough uneven surface and fracture is developed in those trachytic rocks which contain no largely developed crystals, and even in many of a much more basic composition than what are usually termed trachytes. Rhyolite, andesite and dolerite are examples of this order.

10th. In this order of texture the porous appearance above referred to is developed to such a degree that a scoriaceous or cavernous structure results. This structure is peculiar to volcanic rocks, which also afford examples of purely vitreous texture, in which no "grain" nor any mineralogical constituents are observable, but an impalpable glassy appearance predominates. This order may be called the *lava texture*, and lava pumice-stone, and obsidian, mentioned as examples of it.

It is not to be supposed that these varieties of texture are at all sharply separated from each other. On the contrary, rocks the most varied in their structure are found to be connected with each other by insensible gradations. Thus, vitreous rocks are gradually found to assume an impalpable and then stony character. Then again, they frequently become porous and cellular, and graduate into scoriaceous lavas. Rocks of the latter order have very often well-defined minerals developed in them, and when also the cellular texture becomes more subdued, trachytic rocks result. These, when they gradually become more compact or their felspars gradually lose their vitreous and fissured appearance, become indistinguishable from felsites and porphyries. Further, when the matrices of the last-mentioned rocks gradually become coarser grained and their crystals reduced in size, they pass into thoroughly granular rocks. When, on the contrary, the well-developed crystals of porphyries gradually disappear, fine-grained rocks are the product. Nothing is more common than to find the latter gradually assuming a slaty structure or gradually becoming coarser in the grain, and so giving rise to schistose or granular rocks. And nothing is more common than to find the constituents of granular rocks, little by little, arranging themselves in a given direction, and so producing coarsely schistose structure.

But with all the frequency of gradation between original rocks of various textures, it is to be remarked that those which differ widely from each other in structure, do not exhibit sudden transitions the one into the other. Cavernous and coarsely granular rocks are never found to constitute part of one and the same mass, or to pass into each other, without gradually assuming the character of intermediate impalpable and fine-grained rocks. Nor is it ever the case that coarsely schistose rocks become trachytes all at once. A certain consistency or method is recognisable in all these transitions, and it is only those orders which are more nearly related to each other as regards texture, or are more intimately associated, geologically, that graduate into each other in the manner above described. In the description of the various species of texture given above, those have been placed nearest to each other which are most prone to pass into each other by modifications of texture.

To account satisfactorily for these variations of texture among original rocks is no easy matter; but if the facts already given, as regards the solidification of artificial silicates, have any value as applied to lithogy, they would lead us to suppose that the coarsely schistose rocks solidified very slowly during the lapse of great intervals of time and under the influence of widely extended movements of the crystalline, but still fluid mass; that the coarsely granular rocks solidified very slowly, but in comparative rest; that porphyritic and small-grained rocks cooled more quickly than coarse granites, although crystallisation evidently took place while they were in a plastic condition; that fine-grained schistose rocks solidified while in motion, but are the products of comparatively rapid cooling; that porous trachytes cooled rapidly, but in comparative rest; that very cavernous rocks came into contact with water during cooling, and we may suppose that, where that element was present in great quantity, many original rocks underwent disintegration while their solidification was in process, giving rise to the tufaceous series of derived rocks. Many of those generalisations are supported by observations recently made on the microscopic structure of rocks to which, however, it is impossible here to refer.

(*To be continued.*)

AQUARIA STUDIES.

(PART II.)

BY A. S. RITCHIE.

In the last number of this journal a description was attempted of some of the different representatives of animal life contained in our aquarium, of what may be termed its visible beauties, that is, such creatures as may be seen with unassisted vision. The present sketch is connected still further with its denizens, as beautiful in their structure, and, notwithstanding their minuteness, no less wonderful in their design.

The unassisted eye can only look at relatively few of the creator's works: it cannot enter the inner shrine of nature's temple, or take cognizance of the myriad manifestations of the power and wisdom which enables these animated atoms to live, move, and have their being, and to enjoy themselves as well as the more complex productions of the Infinite.

The microscope, however, gives us an insight into worlds heretofore hidden from view, and shows us creatures more strange than "fancy ere had feigned or fear conceived." We may see in "the small dimensions of a point" a world peopled with creatures, to which, as we believe, there is no limit. More powerful glasses are only wanted to lead us farther into the labyrinth of the creative wonders of the Almighty.

Comparatively few enquire into this world of hidden wonders in order to become acquainted with its inmates, still, a few philosophical spirits are yet to be found, who, like Sir Thomas The Good,

> "Would pore by the hour
> O'er a weed or a flower,
> Or the slugs that come crawling out after a shower."

At the outset of the present sketch we would premise that the glass side of our aquarium which is placed next to the wall, is never cleaned, and, in consequence of this, it is soon covered over with a growth of what botanists call *Confervæ*. The *Confervæ* are among the lowest forms of *Algæ*, a group which contains a great number of very minute microscopic plants, which have been, of late years, specially studied by microscopists. Among the lower forms of these Protophytes are the *Diatomaceæ*, *Desmidiæ* and *Volvocinæ*, plants of very simple organization, only lately removed from the animal kingdom. Other orders are the *Palmellaceæ*, likewise plants of humble type; *Ulvaceæ*, plants of a rather more complex character; *Oscillatoriaceæ*, remarkable for a peculiar kind of motion; *Nostochaceæ*, *Ulvaceæ*, *Siphonaceæ*, and *Confervaceæ*.

First, let us scrape some of the growth off the glass at the back of the tank, then place it in the live box with a drop of water over it, and, having adjusted our microscope, what do we see?

First of all notice the vegetation contained in this drop of water. That long pointed ribbon, having the green colouring matter twisting and curling through the centre, is one of the *Confervæ*, a species of *Spirogyra*, and close beside it there is another jointed species having the chlorophyll or colouring matter in patches:

this is a variety of *Stigeoclonium.* These are purely vegetable, and are the resort of many little creatures which revel and hide themselves among their tiny clusters of bands.

The first intruder in the field of the microscope we would call attention to is that shapeless mass near the centre. It looks like a small piece of clear jelly with little black dots or granules within. But see, it has changed its shape: it is, as it were, running out ; a finger-like process is flowing out here and there; the granules also are moving. Again we look; it has now assumed a shape something like an outline of a map of Italy. While you are looking it has again changed. You ask, what is that? That is one of the simplest forms of animal life; it is called the *Amœba* or *Proteus.*

In the *Amœba* we see an animal that breathes without lungs or gills, digests without a stomach, moves without limbs, and contracts without muscles. Like other animals, of simple type, which live for the most part in the deep sea, and which from the possession of root-like feet, are called *Rhizopods,* its body is composed of a jelly-like substance called sarcode. Some of these creatures have siliceous and some calcareous shells, while others have none at all. You will ask how does the *Amœba* live, and how does it feed ? We shall endeavor to shew. Although without a nervous system, it is nevertheless very sensitive, as will be seen.

That other creature near it is a *Rotifer* or wheel-bearer. If you watch you will now see how and upon what the *Amœba* feeds. As its body flows and contracts, it is nearing the *Rotifer* which is attached by its foot to the glass, unconscious of his fate. Presently the little mass of jelly flows and touches him, but too late for the *Rotifer* to make his escape ; as if stimulated by the contact, the *Amœba* has fairly covered him, and through its transparent body the *Rotifer's* struggles for life are perceptible. All is over with it now, the laws of absorption have so decreed it, and soon nothing will be left of it but its silicious covering.

This is the way the *Amœba* feeds, by absorbing the juices of its victim.

This creature is reproduced by fission, that is, by splitting or dividing itself into pieces, each of which pieces becomes a perfect animal.

The wheel animalcule (*Rotifer vulgaris*) will be our next subject for examination. He is many degrees higher in the scale than the *Amœba*; his body is constructed in some degree on the principle of the tube of a telescope; he can also draw himself into a ball at pleasure; he has a mouth and jaws, which are constantly at work; his eyes are distinctly visible. When fishing he attaches himself by a foot or tail-like process either to the glass or to the stems of aquatic plants and stretches himself out, when the entrance to his mouth opens and the cilia, or hair-like appendages with which his mouth is furnished, commence moving or rushing, thus causing a current or small whirl-pool in the water, by means of which monads and other animacules are drawn in, and amongst others, our friend the *Amœba* falls in, so that the victor of yesterday is the victim of to-day.

Rotifers are produced from eggs, although in one species (*Actinurus Neptunius*) we have distinctly seen the young one in the body of the parent, and not only so, but have noticed its jaws going as if the creature was feeding. The red eyes of the young Actinurus could also be distinctly seen.

When swimming, the *Rotifer* is a very graceful creature, with his crown of cilia extended, he glides across the field of view with amazing swiftness.

We well remember when young at microscopy, the anxiety experienced to possess a Rotifer; the quantities of infusions of leaves of all sorts we made, including hay, straw and sage, but all to no purpose. We could get lots of monads and other varieties, but no rotifer. For two years this state of things went on, when we were tempted to bottle some water from one of the street puddles, taking some of the sediment with it. The bottle was placed, uncorked, in the window, so that the full benefit of the sun-light might be obtained. As soon as business was over that day the bottle was produced, the animalcule cage filled, the focus of the microscope adjusted, and, to our delight, the water was swarming with rotifers; and, from that day to this, we have been close companions. This water was kept for nearly three years, and fresh water now and then added to compensate for evaporation, with a little piece of pond weed (*Anacharis alsinastrum*,) or duck-weed (*Lemna*,) to keep the water sweet. Many generations of Rotifers lived and died in that bottle, as their siliceous skeletons testified, the sediment being full of them.

Temperature has very little effect on *Rotifera*. We have had a bottle of water containing these creatures frozen solid, and, on thawing them, they were as lively as ever. We have also placed a large-sized drop of water on a slip of glass, and held it over the flame of a lamp, long enough for the glass to be uncomfortable to the fingers, with the like result. They only appeared to be a little more active after their warm bath.

The old experiment of evaporating a drop of water on a slide containing Rotifers we have also tried, and, on again wetting the spot, have resuscitated some of them. We have had them the twenty-fifth to the thirtieth part of an inch in length; about the fiftieth part of an inch is the usual size.

A little to the left of the Rotifer, attached to a piece of *Conferva*, is a beautiful cluster of bell-shaped animalcules, *Vorticella campanularia*. They are attached to the plant by means of a stalk, which has a contractile muscle running from the base to the upper end: they have a ciliated mouth. Just watch that little cluster of crystal bells. They have, by means of the muscle, drawn back, until they look like an irregular mass of gelatine. Now they slowly move out again, as if all were guided by the same will. Now they are at full stretch, with cilia revolving, fishing and feeding. Again, they are all retracted with a jerk. Some of them look as if they were double. Reproduction is going on in these: it is effected by fission. Bye-and-bye these will separate and detach themselves, and swim about till matured, when they attach themselves, to go through the same existence as their progenitors.

A smaller species, *Vorticella nebulifera*, is to be found attached to the bodies of some *Entomostraca*, as *Cyclops quadricornis*, and on *Lynceus*. Another species (*Carchesium polypinum*) is also found attached to these creatures. We have a specimen of Cyclops mounted as a microscopic object, having *Vorticella nebulifera* attached to the back of the crustacean. The presence of the *Vorticella* on the slide was accidental, as the object was intended to be *Volvox globator* only. It evidently got in either attached in some way to some of the *Confervæ*, or from the water.

The stalks in *Carchesium* are not retractile; the body, however, has the power of closing up by muscular action. These we have not found in numbers in our aquarium, but in the ponds near the city they are to be met with in abundance.

Another beautiful creature — the Blue Stentor (*Stentor cœruleus*)—has attached itself to a little bit of weed; its beautiful crown of cilia is expanded, and moves rapidly, creating quite a small whirlpool, into which the unfortunate monads are drawn in and engulphed into its stomach. It is of a beautiful blue colour, and is found in great abundance at times on the tops of ponds, which look then as if the water was covered with coal dust.

On taking another drop of water from the aquarium, with more of the vegetable matter, we observe other and different creatures, resembling snakes, twisting and entwining each other in their folds: these are called *Lurcos* or Gluttons. They are well named, for they are very voracious, feeding on animal and vegetable life; their bodies are annulose, or composed of rings having hair-like processes on each segment, which enables them to move about with considerable quickness; their mouth is capacious and ciliated; the intestinal canal is plainly seen, and their food can be well observed through their transparent bodies. We have seen them devour rotifers, monads, bell animalcules, and other species; in fact, they refuse nothing. They are produced from eggs.

That slipper-shaped species is very common, and found in great numbers: it can be seen by the unassisted eye as a tiny speck coursing across the animalcule cage. It is called the Chrysalis animalcule (*Paramecium aurelia.*) It is ciliated all round the sides of its body, and moves about very swiftly; it is like a porpoise in a shoal of herrings—dashing here and there, devouring the smaller species, such as monads, in all directions. It undergoes many changes, and assumes many shapes during its metamorphosis; it is produced by fission as well as from the egg.

That restless little fellow with four horns is *Cyclops quadricornis.* The only way to get a good look at him is to bring a little pressure to bear by giving the cover of the live-box a slight squeeze so as to keep him still. He is very active, and measures about the sixteenth of an inch in length. His head is furnished with four antennæ or horns, and the creature is provided with five pairs of feet, and a long tail, which is terminated by bristles. It has, in the centre of its forehead, a single red eye—hence the name Cyclops, after Vulcan's Workman. The legs of the Cyclops, at each of the joints, are furnished with hairs, evidently to help the creature in swimming, as is is also the case with aquatic beetles. The female carries two ovaries at the extremity of the abdomen, where the eggs are hatched, and, on the young leaving these sacs, they fall off. The young, according to Carpenter, undergo five changes in their development.

Besides these little creatures we have mentioned there are many more about which much might be said.

We have monads, vibrios in great numbers, always present in the water of our aquarium: not only there, we may state, but in the Montreal water this spring we detected, in two instances, living vibrios in the water immediately taken from the pipe.

In concluding this sketch of the inhabitants of our aquarium the following remarks may not be out of place.

How little is known, by the great mass of mankind, of the various creations possessed with the wonderful and unknown principle, "life," respecting which much more might, perhaps, be known by means of patient microscopic research. By its aid we may learn how admirably each little organ plays its part, and how the various members contribute to each of these creatures happiness in their struggle for life, for, for some wise purpose, every animated being, from the monad to the whale, is battling for existence.

There is not, perhaps, a single species of animated being whose existence depends not, more or less, upon the death or destruction of others.

In the plan of nature death and dissolution seem to be indispensable for the support and continuance of animal life.

Man may be said, with a few exceptions, to have universal empire over the other animals. Carnivorous animals and birds are also engaged in this general work of destruction.

In fishes, also, as their habits demonstrate, from the least to the greatest, their appetite is almost insatiable, and their object in life seems to be either to devour other fishes or to avoid their own destruction.

Insects, also, are no exception to the rule. We find the same struggle going on among them, each preying on, or being preyed on by other species.

Even in our aquarium this struggle can be witnessed, as illustrated in the first part of these sketches; also among microscopic creatures, the subject of the present paper. They also have their enemies, the fish swallow them in countless thousands, while the smaller ones supply the larger with food.

In the economy of nature no creature lives for its own happiness alone, but, by its destruction, contributes to the happiness of others. The balance of power is not entrusted to any particular class or species, and He who in wisdom made them all governs and guides the whole.

ON FORAMINIFERA FROM THE GULF AND RIVER ST. LAWRENCE.

By G. M. Dawson.

By way of introduction to these notes, I may state that the reader will find some account of the curious and interesting animals to which the paper relates, with figures of characteristic examples, in Vol. IV, new series, of this Journal, page 413; and that several species found in the Gulf of St. Lawrence have been catalogued by Principal Dawson, in the same Journal, Vol. V, page 188 *et seq.* The following table is, however, the only approach to a complete view of the species and their distribution hitherto attempted.

Many of the deeper samples were small quantities of mud brought up in sounding, by Capt. Orlebar, R.N., of the Coast Survey, and by him kindly presented to Dr. Dawson.

The specimens from Labrador were obtained from material dredged by the officers of the Geological Survey; those from Prince Edward Island, were from a specimen secured by C. Robb, Esq.; and those from the Bank of Newfoundland, were obtained from the late Sheriff Dickson, of Kingston.

The somewhat extensive series from Gaspé Bay was obtained during a dredging expedition in the summer of 1869. The mud was sampled when brought up by the dredge, and reserved for examination, the depth being ascertained as carefully as possible. Several very rich and interesting samples are also from the dredgings of Mr. J. F. Whiteaves, F.G.S., in Gaspé and its vicinity. Mr. Whiteaves has also gone over this material with care, and has detected some additional species.

The means were unfortunately not at hand for ascertaining the temperature at the bottom. But, though there is reason to believe that the water at Gaspé Bay is somewhat warmer than the Gulf of St. Lawrence in general, the mud as it came over the boat's side felt icy cold to the hand, showing even here what a great effect the iceberg-laden Arctic current has on the bottom temperature. The number of species tabulated must not in every instance be taken as a criterion of the relative richness of the localities, as much often depends on the amount of material at disposal. This is especially the case when comparing dredgings with soundings.

The general aspect of the Gulf of St. Lawrence Foraminifera is northern, and in many places closely resembles the fauna of the Greenland coast and the Hunde Islands, as given in Parker & Jones' Memoir.* The Gulf, at least so far as its Foraminifera are concerned, evidently belongs to the Arctic province, the limits of which skirt the Banks of Newfoundland and pass from thence southward to Cape Breton.

The refrigeration of its waters depends on the Arctic current, which, entering the Straits of Belle Isle, floods the whole bottom of the Gulf with water almost at the temperature of the Arctic seas. To these conditions the series of collections from Gaspé offers somewhat an exception, and is of a slightly more southern character, both as regards the species represented and the developement which they attain. This difference depends on purely local causes, which, while slightly changing the character, give opportunities for a very abundant developement of Foraminifera, more especially of the arenaceous forms. Gaspé Bay in no part exceeds 50 fathoms in depth; is about 20 miles in extreme length, well land-locked, and disturbed by no other current than that caused by the ebb and flow of the tide. The depth is not so great as to allow of the incursion of the cold and deep layer to any great extent, and the proximity of land and the shelter thus afforded tend still further to modify its temperature.

The bottom, in most of the deeper parts, is composed of fine sand and mud, and this it is which favors the very large development of arenaceous forms.

Past the mouth of Gaspé Bay sweeps the very strong tidal current of the St. Lawrence, and immediately we pass the shelter of Ship Head and come within its influence, the changes in the Foraminifera become strikingly apparent. The bottom consisting for the most part of clean gravel or coarse sand, most of the arenaceous forms disappear at once, and instead of the abundance of Nonioninas and Miliolas previously found, a very large proportion consist of Planorbulina lobatula, which can hold its own, attached to seaweeds and polyzoons. Polystomella Arctica also becomes somewhat prominent, while the Lagenidæ and Entosolenidæ appear in abundance.

What few sandy forms do occur are depauperated and composed of very coarse particles. The Foraminifera as a whole however are very abundant, and in some samples dredged by Mr.

* Philosophical Transactions, 1865.

Whiteaves almost equal in quantity those in the deeper Atlantic soundings.

In the estuary of the St. Lawrence itself, Bulimina pyrula becomes a somewhat common form. Among forms which in the Gulf of St. Lawrence may be mentioned as specially characteristic of deep water, are Nodosaria (Glandulina) lævigata, Globigerina bulloides, very small; Bulimina, principally B. squamosa, also small; Uvigerina pygmœa, Cassidulina.

From depths greater than 100 fathoms all the Foraminifera are very small and delicate; and Lagenidæ, Buliminidæ, Globigerina bulloides, together with a few depauperated Nonioninæ, constitute the greater part of the fauna. From these depths also come many Diatoms, mostly Coscinodiscus, and Sponge spicules. Polystomella striatopunctata is almost everywhere prevalent, though it nowhere attains to any very great size, and below about 30 fathoms, becomes small and generally rare, and continues increasing in rarity till it almost disappears at 300 fathoms. In some localities, at about 30 fathoms, P. Arctica is abundant, and greatly surpasses in size the ordinary Polystomellæ occurring along with it. The remaining P. striatopunctatæ also at this depth often show a remarkable proneness to run into modifications resembling one or other of the numerous species and varieties into which the genus is subdivided, but as the transition series are complete, it is very difficult to place the bulk of the specimens satisfactorily under them. It has been thought better in the table to include as many as are easily seen to be modified striatopunctatæ under that name. Nonionina Labradorica, though not so universally distributed as the above, is a very characteristic species in the Gulf. It seems to be best developed and in largest numbers at about 30 fathoms. It thins off both in numbers and size as we go into shallower water, and decreases much in size, though not so perceptibly in numbers as the water deepens to 100 fathoms and below. There is a remarkable absence of Miliolas in the estuarine parts of the Gulf, which strongly contrasts with their abundance in Gaspé Bay, and also on the Atlantic coast of Nova Scotia, and south.

One specimen of a curious sandy form of Cornuspira foliacea was obtained at a depth of 18 fathoms at Gaspé.

Biloculina ringens scarcely occurs above 30 fathoms.

At Murray Bay, which is only about 60 miles below the point where, at least, the surface of the St. Lawrence becomes permanently fresh, the Foraminifera become very scarce and poor. Polystomella striatopunctata is the most common, but it has become very small. Nonionina Labradorica, Lituola Canariensis, and Trochammina inflata also occur, but all much reduced in size, and scarce relatively to the amount of material examined. On passing from the Gulf to the east of Newfoundland, or to the south of Cape Breton, a change from the Gulf Fauna is immediately detected. Polystomella striatopunctata, there so common, becomes rare. Nonionina Labradorica to a great extent ceases to appear, and Uvigerina pygmæa and Cassidulinidæ become more frequent.

The arenaceous Hippocrepina, (Fig. 2,) and Lituolæ (Figs. 1 and 3) are most plentiful at depths less than 20 fathoms. Lituola scorpiurus (Fig. 4) goes down to the greatest depths in Gaspé Bay, and is yet abundant at 10 fathoms, while the immense Rhabdopleura abyssorum (Fig. 6) only appears at about 20 fathoms, and continues from that point increasing in numbers and size to the depth of 50 fathoms, which is the greatest depth in Gaspé Bay, where alone it has been found.

The distribution of these Foraminifera would tend, with other facts, to show that these organisms, together with most other marine animals of low organization, do not depend, to any great extent, on the depth or intensity of daylight, but almost entirely on the *temperature* of the water, as Dr. Carpenter maintains in his account of his recent deep-sea dredging, so that they would not give very satisfactory evidence of the conditions of deposit of Post pliocene or other beds, unless other facts were at disposal to show the depth, when the Foraminifera would give valuable assistance with regard to the climatic conditions at that depth. The quality of bottom has however, much to do with the general *facies* of the Foraminifera, as with other animals. For, as shown above, calm water, with a bottom composed of fine sand and sediment, is particularly favorable to the arenaceous forms, though, even under these conditions, they do not thrive in the very cold, deep water (such as that below 100 fathoms) in the open Gulf. A strong current at once causes all sandy forms to disappear, mostly, no doubt, from want of the fine materials necessary for their shells, and brings in a large preponderance of Truncatulinas, Lagenidæ, &c.

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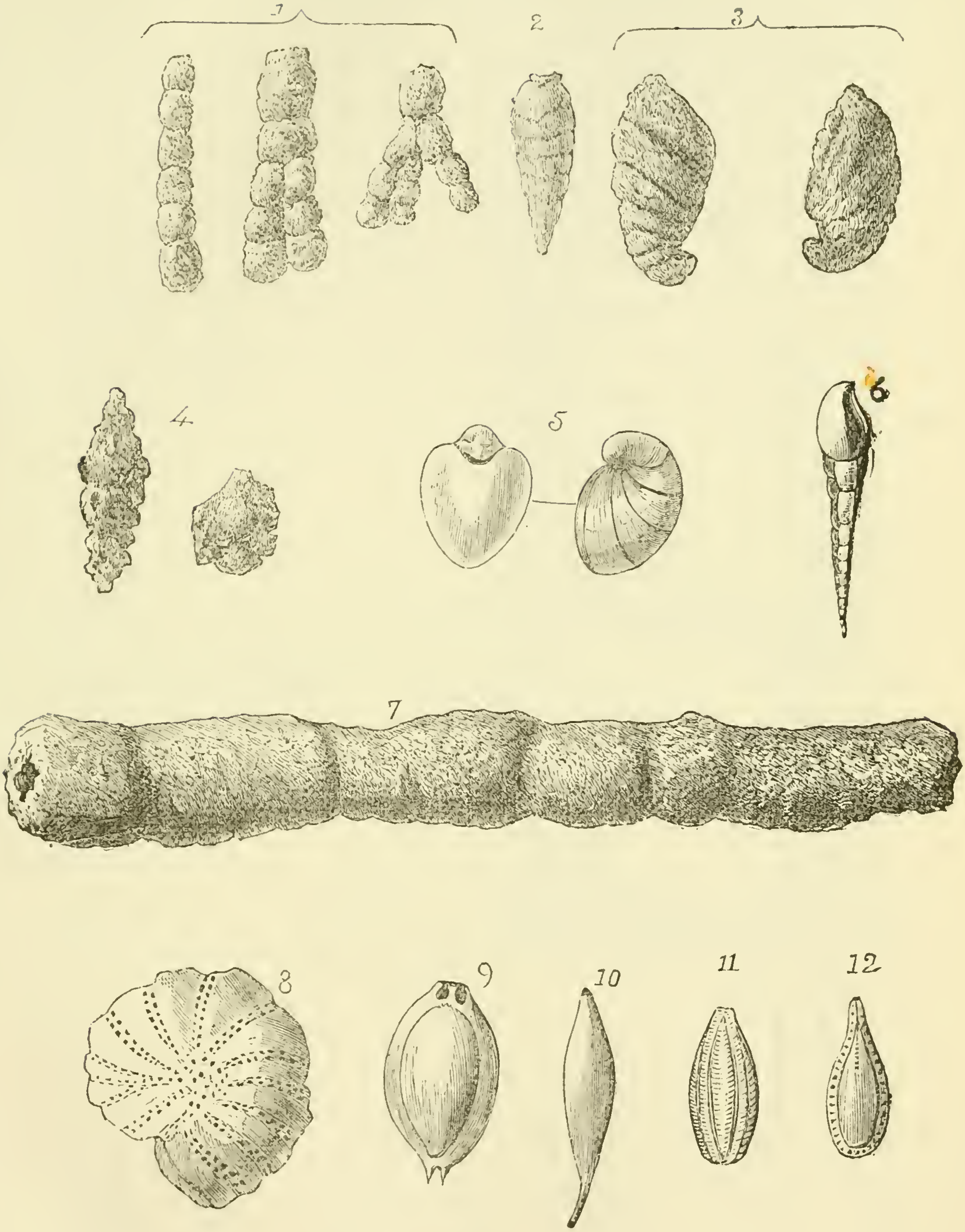
* The figures refer to the numbers of the wood-cuts.

The arenaceous forms, with the exception of those which are tubular, constitute a series parallel to the calcareous forms, and the members of which graduate into one another. It seems not improbable that the individuals of the same species may assume either appearance. It does not appear, however, that the same individual can present both forms at successive periods. On the other hand, the sandy forms may really constitute a distinct group parallel to the others. Sketches of some interesting forms are given which do not appear to be precisely similar to described species. These have been kindly examined by Dr. Parker, of London, who regards the Lituolæ represented in figs. 1 and 3 as new species, to which he assigns the names *L. findens* and *L. cassis.* The form represented in fig. 2 he regards as the type of a new genus, to which, from the horse-shoe shaped form of the aperture, he gives the name *Hippocrepina*, naming the species *H. indivisa.*



Fig, 1. Lituola findens, P. Fig. 2. Hippocrepina indivisa, P. Fig. 3. Lituola cassis, P. Fig. 4. Lituola scorpiurus. Fig. 5. Nonionina scapha, var. Labradorica (313 ftms.) Fig. 6. Bulimina Presli., var. squamosa (313 ftms.) Fig. 7. Rhabdopleura? Fig. 8. Polystomella Arctica. Fig. 9. Biloculina ringens. Fig. 10. Lagena sulcata, var. Fig. 11. Entosolenia striato-punctata. Fig. 12. Entosolenia marginata. Figs. 1, 2, 3, 4 and 7 are drawn to a scale half that of the other figures.

TABLE I. — *Showing the Distribution of Twenty-three Gatherings of Foraminifera, from the Gulf and River St. Lawrence, and neighbouring parts of the Atlantic.*

(C) common. (R) rare. (S) small specimens. (L) large specimens.

FORAMINIFERA.	313 Fathoms, Gulf St. Law. Lat. 48° 25'; Long. 60° 20'	250 Fathoms between St. Pierre and Scatari.	200 Fathoms, Cape Camille.	144 Fathoms, North-east of Anticosti.	140 Fathoms, Gulf St. Lawrence.	40 Fathoms, Cape St. Nicholas.	Labrador.	Banks of Newfoundland.	Off West Cape, Prince Edward Island.	Off South Coast, Cape Breton, 90 Fathoms.	Gaspé, North-west Arm, 7 Fathoms.	Gaspé Bay, 10 Fathoms (sand.)	Gaspé Bay, 10 to 15 Fathoms.	Gaspé Bay, 16 Fathoms.	Gaspé Bay, 16 to 17 Fathoms.	Gaspé Bay, 18 to 20 Fathoms.	Gaspé, bet. Ship Head and Cape Bon Ami, 30 Fathoms.	Gaspé Bay, off Grande Grève, 35 Fathoms.	Gaspé, off Ship Head, 30 to 40 Fathoms.	Gaspé Bay, off Grande Grève, 40 to 50 Fathoms.	Gaspé Bay, Grande Grève, St. George's Cove.	Gaspé, River St. Lawrence, off Cape Rosier Village.	Riv. St. Lawrence, Murray Bay, 15 to 20 Fathoms.
Nodosaria (Glandulina) lævigata	* R			* R	* R												*	* S		*		* R	
Dentalina pauperata	* R																						
— communis																	* R L			*		* L	
Lagena sulcata														* R		* R	*	*	* R	* L	* R		
— — var. distoma	*	* R		*								* R						*					
— — var. semistriata							*										*	*	* R	* L		* R	
— — var. lævis		* R																					
— — var. substriata										*													
Entosolenia globosa	*						* R								* R			*	*		* R		
— costata							* R		* R			* R		*			*	* R S	* R		*		
— melo, D'Orb.							* R	* R				* L					* R		* R	* R			
— caudata, D'Orb.								*									* S		* R				
— marginata, var. ornata							* R										* S						
— marginata																	* R S						
— squamosa																	* R S		*				
— striato-punctata																	* R						
Polymorphina lactea	* R					*								*	* S		*					* R	
— — var. compressa							*		* R L			* R L	* C L	* L			* L				* R S		
Uvigerina pygmæa								* R		* C S							* R S		* R S		* R		
Globigerina bulloides	* C S	* C S		*			* R	* R									S		* R S				

	Sounding.	Sounding.	Sounding.	Sounding.	Sounding.	Sounding.	Dredging.	Dead Balanus, bro't up on cod hooks.	Sand from an Anchor.	Sounding.	Sounding.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.
Textularia agglutinans								*R							*R S								
— — var. biformis							*R																
— — var. Verneuilina polystropha							*					*		*		*R							
Bulimina Presli, type	*																						
— — var. pyrula		*	*C	*C	*						*R									*R L			
— — var. squamosa	C	*C		*			*R																
— — var. Bolivina costata		*																					
— — var. marginata		*		*																			
— elegantissima																*C							
Cassidulina lævigata							*R	*					*			*R	*	*	*	*	*	*	
— crassa																	*	*	*	*R	*	*	
Truncatulina lobatula							*C L	*C			*S	*R					*C		*C		*L		
Rotalia Beccarii	*	*R																					
Pulvinulina repanda, sub. var. Karsteni		*R					*			*C S							*	*	*R	*R	*R S		
Patellina corrugata																			*R S				
Polystomella crispa, var. striato-punctata	*R S	*R		*R S	*		*		*C		*C S	*S	*C	*C S	*	*S	*C	*R S	*C S	*R S	*S		*C S
— — var.									*R														
— Arctica																	*L		*L		*L		
Nonionina scapha								*C										*			*		
— — var. Labradorica	*	*	*	*C	*C		*	*R			*C		*		*	*	*L	*C	*	*C L	*R	*	*S
Lituola nautiloidea, var. Canariense			*				*				*R S		*	*	*C		*R S	*C L		*C	*C L	*C	*S
Trochammina inflata												*C S		*		*C S			*R S				*S
Cornuspira foliacea?		*R S												*R S		*L					*R S		
Quinqueloculina seminulum	*R		*R	*			*		*			*C L	*C L	*C S		*R S	*R S	*L		*L	*L	*C L	
— — var. subrotunda							*R																
— — var. agglutinans							*						*S	*		*S		*	*R S	*R	*R S	*	
— — var. Ferussacii							*R											*L		*L		*L	
— bicornis, var. elegans									*R														
Triloculina tricarinata																*R	*R S	*R S				*R	
Biloculina ringens	*						*R													*R	*R	*R	

TABLE II.—*Supplementary List of Peculiar Arenaceous Forms.*

(See Figs. 1 to 4, and Fig. 7.)

FORAMINIFERA.	Labrador.	Gaspé Bay, 10 Fathoms, (sand.)	Gaspé Bay, 10 to 15 Fathoms.	Gaspé Bay, 16 Fathoms.	Gaspé Bay, 18 to 20 Fathoms.	Gaspé Bay, 16 to 17 Fathoms.	Gaspé Bay, off Grande Grève, 35 Fathoms.	Gaspé Bay, off Grande Grève, 40 to 50 Fathoms.	Gaspé Bay, St. George's Cove.	River St. Lawrence, off Cape Rosier—Whiteaves.
Lituola findens, Parker—Fig. 1	....	....	....	*C L	*	*	....	....	*R	...
Hippocrepina indivisa, P.—Fig. 2	....	....	....	*C L	*C	....	....	....	....	....
Lituola cassis, P.—Fig. 3.	....	*	*C	*C L	....	*	....	....	....	....
Lituola scorpiurus—Fig. 4	*	....	*C	*C L	*	*C	*C L	*C	*C	*C L
Var.—Fig. 4	....	....	....	*C L	....	....	*C L	....	....	....
Rhabdopleura—Fig. 7	....	....	....	....	....	*	*C L	*	*C L	*C L

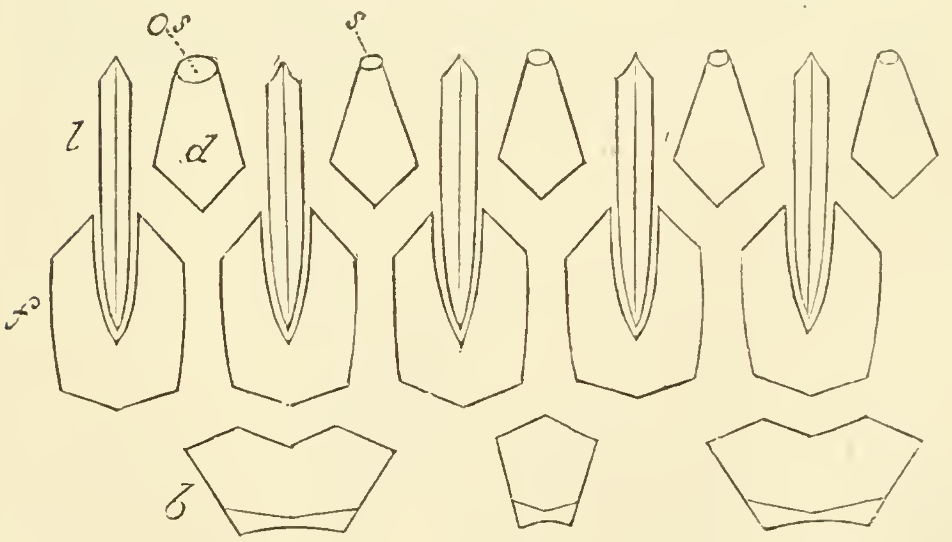
NOTES ON THE STRUCTURE OF THE CRINOIDEA, AND BLASTOIDEA.

By E. BILLINGS, F.G.S., Paleontologist of Geological Survey of Canada.

Reprinted from the Am. Journal, Sc., and Arts, Vol. L., Septr. 1870 : *and concluded from this Journal, N. S. Vol.* 4, *pp* 426--433.

6. ON SOME POINTS RELATING TO THE STRUCTURE OF PENTREMITES.

1.



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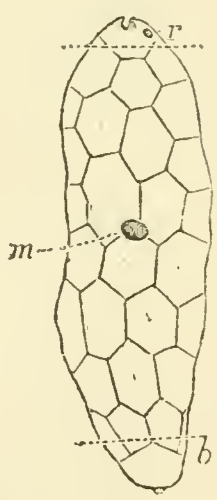

Fig 1.—Calycine plates of *Pentremites,* — *b*, the basals ; *f,* one of five forked plates; *d*, deltoid plate ; *l*, lancet plate ; *os*, oral spiracle ; *s*, spiracle.

Fig. 2.—*Caryocystites testudinarius,* Hisinger,—*b*, basal plates ; *r*, radials ; *m*, mouth.

Professor Wyville Thompson has proposed a division of the skeleton of the existing Crinoid, *Antedon rosaceus* into two systems of plates, which he terms respectively the "*Radial*," and the "*Perisomatic*" systems.* These he considers to be thoroughly distinct from each other in their structure and mode of growth. The radial system consists of the joints of the stem, the centrodorsal plate, the radial plates, the joints of the arms, and also those of the pinnules. In the perisomatic system he includes the basal and oral plates, the anal plate, the interradial plates, and any other plates or spicula which may be developed in the perisome of the cup or disc. This I think a good arrangement, except in so far as it regards the stem, which appears to me to be, always, an appendage of the perisomatic, rather than of the radial system.

Throughout the whole range of the Crinoidea, the plates of the radial and perisomatic system, are easily distinguished from each other. In general, the Cystidea have no radial plates in their calyces except, perhaps, in a small area around the ambulacral orifice. This accords well with an important observation of Professor Thompson's on the structure of Antedon, while in the earlier periods of its growth. "The entire body of the Pentacrinoid is," he says, "at first, while yet included within the pseudembryo and during its earliest fixed stage, surrounded and inclosed by plates of the perisomatic system alone, and it is quite conceivable that plates belonging to this system may expand and multiply so as to form a tessellated external skeleton to the mature animal, the radial system being entirely absent, or represented only in the most rudimentary form." (Op. cit., 541). Such is the structure of all of the Cystidea. On referring to fig. 2, it will be seen that the whole of the body of *Caryocystites testudinarius*, is covercred with polygonal plates, without any trace whatever of a radiated arrangement. The plates are disposed in nine transverse ranges, girding the body like so many rings. This species is, (and so are most of the elongated subcylindrical Cystideans), annulated rather than radiated, so far as regards the external integument. The lower range, below the line, *b*, consists of the basals, whilst the upper, above the line, *r*, may possibly, be radiated. In all the globular or ovate Cysti-

*On the Embryogeny of Antedon rosaceus Linck (*Comatula rosacea* of Lamarck). By Professor WYVILLE THOMPSON, L.L.D., &c. Philosophical Transactions of the Royal Society, vol. clv, Part II, p. 540.

deans, with numerous plates, such as *Sphæronites*, *Malocystites*, *Comarocystites*, *Amygdalocystites*, and others, the shell is neither annulated nor radiated, but composed of an indefinite number of plates, reasing with the age of the individual, and arranged without any well defined or constant order. It seems clear, therefore, that the test of the Cystidea belongs mostly to the perisomatic system.

In *Pentremites* the three plates which are usually called the basals, consist each of two pieces, one placed above the other, and, in general, closely anchylosed together. The lower pieces have each a re-entering angle , in their upper edges, for the reception of the upper pieces which stand upon them. This structure was first pointed out by Mr. Lyon (Geol. Ky., vol. iii, p. 468), and is not generally admitted, although I believe it certainly does exist. It is said that the lower pieces consist of the upper joint of the column, divided into three by vertical sutures. To me they appear to calycine plates. It is true that they do not form the bottom of the visceral cavity, but this may be due to the growth inward of the lower edges of those of the upper series. Something like this occurs in *Antedon*, where, at first, the bottom of the cup is formed by the basals, but afterwards principally by the first radials.

The forked plates are usually called "*Radials*," but they certainly do not belong to the radial system. If they did, they would represent the first radials of the Crinoidea, and therefore they should support the bases of the ambulacra. A little consideration will, however, enable any one to perceive that in *Pentremites* the bases of the ambulacra are situated in the apex of the fossil, and do not come in contact with the forked plates. The apex of *Pentremites* is identical with the actinal centre of Sea-urchins and Star fishes, in which the mouth is situated. It is here that the ambulacra originate and grow outward by the addition of new plates to their distal extremities. There can be little doubt that such was the mode of growth of the ambulacra of the *Pentremites*. The smaller extremity, therefore, of their ambulacra, which is received into the forked plate, is not the base, but corresponds with the apex of the ambulacrum of a Sea-urchin or of a Star-fish. It also represents the tip of the arm of a Crinoid. If the forked plate is radial, then the arrangement of the ambulacrum must be the same as that which would be exhibited in a Crinoid, with the upper end of the arm downward, and resting on the first radial, whilst the lower end would be upward, the tip being formed of the second radial. From this it follows that the forked plates do not belong to the radial, but to the perisomatic system.

The five deltoid plates alternate with the forked plates, and are also perisomatic.

It is not certain that the lancet plates represent any of those plates which in the Crinoidea are usually called "radials." They are so arranged that if they were loosened from the walls of the cup, and their smaller extremities turned upward, whilst their bases or larger ends retained their position, they would stand in a circle around the apex, as do the arms of an ordinary Crinoid. Their bases would alternate with the apices of the deltoid plates. They would form the outside of the arms, whilst the grooves and pinnulæ would be inside. Each would bear, on its outer or dorsal aspect, two elongated sacks, the two hydrospires that belong to the ambulacrum. I believe that the small groove in the ambulacrum of *Pentremites* was occupied by the ovarian tube only. If this be true, and if, also, the lancet plates represent the radial plates of the arms of the Crinoids, then the arm of *Pentremites* would have the respiratory portion of the ambulacral system on its dorsal, and the ovarian portion on its ventral aspect.

In the true Crinoids, both the respiratory and ovarian tubes are situated in the groove in the ventral side of the arm.* In the Crinoids the pinnulæ are attached to the radial joints of the arm. In *Pentremites* they are not connected with the lancet plate, but with the pore plates. In *P. pyriformis* they appear to me to to stand in sockets excavated in the suture between the pore plates. Müller compared them to the series of azygos

* Thomas Say, who was the first to recognize the Blastoidea as a group distinct from the Crinoidea, also supposed the function of the ambulacra to be respiratory. He says, "I think it highly probable that the branchial apparatus communicated with the surrounded fluid through the pores of the ambulacræ, by means of filamentous processes; these may also have performed the office of tentacula, in conveying food to the mouth, which was, perhaps, provided with an exsertile proboscis; or may we not rather suppose that the animal fed on the minute beings that abounded in the sea water, and that it obtained them in the manner of the Ascidia, by taking them in with the water. The residum of digestum appears to have been rejected through the mouth." (Jour. Acad. N. S. Phil., vol. iv, p, 296, 1825).

plates, which underlie that portion of the ambulacrum of *Pentacrinus* that runs from the mouth to the base of the arm. These resemble the lancet plates, in their being azygos and not connected with pinnulæ; but then, on the other hand, they differ from them in having, a portion at least, of the respiratory tubes on their ventral aspect. Mr. Rofe says that, "in many species of Pentremite, if not in all, this lancet plate is in reality a compound plate, formed of two contiguous plates, extending from the bottom to the to the top, and then turning right and left round the summit-openings, they pass down the adjoining sinus to form half its lancet-plate, leaving at the apex of the body a pentagonal aperture supposed to be the mouth. In some weathered specimens, the two parts of the lancet plate are separate; and in many they appear to meet only at the top and bottom of the cross section, leaving a lozenge-shaped opening between them." (Geol. Mag., vol ii, p. 249.) In a large specimen of *P. obesus* (Lyon and Cassiday) which was given to me by Mr. Lyon, a polished section shows that one of the lancet plates is thus divided, but in general no trace of a suture can be seen in these plates.

There are several points in the structre of the ambulacra of *Pentremites* that are well worthy of the study of those who have plenty of well preserved specimens. Among these, I would direct special attention to the markings in the ambulacrum of *P. pyriformis*.. The median groove, which I suppose to have been exclusively occupied by the ovarian tubes, sends off branches right and left alternately, towards the sides of the ambulacrum. These branches do not run directly to the ambulacral pores. Each of them terminates at a point between the inner extremities of two of the pores. There is at this point a small pit which appears to be the socket of an appendage quite distinct from the pinnule. The groove does not reach the socket of the pinnule, which is situated further out, between two of the pores. On the other hand a small groove runs from each pore inward, and terminates at another socket, about half-way between the pore and the main median groove of the ambulacrum. It would thus appear that besides the ordinary pinnules, there were two other rows of appendages on each side of the median groove.

The general conclusions at which I have arrived from the above, are, that all the principal plates that compose the shell of *Pentremites*, belong to the perisomatic system of Professor

Wyville Thompson; that it is doubtful whether or not the lancet plates are homologous with the radial plates of the Crinoids; and that the ambulacra are more complicated in their structure than is generally supposed.

7. On the Structure of the genus Nucleocrinus.

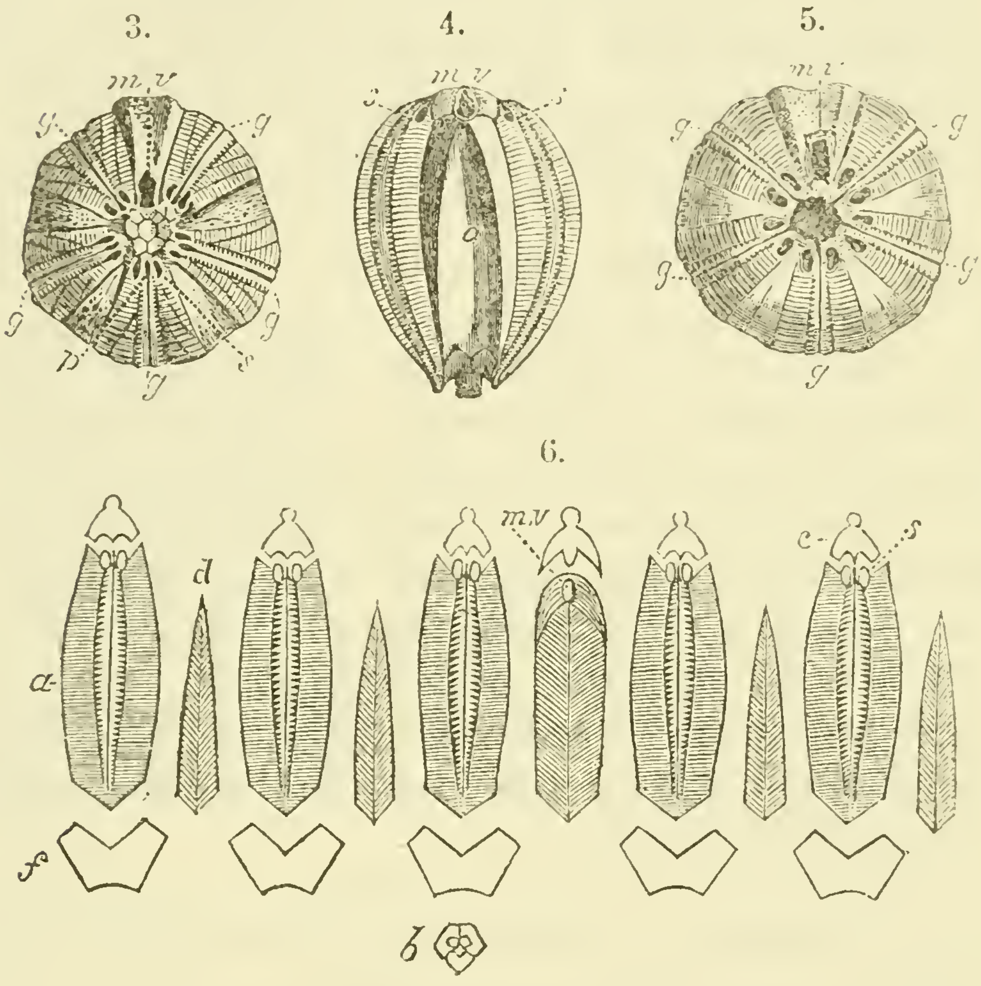

Fig. 3.—Apex of *Nucleocrinus Verneuilii* Troost. *g*, ambulacral groove: *p*, pore through which groove enters into the interior; *s*, one of the ten spiracles; *mv*, oro-anal aperture. 4. Anterior side of a specimen; *a*, the anterior interradial. 5 Apex of a specimen which has lost the integument that covered the centre. 6. Diagram of the plates of the test; *a*, ambulacral plate; *b*, the basals; *c*, plates of the apex; *d*, one of the interradials; *f*, forked plate.

The body of this remarkable genus is ovate, elliptical or oblong, and inclosed in a shell of strong perisomatic plates, which are, in general, so closely anchylosed that the sutures between them cannot be distinguished. According to Mr. Lyon, who, through his long continued geological researches. has collected and studied a vast number of specimens, there are three minute lozenge-shaped, or quadrilateral basal plates, situated at the bottom of the columnar pit; always concealed when the column is present. These are surrounded by three other plates, the six altogether corresponding to the six pieces which constitute the compound basal plates of *Pentremites*. They are represented at fig. 6, *b*, as figured by Mr. Lyon (Geol. Ky., vol. iii, pl. v, fig 1, *b*.)

In the next series there are five plates which are undoubtedly the homologues of the five forked plates of *Pentremites*. They are very short and confined to the base of the body. They form a shallow basin with ten re-entering angles in its margin. Fig. 6, *f*.

Alternating above the forked plates, are five pieces corresponding to the deltoid or interradial plates of *Pentremites*. Some of these are lanceolate in form (fig. 6, *d*), their broader extremities fitting into the angles between the forked plates. They taper to a point upward, and their sides are bevelled so as to pass under the ambulacral plates, to which they are, in general, so closely united, that the line of junction is indicated only by the difference in the markings of the surface. Owing to this structure, these plates have not always been recognised by the authors who have described this genus. They were first pointed out by Mr. Lyon. The fifth deltoid or interradial plate is truncated at its apex for the reception of the oro-anal orifice (*mv*, figs. 4, 6). The sutures on each side of this plate are generally distinctly visible, especially in the upper part of the body.

The ambulacra are narrow—one line wide in a specimen fifteen lines in length, with a fine median groove, about large enough to accommodate a tube of the size of a horse-hair. There are two rows of pores, those on one side of the groove alternating in position with those on the other side. These pores lead into the hydrospires. There appear to be only two rows of ambulacral ossicles. The pores are situated in the sutures between them. On each side of the ambulacrum there is a broad transversely grooved marginal plate. From each pore a small rounded ridge runs across this plate. The grooves between the ridges originate at the outer extremities of the ambulacral ossicles. In well-preserved specimens the surface of these marginal plates exhibits no other structure than the transverse grooves and ridges; but in one weathered specimen that I have examined, they seem to be composed of a number of narrow elongated pieces, arranged transversely, in such a manner that two of them abut against the outer extremity of each of the ambulacral ossicles, and extend outward toward the interradials. This seems to prove that the marginal plates belong to the ambulacra, as pointed out by Mr. Lyon, and not to the interradials, as represented by other authors. Although I have studied a large number of specimens, none of them were sufficiently perfect to enable me to make out the whole structure of this part of the test of *Nucleocrinus*. I have, however, seen enough to convince me that the ambulacra are much more complex than is usually supposed. The lancet plate, if it occur at all in this genus, must be very narrow. The ambulacral groove, as in *Pentremites*, sends off branches, right and left. There is also evidence of the existence of minute marginal plates on each side of the groove.

7.

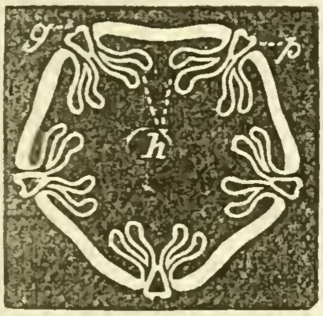

Fig. 7. Transverse section through a specimen which has all the hydrospires preserved. *h*, the two anterior hydrospires; *p*. pore leading into the hydrospire; *g*, one of the grooves.

The hydrospires are ten elongated sacks, each with two deep folds. They are perfectly homologous with those of *Pentremites*, only differing therefrom in not being united in pairs; consequently there are ten spiracles instead of five. The mouth, or oro-anal orifice, is larger in proportion to the size of the body than it is in *Pentremites*. Mr. Meek informs me that the mouth in some of the Blastoidea is protected by a single valve that covered it like the lid of a jug. From the structure of the orifice, I am inclined to think that in *Nucleocrinus* it possessed a similar protection.

In the apex, nearly all the space within the circle of apertures is covered by a thin integument of small plates, fig. 3. When this is not preserved, a large snb-pentagonal aperture is seen, as shown in fig. 5. This aperture occupies the position of the mouth in the existing echinoderms. The integument, as will be shown further on, represents that which covers the mouth of an embryonic Star-fish. Mr. Conrad described this genus in 1842, as having only one aperture in the summit. "This genus differs from PENTREMITES, Say, in having only one perforation at top, which is central." (Jour. Acad. Nat. Sci. Phil., vol. viii, p. 280, pl. xv, fig. 17). His figure represents the fossil with the apex downward. Dr. Ferd. Roemer, showed that, when perfect, there is no central opening, and he made this one of the grounds for separating the genus from *Pentremites*. He described the apex as being provided with six apertures, five of which were divided by a partition within each. These he considered to be the ovarian orifices. The sixth he supposes to be both mouth and vent, which accords with my view. (Mon. der Blastoideen, p. 378). In 1868 I discovered the five small pores at the apical extremities of the ambulacral grooves. (This Jour., II, xcvii, p. 353, and Annals Nat. Hist., IV, vol. 4, p. 76). In general it is difficult to to see these pores, but if a silicified specimen, which has been fossilized in a calcareous matrix, be placed in an acid for two or three minutes, the acid cleans them out and they then become distinctly visible. I believe these to be the pores through which the ovarian tubes passed outward along the grooves to the pinnulæ. There are thus, sixteen apertures in the apex of *Nucleocrinus*,—ten spiracles, five ovarian orifices, and one oro-anal aperture. There are no true radial plates. The whole of the test with the exception, perhaps, of the ambulacra belongs to the perisomatic system.

8. On the occurrence of Embryonic forms among the Paleozoic Echinoderms.

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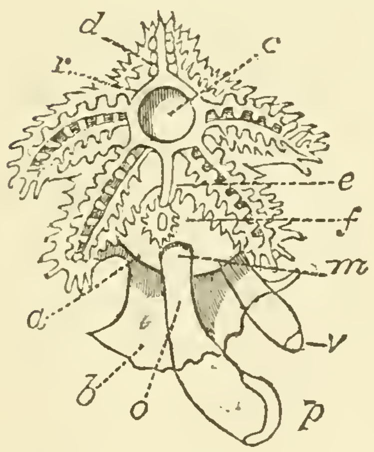

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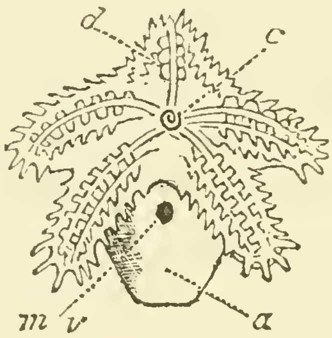

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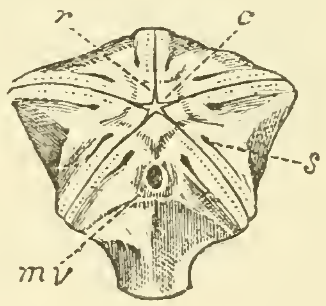

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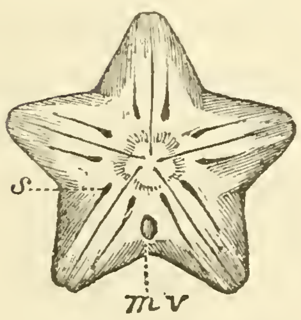

Fig. 8. *Bipinnaria asterigera* Sars, (copied from Muller). *a*, the stomach; *b*, part of the body of the larva; *c*, ambulacral centre, position of the permanent mouth, in this stage not open; *d*, one of the five ambulacral canals; *e*, sand canal; *f*, madreporic plate; *m*, entrance into the stomach; *o*, œsophagus; *p*, larval mouth or pseudostome; *r*, œsophageal ring; *v*, vent. 9. Ideal figure described below. 10. *Codonites stelliformis*, oblique view to show both body and summit. 11. Summit of fig. 10.

No proposition in Natural History has been more clearly demonstrated than this:—That, in general, the paleozoic animals resemble, both in external form and internal structure, the embryonic stages of those of the same class at present existing. Prof. Agassiz has long taught in his lectures and various publications, that this is especially observable in the Echinodermata. Judging from the figures and descriptions of Muller, Agassiz, Thomson, Carpenter and others, I should say, that in this class, the most striking resemblance is that which occurs between the adult stages of the Cystidea, Blastoidea, and paleozoic Crinoidea, on the one hand, and the embryonic Star-fishes on the other. The structural character that has the most important bearing on the subjects discussed in these notes, is, that in all four of these groups, the mouth is situated in one of the interradial areas,—not in the ambulacral centre, as it is in the adult forms of the existing Echinodermata.

In *Bipinnaria asterigera* Sars, according to Muller, the digestive cavity is a sub-globular sack without any extensions into the rays, as there are in the adult Star-fishes. The œsophagus, fig. 8, *o*, is a fleshy, consistent tube, with a large mouth or pseudostome, *p*. It passes through the wall of the stomach by an opening somewhat smaller than the mouth, and situated in one of the interradial spaces at *m*. The madreporic plate, *f*, and sand canal, *e*, the latter holding the convoluted plate (when it occurs), are situated above the orifice, *m*, and between it and the ambulacral centre, *c*. The circular space at *c*, is undoubtedly the homologue of the central space in the apex of *Nucleocrinus*, figs. 3 and 5, and of *Codonites*, figs. 10 and 11. It is also the position of the mouth in the adult Star-fish; but in the larval stage it is completely closed by the soft external skin and sarcode of the body. In the fossils it is also closed, by an integument of thin calcareous plates. The *Bipinnaria* is nourished by minute particles of matter diffused through the water, and drawn into the digestive sack through the mouth and œsophagus by the action of internal cilia. I believe that all the fossil Crinoidea, Blastoidea and Cystidea, ingested their food in this way, and without any aid whatever from the arms or pinnulæ.

Perhaps there is no embryologist who will not admit, that it is possible for an animal like *Bipinnaria* to develope organs of reproduction and propagate its species, none of its other parts making any further advance. Such an animal, with some slight modifications, would not be very widely different from a paleozoic Crinoid. If the sarcodic body wall were to be consolidated into a thin calcareous integument, with the mouth even with the surface, the swimming appendages aborted, and the vent closed up, it would resemble the cup of an *Actinocrinus*, fig. 9, *a*. The lateral orifice would then be both mouth and vent, as it is, at first (according to Prof. A. Agassiz, Seaside Studies, p. 125), in the embryo of *Asteracanthion Berylinus*. The ambulacral canals of *Bipinnaria* are the homologues, in a general way, of those which are found beneath the vault of *Actinocrinus*, and extend out into the grooves of the arms. If the ventral perisome of the Crinoid were to be removed (the internal organs remaining undisturbed) the arrangement disclosed would be that represented in fig. 9,—a convoluted plate in the centre with the canals radiating from it. The most striking difference is the absence of the œsophageal ring. According to the organization of *Actinocrinus* there could be no œsphagus at that point, and consequently there is no ring. The convoluted plate represents the madreporic apparatus. The sucking feet of the Star-fish, most probably, represent the respiratory tentacles that border the grooves of the Crinoids, but modified into prehensile and locomotive organs. *Bipinnaria* and *Actinocrinus* agree in having the mouth in one of the interradial areas, and in the absence of an orifice through the perisome at the ambulacral centre. These two characters are enbryonic and transitory in the Star-fish, but they were permanent in most paleozoic Crinoids.

In *Codonites stelliformis* (*Pentremites stelliformis* Owen and Shumard), figs. 10, 11, the ambulacral centre, *c*, is completely closed. Five minute grooves radiate out to the extremities of the five angles of the disc. These grooves are identical with those of *Pentremites* and *Nucleocrinus*, and were occupied by the ovarian tubes. The ambulacral canals of the true Crinoids and of the Star-fishes are represented in a rudimentary condition, in this species, by the hydrospires which open out to the surface through the ten fissure-like spiracles, *s*. The oro-anal orifice is interradial. *C. stelliformis* in external form, the interradial position of the mouth, and the closed ambulacral centre, resembles *Bipinnaria* and *Actinocrinus*, but differs importantly in having its respiratory organs arranged in ten separate tracts, all totally disconnected from each other. It is a lower form than *Actinocrinus*, which in its turn is lower than *Bipinnaria*, and yet all three are constructed on the same general plan.

C. stelliformis, although much resembling a *Pentremite*, is a true Cystidean. Its affinity to *Codaster* was first pointed out by Dr. C. A. White, who also suggested that it should be assigned to a distinct group. (Bost. Jour, N. H., vol. vii, pp. 486,487). The main difference between the Cystidea and the Blastoidea is, that in the former the hydrospires do not communicate with the pinnulæ, whilst in the latter the cavities of the pinnulæ and hydrospires are directly connected by the ambulacral pores.

The developement of the recent Crinoid, *Antedon rosaceus*, as described by Prof. Wyville Thomson (Phil. Trans., 1866), pursues a course that could not possibly result in the production of such an animal as *Actinocrinus*. The pseudembryo, as it is called by Prof. Thomson, is a small ovate organism, with four transverse, ciliated bands, a large key-hole-shaped mouth (pseudostome), and a small circular vent (pseudoproct). These orifices are connected by a rudimentary intestine (pseudocele). In this stage there is no trace of radiation, and the mouth, therefore, cannot be said to be interradial in its position.

The nascent Crinoid originates within the pseudembryo, but developes a mouth, vent and and stomach, of its own, all quite distinct from those of its nurse. The new, or permanent mouth, is for a short time both oral and anal in its function, but although in this respect it resembles that of *Actinocrinus*, its position in the centre of the ambulacral system, shows it to represent the mouth of the adult Star-fish, while that of *Actinocrinus* rather homologates with the oral orifice of the *Bipinnaria*. At no time during its development does the ventral perisome exhibit the structure of that of the paleocrinoids, *i. e.*, no orifice in the ambulacral centre, and at the same time one in an interradial space. In the central position of its mouth, and in the possession of an œsophageal ring, *Antedon* stands above *Actinocrinus* in rank, and between it and the adult Star-fish. In none of its stages does it resemble a *Bipinnaria* either in form or in structure.

9. ON SOME OF THE OBJECTIONS THAT HAVE BEEN ADVANCED AGAINST THE VIEWS ADVOCATED IN THE PRECEDING NOTES.

In all the known species of the existing Echinodermata, the mouth is situated in the centre of the ambulacral system, and it is contended that this fact proves that such must have been its position also in the paleozoic forms.

This reasoning is not strictly logical. It is true that in the known existing species, the mouth is in the centre, but it does not certainly follow that it is so in all the Echinodermata, living and extinct. Whether it be so or not in any particular fossil species, whose structre may be under investigation, *is a question of which fact can only be positively determined by direct observation of specimens.* On appealing to these we find that, in a large proportion of the fossil forms, there is no aperture in the perisome at the ambulacral centre. It also becomes evident by the comparison that, in general, the paleozoic species resemble the embryonic stages of some of the recent Echinoderms, and that in these, (*Bipinnaria* for instance), the mouth is interradial. Rules such as are relied on in this case, afford a certain amount of presumptive evidence, which, however, cannot prevail against material and visible facts. When we can see clearly that there is no aperture in that point in the vault of a Crinoid, beneath which we know the ambulacral centre is situated, it is perfectly useless to supply one by deduction.*

The second objection is, that many of the fossils have a *Platyceras* attached to them, in such a position so as to cover the aperture which I call the mouth, and under such circumstances as to induce the belief that it lived parasitically on the Crinoid. The only answer I can make to this is that, admitting the facts, we must suppose that space was left for a stream of water to pass under the edge of the shell, into the mouth of the Crinoid. In general, where one animal lives parasitically upon another, it does not destroy his host. Some of the gasteropods of the Devonian and Carboniferous ages, were carnivorous, as is proved by the bored shells and Crinoids that are occasionly found. I have seen a great number of such specimens, and several years ago I read a paper on the subject (which was never publiished) before the Natural History Society of Montreal. There were several good Conchologists present, and the specimens exhibited were compared with bored shells of existing species. All pronounced the style

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* The position of the ambulacral centre may thus be found. When the mouth is eccentric, the ambulacral tubes usually converge to the centre of the vault. But when the mouth is central, we first find the azygos interradius, in general easily recognized by its possessing a greater number of plates than do any one of tho other four interradii. On the opposite side of the fossil is the azygos arm. The ambulacral centre is always situated between this arm and the mouth, never on the side of the mouth torward the azygos interradius.

of workmanship to be precisely the same. I have the proboscis of an *Actinocrinus* that is bored near the base, and among the fossils lent me by Mr. Wachsmuth is a *Codonites stelliformis*, that is bored through one of the ambulacra. The view I took of the subject in my paper, was that the gasteropod ascended the stalk of the Crinoid, and thrust its proboscis into the mouth of the latter. The Crinoid then slowly drew its arms together and held the shell fast until both died.

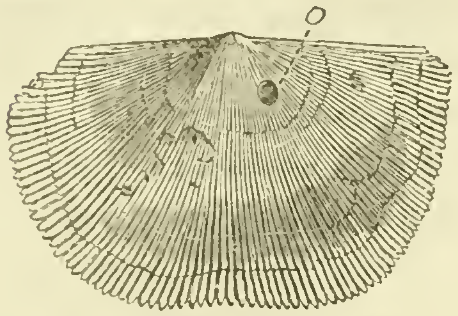

Fig. 12. *Streptorhynchus Pandora*. A specimen bored at *o* by a carnivorous gasteropod. From the Corniferous Limestone, Devonian, Canada.

A third objection is the small size of the aperture in some of the species. In general, where there is no proboscis the orifice is from one-twentieth to one-tenth of an inch in diameter, quite sufficient for an animal that subsists on microscopic organisms. It is stated by Meek and Worthen that where there is a proboscis, the aperture is sometimes scarcely " more than *one-hundredth* of an inch in diameter." I believe in many such instances the tube is filled up by calcareous deposits on its inside, and that when entirely obstructed, either a new aperture is opened out in the side of the proboscis, or that the animal died. In Mr. Wachsmuth's collection, I saw a specimen with a second aperture in the process of formation. A ticket was attached to it by him, giving this explanation. I am also informed that in some of the existing species of *Antedon* " the mouth is an exceedingly minute aperture."

A fourth objection is that the aperture is so situated that the arms could not have conveyed food to it. It is however proved by Dr. W. B. Carpenter, that in the recent Crinoids the arms are not prehensile organs. The animal while feeding remains motionless, attached by its dorsal cirrhi to a stone, shell, or other object on the bottom. Its arms are either stretched out to their full length, or more or less coiled up, but quite immovable. As Dr. Carpenter's remarks have a very important bearing upon the subject, I shall take the liberty of quoting the following :—

" Whatever may be the purpose of the habitual expansion of the arms, I feel quite justified that it is *not* (as stated by several authors whom I cited in my historical summary) the prehension of food. I have continually watched the results of the contact of small animals (as Annelids, or Entomostracans and other small Crustaceans) with arms, and have never yet seen the smallest attempt on the part of the animal to seize them as prey. Moreover, the tubular tentacula with which the arms are so abundantly furnished, have not in the slightest degree that adhesive power which is possesed by the "feet" of the ECHINIDEA and ASTERIADA; so that they are quite incapable of assisting in the act of prehension, which must be accomplished, if at all, either by the coiling-up of a single arm, or by the folding-together of the arms. Now I have never seen such coiling up of an arm as could bring an object that might be included in it into the near neighbourhood of the mouth; nor have I seen the contact of small animals with a single arm produce any movement of other arms towards the spot, such as takes place in the prehensile apparatus of other animals. Moreover, any object that could be grasped either by the coiling of one arm, or by the consentaneous closure of all the arms together upon it, must be far too large to be received into the mouth, which is of small size and not distensible like that of the ASTEROIDA." *

Farther on Dr. Carpenter says:

"It was affirmed by M. Dujardin (l'Institut, No. 119, p, 268) that the arms are used for the acquisition of food in a manner altogether dissimilar to ordinary prehension; for recognizing the fact that the alimentary particles must be of small size, he supposed that any such, falling on the ambulacral (?) furrows of the arms or pinnæ, are transmitted downwards along those furrows to the mouth wherein they all terminate, by mechanical action of the digitate papillæ which fringe their borders. This doctrine he appears to have abandoned; since in his last account of this type (Hist. Nat. des Echinoderms, p. 194) he affirms that the transmission of alimentary particles along the ambulacral (?) furrows is the result of the action of cilia with which their surface is clothed. Although I have not myself succeeded in distinguishing cilia on the surface which forms the floor of these furrows, yet I have distinctly seen such a rapid passage of minute particles along their groove as I could not account for in any other mode, and

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* Reaserches on the Structure, Physiology, and development of *Antedon* (*Comatula*, Lamk.) *rosaceus.*—Part I. By W. B. Carpenter, M.D., F.R.S. Philosophical Transactions of the Royal Society, vol. clvi, Part II. 1866.

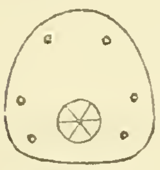
am therefore disposed to believe in their existence. *Such a powerful indraught, moreover, must be produced about the region of the mouth, by the action of the large cilia which (as I shall hereafter describe,) fringe various parts of the internal wall of the alimentary canal, as would materially aid in the transmission of minute particles along those portions of the ambulacral (?) furrows which immediately lead toward it;* and it is, I feel satisfied, by the conjoint agency of these two moving powers that the alimentation of Antedon is ordinarily affected. In the very numerous specimens from Arran the contents of whose digestive cavity I have examined, I have never found any other than microscopic organisms; and the abundance of the horny rays, *Peridinium tripos*, (Ehr.) has made it evident that in this locality that Infusorian was one of the principle articles of its food. But in Antedons from other localities, I have found a more miscellaneous assemblage of alimentary particles; the most common recognizable forms being the horny casings of ENTOMOSTRACA or of the larvæ of higher CRUSTACEA." (Op. cit., p. 700).

The existence of large cilia within the intestinal canal, capable of producing a powerful indraught of water, renders any movement or concurrent action of the arms quite unnecessary in the ingestion of food. It does not matter, therefore in what part of the body the mouth of a Crinoid may be situated, or how remote from the reach of the arms. Attached permanently to the bottom of the sea by their columns, the Crinoidea, Cystidea and Blastoidea remained, while feeding. most probably motionless, drawing in streams of water through their mouths by the action of their intestinal cilia. The long tubular proboscis with which many of the species are provided, would be, thus, analogous in function to the siphon of the acephalous mollusca. The indigestible particles would be, from time to time, thrown out the mouth, just as a Star-fish or a Zoophyte frees itself of the refuse portion of food, by casting it out of the same aperture through which it entered.

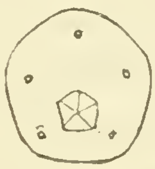
10. ON THE THEORY THAT THE AMBULACRAL AND OVARIAN ORIFICES ARE THE ORAL APERTURES.

Assuming that the four objections above noticed are sufficient to prove that the aperture which I call the mouth is not that organ, it is contended that the Cystidea, Blastoidea and Palæocrinidea ingested their food through their ambulacral and ovarian orifices. This appears to me in the highest degree improbable. In the recent Crinoids the grooves of the arms are occupied by four sets of tubes, which Dr. Carpenter calls the cæliac, the subtentacular, the ovarian and the tentacular canals. None of them communicate with the stomach. It is impossible that the most minute particle of food could gain acess into the interior of the animal through any of them. The structure of the arms of the paleozoic Crinoids is such, that we must presume that their grooves were occupied by similar tubes, which passed through the ambulacral orifices into the perivisceral space. In the Cystidea and Blastoidea the respiratory organs were not situated in the grooves of the arms, and the ambulacral orifices were therefore only ovarian in their function. The improbability of their being also oral apertures is best shown by an illustration.

13.



14.



In fig. 13, is represented (natural size) the apertures of the smallest specimen of *Caryocrinus ornatus* in our collection, selected for the present purpose because in the young of this species, the valvular orifice is larger in proportion to the disc, than it is in the adult. It is in this specimen, about one-third of the whole width of the apical disc, while in a full grown *Caryocrinus* it is only one-ninth of the width. The same proportional size of the mouth according to age, occurs in the *Antedon rosaceus*. The valvular mouth at first is as wide as the disc. But as the age of the animal increases the disc grows wider but the mouth does not. The ovarian pores in *Caryocrinus* are however as large in the small ones (once they make their appearance) as they are in those full grown. For recognizing these as ovarian pores we have the following reasons:—1. They are situated at the bases of the arms where the ovarian tubes must pass from the grooves into the perivisceral cavity. 2. When compared with the ovarian pores of a Sea-urchin they have the same size, form and aspect. Fig. 14 represents the ovarian pores of the Sea-urchin *Toxopneustes Drobachiensis* Ag. natural size and arrangement. It may not appear at first view that this latter comparison has any probative effect. But it has, in this way. If these apertures in *Caryocrinus* were large openings a line wide, as are some of the ambulacral orifices of the Crinoids, I would say that they were unlike true ovarian apertures.

According to the new theory, this Echinoderm, *Caryocrinus* *ornatus*, was a polystome animal, and drew in its food through its six ovarian apertures, the large valvular orifice being the anus. To me this appears uterly incredible.

In fig. 14 I have represented the mouth of *Leskia mirabilis* Gray. Both Dr. J. E. Gray and Prof. Lovén have pronounced this aperture to have the structure of the valvular orifice of the Cystidea. I have not the slightest doubt whatever but that the mouth of the Cystideans foreshadows that of the Sea-urchins. There is nothing whatever in its structure to show that it is not the mouth but the contrary.

The new theory is not founded upon any peculiarities in the structure of the ambulacral orifices, which would show that they are oral apertures, but only upon the four objections above noticed. The first of these is not logical, while at the same time it is purely theoretical, and avails nothing against material and visible facts. The fourth is completely disposed of by Dr. Carpenter's observations, which prove that in the Crinoidea the arms have no share whatever in the ingestion of food. The second and third objections are the same in substance, i. e., according to the second the supply of water to the mouth, is diminished by the occurrence of a *Platyceras* over it, while, according to the third, the same effect is produced by the small size of the aperture itself in some instances. It does not require much consideration to convince one, that if these two objections are fatal to my views, they are equally so to the opposite theory. In *C. stelliformis*, for instance, the pores through which we must suppose the ovarian tubes issued from the interior are only large enough to admit of the passage of a fine hair. They are scarcely visible to the naked eye. The tube, under any circumstances, must have filled them entirely. If any space at all were left for the passage of a stream of water through the pore by the side of the tube it must have been exceedingly minute.

When weighed as above, therefore, the evidence gives the following results:—The first and fourth objections avail nothing. The second and third militate against both theories. But when we take into account that in no instance in the existing Echinodermata, where ovarian pores occur, are they at the same time oral orifices, the balance seems to be in favour of my view. This is all I desire to say upon the subject at present. Although I now firmly believe that the valvular orifice in the Cystidea, the larger lateral aperture of the Blastoidea, and the so-called proboscis of the paleozoic Crinoids are all oro-anal in function, yet I shall not maintain that view obstinately against good reason shown to the contrary.

ON THE GEOLOGY OF EASTERN NEW ENGLAND.

By Dr. T. Sterry Hunt, F.R.S.

(*From a letter to Prof.* James D. Dana, *reprinted from the American Journal of Science and Arts, Vol. L., July,* 1870.)

When, more than twenty years since, my attention was turned to the geology of New England, there was no evidence of the existence between the old gneisses of the Adirondacks and the coal measures, of any other stratified rocks than those of the Huronian series, and the New York system, from the Potsdam formation, upward. It is true that Emmons had, before that time maintained the presence, in western Vermont and Massachusetts, of a system of fossiliferous sediments, lying unconformably beneath the Potsdam, but the evidence up to this time adduced with regard to these so-called Taconic rocks, has failed to show that they include any strata more ancient than the Potsdam, while most of them are certainly younger. The researches of Sir William Logan, up to 1848, had led him to refer to a period not older than the Lower Silurian the crystalline sediments of the Appalachian region of Canada, between Lake Champlain and Quebec. These form a chain of hills, the continuation of the Green Mountains, and were found by him to be followed immediately, to the southeast, by more or less calcareous and somewhat altered strata, associated with Upper Silurian fossils, and succeeded across the strike, near the sources of the Connecticut River, by a series, several miles in breadth, of micaceous schists and quartzose strata, occasionally containing chiastolite, garnet and hornblende. These two series of rocks, extending from the base of the Green Mountains to Canaan on the Connecticut, it was suggested by Sir William Logan, in his Report on the Geological Survey, 1847–1848, might be the altered representatives of the rocks of Gaspé, including the Lower Helderberg group, and the succeeding members of the New York system to the top of the Chemung. I then as now conceived that these micaceous and argillaceous schists, often holding garnets and chiastolite, were identical with those which make so conspicuous a figure in the White Mountains and elsewhere in Eastern New England, and when, in 1849, I laid before the American Association at Cambridge, the results of the Geological Survey of Canada (Sill. Jour., II, ix, 19), suggested that to the Gaspé series, as above defined, "may perhaps be referred, in part, the rocks of the White Mountains." Lesley, subsequently, in 1860 (Proc. Philad. Acad. Nat. Sciences, page 363), adduced many reasons for believing that the rocks of these might be strata of Devonian age.* In the large geological map of Canada and the northern United States, lately published by Sir William Logan, no attempt is made to delineate the geology of New Hampshire, but the rocks in question, to the north of the United States boundary, are represented as Upper Silurian, with the exception of a belt of the Quebec group, which has been recognized in that region.

In fact the schists and gneisses of the White Mountains are clearly distinct, lithologically, from the Laurentian, the Labradorian and the Huronian, as well as from the crystalline rocks of the Green Mountains, and from the fossiliferous Upper Silurian strata which lie at the southwestern base of the Canadian prolongation of the latter. Having thus exhausted the list of known sedimentary groups up to this horizon, it was evident that the crystalline strata of the White Mountains must be either (1) of Devonian age, or (2) something newer (which was highly improbable); or (3) must belong to a lower and hitherto unknown series. In the absence of any proof, at that time, of the existence of such a lower system, the first view, which referred these strata to the Devonian period, was the only one admissible.

* In this connection should be recalled the views put forth in 1846, by Messrs. H. D. and W. B. Rogers, in a paper on the Geological Age of the White Mountains, (Sill. Journal, II, i, 411). They there, for the first time, pointed out that the great mass of these mountains consists of more or less altered sedimentary strata, which upon the evidence of supposed organic remains they referred with some little doubt, to the Clinton division of the Upper Silurian. In 1847, however, they announced that the supposed fossils, on which this identification had been founded, were not really such, (Sill. Journal, II, v, 116). Future explorers may, it is hoped, be more successful, and yet discover among the strata of the White Mountains evidences of organic life, probably of primordial Silurian age.

When, however, further investigation showed that the great and progressive thickening which takes place in the paleozoic formations from the west, eastward, is not confined to the augmentation of existing subdivisions, but includes the intercalation of new ones; when the few hundred feet of typical Potsdam sandstone in New York are represented in Vermont, Quebec and Newfoundland, by thousands of feet of strata lithologically very unlike the type; while the Quebec group, not less in volume, appears representing the beds of passage between the Calciferous and Chazy divisions of New York, we begin to conceive that conditions of sedimentation, very unlike anything hitherto suspected in the west, prevailed to the eastward. When, moreover, we find widely separated areas of Labradorian and Huronian rocks,—remaining fragments of great series,—resting upon the Laurentian, from Lake Huron to Newfoundland, we get evidences of a process of denudation in past ages, not less remarkable than the sedimentation.

My observations of last year have led me to a conclusion, which had previously been taking shape in my mind, that there exists above the Laurentian, a great series of crystalline schists, including mica-slates, staurolite and chiastolite-schists, with quartzose and hornblendic rocks, and some limestones, the whole associated with great masses of fine-grained gneisses, the so-called granites of many parts of New England. The first suggestions of this were given me by the observation of Dr. Bigsby, confirmed by specimens since received from that region, that there exists to the northwest of Lake Superior, an extended series of crystalline schists, unlike the Laurentian, and resembling those of the White Mountains. I have already called attention to this resemblance in a review of the progress of American Geology, in 1861 (*Can. Naturalist*, VI., 84). It was contrary to my notions of the geological history of the continent to suppose that rocks of Devonian age could, in that region, have assumed such lithological characters, and I was therefore led to compare these rocks with a great series of crystalline schists, abounding in mica-slates and micaceous limestones, which occupy considerable areas in the Laurentian region in Hastings county, to the north of Lake Ontario. The distribution of this series has been traced out by Mr. Vennor, who in 1869, was able to show that, although much contorted, it rests unconformably upon the old Laurentian gneisses, while it is, at the same time overlaid by the horizontal limestones of the Trenton group. This intermediate series, which attains a thickness of several thousand feet, is terminated by calcareo-micaceous schists, in which *Eozoon Canadense* has been found, both in Madoc and in Tudor. In these localities, as shown by Dawson and Carpenter (Sill. Jour.. II., xlviv, 367), the calcareous skeleton of the Eozoon, instead of being injected by serpentine or another silicate, is simply filled with impure calcareous and carbonaceous matter. The presence of this fossil serves to connect these rocks with the Laurentian system, with which they had provisionally been classed, although their lithological dissimilarity had long been noticed, and in 1866 Sir William Logan had remarked their resemblance to the mica-slate series found near the sources of the Connecticut River (Report Geol. Survey, 1866, p. 93).

Mr. Alex. Murray's report of his explorations in Newfoundland, published in 1866, throws much light on the history of the rocks immediately succeeding the Laurentian in that region. He found in the great northern peninsula, about the Clouds Mountains and Canada Bay, not less than 5400 feet of strata, referred by him to the Potsdam group. Of these the lower 2500 feet consist of bluish-gray slates, holding near the summit, beds which become conglomerate from the presence of quartz pebbles, and are followed by a mass of purplish amygdaloidal diorite, holding epidote and jaspery red iron ore. Then follow 2000 feet of argillaceous and somewhat micaceous slates with beds of quartzite and of limestone, generally impure. These contain, besides numerous fucoidal markings, the remains of a Lingula, and of *Olenellus Vermontanus*, a fossil characteristic of the Potsdam group. To this second division succeeds a third, consisting of about 900 feet additional of limestones and slates. Somewhat farther southward, at Great and Little Coney Arms, the lower half of the above series is not observed, but a succession of strata, supposed to represent the upper portion of the Potsdam, is more particularly described. It consists, at the base, of 300 feet of pale bluish-gray mica-slates, with iron stains, "softer more finely laminated, and more uniform both in colour and in texture" than some micaceous strata described by Mr. Murray as occuring in the Laurentian in that region. To these succeeded 430 feet of similar soft bluish-gray mica-slates, holding numerous thin seams of dark colored limestone, and followed by 1000 feet of impure limestones and slates, often micaceous and calcareous, among which are a few beds of white compact marble. No indications of fossils, save fucoidal markings, were met with in this section. At Coney-Arm Head there is seen a series of "whitish granitoid, very quartzose mica-slates," which appear to have a thickness of from 1500 to 2000 feet. The same rock is found in White Bay, where it overlies what is supposed to be Laurentian gneiss. The relations of these whitish granitic mica-slates are still obscure, but Mr. Murray was inclined to regard them as occupying a position beneath the Potsdam group. The latter, in Canada Bay is immediately followed by the unaltered fossiliferous limestone, and shales of the Quebec group. From these investigations of Mr. Murray we learn that between the Laurentian and the Quebec gronp, there exists a series of several thousand feet of strata, including soft bluish-grey mica-slates and micaceous limestones, belonging to the Potsdam group; besides a great mass of whitish granitoid mica-slates, whose relation to the Potsdam is still uncertain. To the whole of these we may perhaps give the provisional name of the Terranovan series, in allusion to the name Newfoundland.

Imperfect gneisses and schists are found in several parts of the province of New Brunswick, associated with what has been described as a great grantic belt. These rocks have been examined by Prof. Hind, and by Mr. Robb, on the St. John and Mirimichi rivers; and the former of these observers some years since pointed out the indigenous character of the so-called granites. In the summer of 1869 I had an opportunity of examining, with Prof. L. W. Bailey, the region about St. Stephen, on the river St. Croix, where he had already observed a series of ferruginous quartzites and imperfect gneisses, accompanied by soft bluish mica-slates sometimes holding chiastolite, staurolite, and garnet. These highly crystalline schists are not more than five miles removed from unaltered shales of the Gaspé series containing fossils of Upper Silurian or Lower Devonian types, and rest unconformably upon older granitoid rocks, which Prof. Bailey regards as probably Laurentian. We subsequently examined the crystalline schists of the St John, which are apparently identical with those of the St. Croix, and these also overlie, unconformably, an older granitoid gneiss. *

* Subsequent examination and comparison leads me to conclude that the underlying granitic rock here referred to, which occurs on the St. John near the mouth of the Shogamoc is not an indigenous rock, but an

More recently Prof. Hind has pointed out that some of the so-called granites of Nova Scotia are ancient gneisses, probably of Laurentian age, and have shown that between these and the gold-bearing slates of that province, there is found, near Windsor, and near Sherbrooke, a series of beds of no great thickness, consisting of imperfect gneisses, quartzites and micaceous schists, which rest unconformably on the Laurentian, and are sometimes wanting altogether. These include mica-schists with chiastolite and garnet, and appear identical with those already observed by Dr. Dawson in other parts of Novia Scotia, which I had already recognized as the same with those of the White Mountains, and those of the St. Croix, just noticed. Prof. Hind, in a late paper, has called these, from their position in Nova Scotia, Huronian; but the Cambrian or Huronian rocks recognized by Messrs. Matthew and Bailey in New Brunswick, where they are widely spread along the north side of the Bay of Fundy, consist of massive diorites and quartzose feldspar-porphyries, with occasional sandstones and conglomerates, and are very unlike the gneissic and micaceous rocks in question, which I believe to belong, like those of the St. Croix and the St. John rivers, to the great Ierranovan series. The micaceous and hornblendic schists, with interstratified fine grained whitish gneisses (locally known as granites) which I have seen in Hallowell, Augusta, Brunswick and Westbrook, in Maine, appear to belong to the same series; which will also probably include much of the gneiss and mica-schist of eastern New England. If this upper series is to be identified with the crystalline schists which in Hastings County, Ontario, overlie unconformably the Laurentian, and yet contain *Eozoon Canadense*, the presence of this fossil can no longer serve to identify the Laurentian system. To this lower horizon however, I have referred a belt of gneissic rocks in eastern Massachusetts, which are lithologically unlike the present series, and identical with the Laurentian of New York and Canada. To the upper series appear to belong the great endogenous granitic veins so well known to mineralogists as containing beryl, tourmaline and other fine crystallized minerals.

The fine-grained white granitoid gneisses, often present an apparently bedded structure, which enables them to be removed in large plates or layers, lying at no great angle, and apparently con-

intrusive granite. The same view must probably be extended to the granite rocks of the St. Croix.

formable to the present surface of the country. This structure, which I conceive to have been superinduced by superficial changes of temperature, is often quite independent of the bedding, as may be seen in the quarries near Augusta in Maine, and in the cuttings on the Grand Trunk Railway near Berlin Falls, New Hampshire. It is also observed in exotic or intrusive granites, like those of Biddeford, Maine. This is, in fact, the concentric lamination of granite, long since observed by Von Buch, and, I believe, correctly explained by Prof. N. S. Shaler to be due to movements of contraction and expansion in the mass, caused by variation of temperature during the changes of the seasons. He has not however observed this structre at greater depths than from three to five feet, while in some rocks I have found it penetrating probably twenty feet. (See Shaler's paper, read before the Boston Nat. History Society, Feb. 3, 1869, and published in the Proceedings of the Society, vol. xii, page 289).

While however I admit the existence in the Dominion of Canada and in eastern New England, of a great series of crystalline schists, distinct from the Laurentian, and apparently the same with those found by Mr. Murray between the Laurentian and the Quebec group in Newfoundland, it is not less certain that we have in these regions rocks of Upper Silurian and Lower Devonian age, holding the characteristic fossils. These strata in Maine and New Brunswick are generally but little altered. In the Connecticut valley at Bernardston, Massachusetts, near Lake Memphremagog in Vermont, and further northward in the province of Quebec, fossils of this horizon are found in rocks which in some localities, are more or less altered and crystalline. I believe however that much of the calcareous mica-slate of eastern Vermont will be found to belong to the Terranovan series. The extent of these newer rocks, and the limits between them and the more ancient schists, of the ruins of which they are probably in part composed, remain problems for farther investigation. For the solution of these Prof. C. H. Hitchcock, by his labours in Vermont, is already well prepared, and it cannot be doubted that he, with his able assistants, will in the Survey of New Hampshire, now in progress, throw much light on New England geology. It is worthy of remark, that strata holding fossils of Lower Helderberg age, or thereabouts, are not confined to the shores of Maine and New Brunswick, and the valleys of the Connecticut and St. John rivers, but are found beyond the Green Mountains, in the valley of the St. Lawrence near Montreal; where, on the island of St. Helen they rest unconformably on the Utica slate, and at Belœil Mountain, near by, on intrusive diorites, which there break through the shales of the Hudson River group.

The relations of this Terranovan series to the porphyries and diorite rocks which, in New Brunswick, have been called Cambrian and Huronian by Mr. Matthew (first distinguished by him as the Coldbrook group), yet remains to be determined. These rocks are found near to the city of St. John resting directly on what has been regarded as Laurentian, and are overlaid by the uncrystalline schists which contain the primordial fauna now so well known by the descriptions of Prof. Hartt. Rocks which I regard as identical with the same Coldbrook or Cambrian group, are found along the coast of New Brunswick, and constitute the diorites and porphyries of Eastport, Maine. They appear moreover to be the same with those met with near Newburyport, and Salem, Lynn, and Marblehead, Massachusetts. Farther researches about Passamaquoddy Bay, where the mica-slates are found not far removed from these porphyries, will probably enable us to determine their relation to each other.

It will be remembered that Gümbel has found, in Bavaria beneath the oldest fossiliferous clay-slates, a mica-schist (and hornblende-schist) series, reposing upon the Hercynian gneiss, which contains crystalline limestones, with graphite, serpentine and *Eozoon Canadense*, and which he has identified with the Laurentian of North America. He distinguishes beneath this a great mass of red gneiss, apparently without limestones, to which he has given the name of the Bojian gneiss. It will however be remembered, that in his studies of the Laurentian system on the Ottawa, Sir William Logan has shown that this immense series (his Lower Laurentain), some 20,000 feet in thicknesss, includes four great masses of gneiss and quartzite, divided by three limestone formations, and that it is in the uppermost of these, which is, in some parts, 1500 feet thick, that the *Eozoon Canadense* has been found. Some of the lower gneisses of this vast system may very well represent the Bojian of Gümbel, who has not recognized in Bavaria either the Labradorian (Upper Laurentian) or Huronian series. (See Gümbel on the Laurentian of Bavaria, translated and published in the Canadian Naturalist for December, 1866). Comparative studies of this kind should not be neglected in the investigation of our American rocks.

NATURAL HISTORY SOCIETY.

PROCEEDINGS AT THE ANNUAL MEETING,

Held May 18th, 1870.

The annual meeting of this Society was held at its rooms on the evening of May 18th, the Acting President, Rev. A. De Sola, LL.D., in the absence of Sir W. E. Logan, in the chair. Mr. J. F. Whiteaves, the Recording Secretary, read the minutes of the last annual meeting; after which the usual annual address was delivered as follows:—

In the notice calling this meeting, it was announced that there would be an address by the Acting President. I fear, however, that I shall have now to prove there would be more of courtesy than of justice in dignifying my few remarks, illustrative of the work done in the past year, with a title that has frequently, even if not invariably, conveyed on such an occasion the idea of a scientific treatise. When I had the honor of last filling the presidential chair, I called your attention to "some points of interest in the study of Natural History"; but this evening, I do not follow this course, for two reasons, which I trust you will regard as quite sufficient. The first is, that I—and I venture to add most others in my situation—would but little desire to give opportunity of contrast with what, had he been present, our learned President, Sir Wm. Logan, would have favored us. And the second is, that multifarious and urgent official and other duties would have prevented me, however I might have felt disposed to intrude in such a direction. In uniting with me, as I am sure you will, in regretting the absence of our President on this occasion, we may yet have the satisfaction of recalling the fact that on Sir William Logan's recent retirement from the active duties of Director of the Geological Survey, this Society, which in the past had done something to help Sir William in creating the Survey, availed itself of the occasion of his withdrawal to present him with its silver medal, accompanied with resolutions expressive of the Society's desire—although it could not add appreciably to the many honors which Sir William had received, by presenting to him its medal—yet its earnest desire to place on record, not merely on its own behalf, but on that of all the students of natural science in Canada, its high estimation of the value of his services in creating, as well as directing, the Geological Survey of this country; in promoting the development of its mineral resources; in stimulating and aiding the efforts of scientific institutions, and in extending throughout the world the name of Canadian science. The resolutions also express our high appreciation of Sir William's admirable personal qualities, our hope that he may be spared for many years to Canada and science, and that the relief from official cares may give him the opportunity to pursue to completion the researches in scientific geology in which he is now engaged. In the sentiments of these resolutions I am sure all who are here to-night, but who were absent when they were offered, will full and cordially concur, and at the same time unite with me in felicitating the "Survey" and the cause of geological science, that Sir William's mantle should have fallen on so worthy a successor as Mr. Selwyn, whose laurels, already gathered as director of the Geological Survey in Victoria, will doubtless multiply and extend themselves in the new and larger field to which he has been called.

The proceedings to which I have just adverted will find record in the Society's organ, *The Canadian Naturalist*, and it may be proper that I should here say a few words respecting this publication, especially as I have not been editorially or otherwise connected with the volume just completed. This volume forms the fourth of the new series and the first of its publication as a quarterly, and I venture to say that we have much cause for gratification and pride at its appearance, especially when we look to the difficulties attendant upon its production. These difficulties are both of a financial and literary character—the various valuable articles consisting entirely of voluntary contributions—and it is to be feared that not all the members of this Society sufficiently realize or ponder these great difficulties. It must be a source of congratulation to the Editing Committee that they have been enabled to publish the volume within the year—a feat not always accomplished either by the *Naturalist*, or by the publications of sister societies in the Dominion. We need but look at the varied and valuable contributions in this volume to be satisfied that it has not been surpassed by any before it. And what will be considered a very gratifying fact is, that the original articles of the *Naturalist* are now copied *in extenso* in some of the scientific journals of the Mother Country and the United States. Thus, not less than six of these articles of the last volume have been wholly reproduced in the London *Scientific Opinion*, to wit, two by Dr. Edwards, one by Dr. Hunt, one by Mr. Ritchie, and two by Dr. Smallwood. Articles and the monthly proceedings of this Society are also copied in *Nature* and other periodicals. This important testimony to the value of the book must needs prove especially gratifying to those engaged in this labor of love, and should stimulate members to extend to the journal a more general and earnest support.

I would ask leave to bring before you here a list of the original papers read by members during the past year, some of which appeared in the *Naturalist* and reappeared, as I have said, in English periodicals. These are in addition to the interesting lectures given in the Sommerville course, which have been six in number, and which I will enumerate first:—

1. Feb., 10th, 1870. "Explorations in the Nipigon Country," by Professor R. Bell, C.E., F.G.S.

2. Feb. 17th. "Recent discoveries in Solar Physics, and the total eclipse of August 7th, 1869," by James Douglas, jr., President of the Literary and Historical Society, Quebec.

3. Feb 24th. "The Chemistry of Iron and Steel," by Dr. T. Sterry Hunt, F. R. S.

4. March 10th. "On Deep Sea Dredging," by Principal Dawson, L.L.D., F.R.S.

5. March 17th. "On Gold," by Dr. G. P. Girdwood.

6. March 24th. "On Economic Mineral Deposits," by G. Broome, Esq., F.G.S.

I will notice and classify the papers read as follows:—

I. GEOLOGY.

Principal Dawson's paper on "some new Gaspé fossils," after giving a general sketch of the geology of the peninsula of Gaspé, adds some newly acquired information as to the fossil plants of the Devonian rocks of that locality, and records the occurrence in these beds of fossil fishes of the genus *Machairacanthus*, also of the genus *Cephalaspis*,—the first time this latter genus has been observed in America.

Mr. Billings has contributed two papers in the department of palæontology. In the first, he shows that the puzzling fossils called *Scolithus* and *Arenicolites* are not the burrows of marine worms, as was formerly supposed, but casts of sponges. In the other, he states that marine univalve molluscs, of the genus *Ophileta*, occur in beds several thousand feet lower down in the geological series than had been hitherto recorded.

II. ZOOLOGY.

Mr. A. S. Ritchie has brought before the Society three suggestive papers in this department of Natural History. In the first, the history of the introduction of the white cabbage butterfly, from Europe to the immediate vicinity of this city, is given. A careful description follows of the species in its three stages, with its peculiar habits, and suggestions are offered as to the best means to be adopted to check the ravages of the caterpillar of this species in our fields and gardens. The second attempts to answer the difficult question: "Why are insects attracted to artificial light?" The third is an interesting account of the habits of some of our smaller fresh water fishes, reptiles, and crustaceans, as observed in the writer's own aquarium.

Professor R. Bell has contributed observations on the Zoology and Botany of the Nipigon country, a district rarely visited by the naturalist. It is to be regretted that when parties are sent by the Geological Survey to explore places of which little is known, that a Zoological and Botanical investigation of the region in question should not, as in the United States, be made in addition to the Geological Survey. Professor Bell also read a paper on the intelligence of animals. It seems a task of no ordinary difficulty to define where animal instinct ends, and the reasoning power is clearly seen to commence.

The recent dredgings by Mr. Whiteaves in the Gulf of the St. Lawrence, have added many facts to our knowledge of the creatures which inhabit Canadian seas. The marine mollusca have been carefully monographed, and instead of 60 or 70 species, we now know of nearly 130, the number having been thus nearly doubled. The careful identification of the inhabitants of the deep sea, in addition to its Zoological importance, will do much to illustrate the conditions under which the Canadian post-tertiary peposits have been accumulated.

Dr. P. P. Carpenter has given a verbal account of the recent dredgings by Mr. McAndrew, in the Red Sea, those of Captain Pedersen in the Gulf of California and by Mr. Dall in Alaska.

III. GENERAL.

The peculiar appearances of the rose-coloured prominences of the Sun's chromosphere during the solar eclipse of last August, have been described in detail in a paper read by Dr. Smallwood. On that occasion I referred to the want of good astronomical instruments in the city, and now revert to it as a circumstance much to be deplored by those interested in the progress of physical science in our midst.

Besides the subjects already mentioned Dr. Carpenter favored the Society with two papers. The first on the Vital Statistics of Montreal for 1869; with special reference to the great disproportion in death rate between the French, the Irish, and the English portions of the population. And the second, on different modes of computing Sanitary Statistics, with special reference to the opinions lately published by Mr. Andrew A. Watt.

Although not issued under the immediate auspices of the Natural History Society, yet I may be permitted here to refer to a publication emanating from one, of whose valuable services to this society and to education generally, we can never too highly or too gratefully speak; one who, with our President, shares largely the respect and applause of the scientific world—I need scarcely say I refer to Principal Dawson, whom we trust to see soon among us again, occupying the highest place in the directorship of this Institution, for its benefit, and our gratification. The issue of the text-book of Canadian Zoology during the past year, must be a matter of congratulation to all members of this Society. The want of such a volume has been long felt, and the name of Principal Dawson is in itself a sufficient guarantee of the able way in which the subject has been treated. Let us hopefully look forward to a new edition, in which further details respecting the vertebrata of Canada will be included.

The list of papers just recited may be fairly regarded as evincing the desire of members to carry out as fully as possible the objects of the Society in one direction; but they have not been idle in others. One of their efforts to advance the study of natural science in the past year, and which is most likely to be crowned with usefnl and beneficial results, was their determination to avail themselves of an offer made them by their esteemed curator, Mr. J. F. Whiteaves, to place his private collection of shells and fossils in the Society's museum, in such a way as to be accessible to students and visitors, on the very liberal conditions that the collection be kept separate—that the Society find cabinets, &c., for its reception, and insure the collection, Mr. Whiteaves himself undertaking to mount and label the specimens. In availing themselves of such an offer, and voting the amount required to carry out its conditions, the Society was merely doing what other Societies in the mother country have done before them, and in this way: Possessors of a large and valuable collection which they were unable or unwilling to part with entirely, and still desired that the votaries of science generally should benefit by, would offer to deposit, uuder certain restriction, their collection in the museum of a society such as ours, which not having present means to acquire a valuable collection, would only be too glad to avail themselves of such an offer, and thus the cause of science would become well served. Now, although Mr. Whiteaves deposits his collection in this way, and retains the right of withdrawing it after notice be given to that effect, yet I am sure I do but echo the general opinion that the Society is greatly indebted to that gentleman for his liberal and considerate offer, and indulge the hope that ultimately both Mr. Whiteaves and the Society will find the way of securing his unusually valuable and varied collection as a permanent addendum to the Society's Museum.

Another of the members' efforts in the good cause calling for notice on this occasion, was the originating of the Montreal Microscopic Club. Although formed in 1868, this Club has not hitherto received the notice at our annual retrospects of work done, which I think it deserves. Founded for the promotion of microscopic knowledge among its members, by regular meetings for practical microscopic work, and for the interchange of ideas and experiences on microscopical subjects, it has done good and useful work at its fortnightly meetings, which are eminently of a social character, and are held during the winter season. I need scarcely say here how very acceptable we find the presence of our microscopic-brigade, with their costly, improved instruments and beautifully prepared specimens, at our annual conversazione, and how pleasant we regard the evidences of their useful investigations, not merely on those occasions, but in the pages of the Society's journal and in other directions. In England, such clubs have proved very useful and successful. The *modus operandi* is very simple, and is thus described by the honorary secretary of our Montreal organization. "The club appoints a secretary, who arranges for the meeting, and suggests a special subject for illustrations 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 investigations 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." The chairman of the Council, in his report, will doubtless refer to the Society's more general social reunions, the field day at Belœil, and the annual conversazione, both of which were very successful. The latter occasion was distinguished by the presence of His Royal Highness Prince Arthur, to whom the Society presented an address. It was cause of great regret to the Committee to feel that, while they could safely direct the special attention of the Prince to the museum, at the extent and arrangement of which, indeed, His Royal Highness expressed to me much gratification and approval, they felt more than ever, that the library might be considered as displaying evidence of apathy and neglect—evidences which it is earnestly hoped will soon give way to others of a more fitting and gratifying character.

One of the most important measures contemplated by the Society outside its immediate sphere of action, during the past year, is the dredging of the Gulf and River St. Lawrence. Those who were privileged to hear Dr. Dawson's most interesting lecture on deep sea-dredging, delivered during the past winter's Sommerville course, will need no farther exposition of the importance for pursuing such investigation, as will certainly not those who have attentively read the proceedings of the last meeting of the British Association at Exeter. Professor Forbes had previously surmised as a result of his investigations in the Ægean and Mediterranean Seas, that life probably did not exist in the sea below 300 fathoms in depth. His views never received, however, anything like general acceptance with scientific men, and at that Exeter meeting, a most interesting letter was read from Professor W. Thompson on the successful dredging of H.M.S. "Porcupine," in 2,435 fathoms. Professor Sars, in a communication on the distribution of animal life in the depths of the sea, has enumerated not less than 437 species; and as a result of an expedition originated by the British Government, who sent the "Lightning" to dredge in the sea between the Hebrides and the Faroe Islands, we learn —and especially from an account of the expedition, given by Dr. Collins, in the Transactions of the Royal Society—that there were found to be currents of different temperature running side by side. In one place the temperature of the surface was 54°, and at the bottom 48°, and in the other the surface was 54° and the bottom 38°. Dr. Collins considered that one was the back current of the water that had coursed from the tropics to the poles. These and many other interesting facts which time will not permit me to notice, however briefly, on this occasion, may be some warrant for the desire evinced by the Society to do its share of labour in this field, and would be sufficient apology, if any were needed, for the resolutions unanimously adopted by the Society in March last, which affirmed it to be important to the cause of science and conducive to the interests and reputation of this Dominion, that researches by dredging should be prosecuted in the Gulf and River St. Lawrence, in order to ascertain the character of marine life in the greater depths and at the confluence of the fresh and salt waters of the river. And as this Society and individual members thereof, have so far entered upon such researches as to prove their feasibility and importance, but have not the means of continuing them effectually, the Society was of opinion that aid should be afforded to such operations by the government, in the manner in which this has been done in Great Britain and other countries, especially by giving for a short time in summer, facilities on board a government vessel to a party to be furnished and fitted out by this Society, which would undertake to procure observers and scientific apparatus and make reports upon such results as might be obtained. A committee, consisting of Drs. Smallwood, P. P. Carpenter, and Messrs. E. Hartley and J. F. Whiteaves, was organized to correspond with the Dominion Government, through the Hon. the Minister of Marine, with the view of effecting the desired results, and Principal Dawson has been requested, while in London, to obtain information as to the best methods of making such subsidiary observations on the temperature, chemical quality, &c., of the water at great depths, as have been made by the recent dredging operations under the auspices of the British Government, and, if possible, to procure specimens of the necessary apparatus. I will only say further on this subject that the committee have already taken steps in the matter, which may be safely left in their hands for a successful issue, and should—which is by no means impossible—the Government decline to allow our investigators a free passage in one of their ordinary cruisers, it will then become the duty of this Society to decide whether they themselves will provide the necessary means for the investigations contemplated by the resolutions, which would really not involve a very large expenditure.

I have already detained you so long, that I must leave for some other occasion a few minor topics on which I had proposed to say a few words. Permit me, before sitting down, to ask your earnest attention to the important matters referred to in the reports about to be read, and your cordial co-operation, not merely with reference to the details of those reports, but in all that can subserve the interests of the Natural History Society, and verify and realize its motto—TANDEM FIT SURCULUS ARBOR.

The Chairman of the Council (Dr. J. Baker Edwards, F.C.S.,) then submitted the following :—

REPORT OF THE COUNCIL,

May, 1870.

In reviewing the scientific work of the past Session, your Council feel it especially due to the active members of the Society to recognize the valuable contributions placed on the Society's record, and which they believe will be found equal, both in value and general interest, to those of any preceding session.

Your Council have felt increasingly, of late years, the desirability of popularizing the proceedings of the Society as much as possible, so as to interest a larger number of members in the objects. To accomplish this they have established field meetings; invited ladies to join the Society as associate members; added to the attraction of the annual Conversaziones; secured more comfortable accommodation for their guests; and popularized the character of their scientific periodical, "The Canadian Naturalist."

They cannot but feel, however, that the response to their efforts has been but of a partial character, and much has yet to be done to establish that "*entente cordiale*"—that "*corps d'esprit*" amongst the members which actually prevails in European societies of a like nature.

It is also a matter of regret that a succession of our wealthy and influential citizens are retiring from the annual subscription list, without placing their names upon the life members' roll, a course your Council would strongly recommend to those who desire to retire from active participation in the Society's affairs. A sufficient loss is felt by the Society even by such retirement; and the withdrawal of some fifteen members from active subscription to and interest in the work of the Society, to the roll of life membership, forms a serious episode in the history of the present year, as it too often follows that life members lose some of their interest in the practical working of a voluntary association.

A vigorous effort has been made during the past two years to extinguish the debt upon the building, and this effort has been attended with considerable success. The mortgage debt on the building amounts to $2,600, and towards this $1,630 have already been promised, and it behoves the earnest friends of the Society to raise the balance if possible during the present year. In the meantime it is absolutely necessary to pay some attention to the drainage of the building, which is now flooded in the winter, and to paint and whitewash the premises; and it may be necessary to devote some portion of this subscription to the temporary use of putting the premises in necessary repair. The Council, therefore, feel the necessity of a renewed effort towards the liquidation of this debt, and also to replace on the roll of annual subscribers the number of members who, from various causes, have retired therefrom.

Our losses have numbered thirty subscribers during the past session, whilst we have added only seven to the list. The number of lady associates we regret to say has not been extended. An appeal is therefore necessary to existing members to add to the ranks of the Society.

Theoretically, subscriptions are due in advance, in order to meet the current expenses of the year, but practically, members are apt to defer their payments, so that the income of the year becomes a debt instead of an asset. This practice is a source of embarrassment to the Treasurer, which your Council trusts will not become chronic.

Again, the "Naturalist" is a charge upon the Society of a grave character. In addition to the 100 copies purchased for the members, the Society distributes, for the purpose of exchanges, about 70 copies gratuitously. It is quite necessary, therefore, that the subscription list should be free from arrears. At present 30 subscriptions only have been received out of a list of 85. The Council feel that it will be impossible for them to maintain the efficiency of this periodical, in which they take a literary pride, unless supported by the prompt discharge of those obligations which the subscribers have undertaken, and upon the good faith of which the Council have assumed the responsibility of its publication.

Three objects present themselves to your Council as most desirable to secure, and they commend their consideration to their successors, viz :—

1st. The funding of the Somerville bequest, so as to apply the interest thereof to the extension and success of the Somerville lectures.

2ndly. The discharge of the debt on the building, so as to enable the Society to be rent free.

3rdly. The appropriation of the Government grant to the main tainance and increased efficiency of the "Canadian Naturalist" and to the extension of the museum.

In order to secure these objects, your Council desire to see the current expenses of the Society borne by the annual income by subscription, and to this end feel the necessity of a large accession to the list of members and associates.

Your Council have been called upon to relinquish the services of their faithful janitor and skilful taxidermist, Mr. W. Hunter, under the painful circumstances of failing health and of domestic bereavement; and it has been a matter of anxious consideration whether his valuable services can be replaced.

The retirement of Sir Wm. Logan from the direction of the Geological Survey, has deprived the Society of his valuable presence and aid in the Presidental Chair; but your Council desire to express their obligations and thanks to the Senior Vice-President, Dr. DeSola, who has so efficiently filled his place during the present session. In his able hands the Council have left the review of the ordinary business of the past session.

The extraordinary meetings, with which so much pleasure was combined with science, were the charming excursion to Belœil, on the 9th June, to the success of which Dr. T. Sterry Hunt so largely contributed; and the Conversazione of 9th March, when the Society had the honor of receiving H.R.H. Prince Arthur. It is to be regretted that, whilst great efforts were made upon these occasions to interest the members, the amount of their response did not accomplish a financial success. The excursion prize was awarded to Miss I. McIntosh, for a large collection of named species, and juvenile prizes were awarded to Master R. Dawson and G. T. Robinson. Very creditable gatherings were also made by Master R. Lewis and E. P. Peavey. Full reports of these agreeable re-unions will be found in the "Naturalist."

Your Council has accepted the offer of our esteemed Curator, Mr. Whiteaves, to deposit his valuable private collection of shells and fossils in the Museum of the Society, for the inspection of members and students, which will add greatly to the attraction of the Society's collection.

The Council, in retiring, desire to acknowledge the very valuable services of their active officers, who have carried through the business of the session.

J. BAKER EDWARDS,
Chairman.

After which, Mr. Whiteaves read the following:—

REPORT OF THE SCIENTIFIC CURATOR.

In consequence of the protracted ill health of our taxidermist, Mr. Hunter, also, in some measure, from the want of funds, my attention, so far as the Museum has been concerned, has been almost exclusively devoted to the lower animals, and to the Society's collection of fossils. Consequently, not many new mammals or birds have been added during the past session. A fine example each of the Canadian Otter, from Gaspé, and of the White-Bellied Mouse, from Labrador, have been added to our series of mammals. Six weeks, during the past summer, were spent in careful dredging round the peninsula of Gaspé, and the results obtained are of considerable interest and importance. So many specimens were obtained that the whole of the material has not yet been worked up. Commencing with the molluscs, 16 species, new to Canada, one of which is new to science, were procured. This group of animals has been very closely studied; and where there were any doubts about the identification of species, the specimens have been sent to the best English authorities. An exhaustive monograph of the sea shells inhabiting the river and gulf of the St. Lawrence, has been published in the last volume of the "Canadian Naturalist." In it 118 marine shells and 5 naked molluscs are described as inhabiting the seas of Canada.

only about 65 species being previously recorded. Thus the dredging expeditions of 1867 and 1869 have just doubled the number of species previously known to occur in our waters. These Gaspé species are, in many instances (say 50 per cent. of the whole), conspecific with those discovered by Moller in Greenland, and described by him. Unfortunately, Moller's work on the shells of Greenland (published in Denmark) is very rare and out of print. Not having access to the work, my Gaspé shells have nevertheless been carefully compared with specimens in the British Museum and in the cabinets of Messrs. Jeffreys & Hanley, which had been named and distributed by Moller. The importance of such identifications will be apparent, not only to the student of Canadian zoology, but also to those interested in the study of Canadian post-pliocene fossils.

Twelve additional species of crustacea, mostly small species, were obtained in these dredgings, named species of each of which will be found in their proper place in the museum.

The Canadian Marine Polyzoa have been submitted to a careful microscopical investigation, and the whole of the collection, including many recent additions, have been re-mounted and labelled. The recent receipt of an elaborate monograph of the recent Bryozoa of Scandinavia, by F. A. Smitt, published by the Royal Society of Stockholm, will, however, necessitate a re-study of this group. The Foraminifera obtained in the recent dredgings have been also subjected to microscopical examination, and, so far, 22 species or varietal forms have been observed. It is proposed to mount a series of the larger species for the collection, and a number of Canadian and exotic specimens have been put aside with that end in view. Materials are being collected for a paper on the distribution of the Marine Protozoa of the River and Gulf of the St. Lawrence which will embody some of the results of both Principal Dawson's and my own collections and study.

Several rare sponges and other marine animals, especially Hydrozoa, have been added to our fauna, but these have not yet been worked up. Duplicates of the rarer Canadian sea shells have been sent to well known collectors in England, in exchange for other specimens. In this way we have received a fine series of English cretaceous and crag fossils (about 80 species), and hope shortly to receive other interesting specimens which have been promised. The fossils above alluded to have been mounted and labelled.

I have concluded to place my own collection of recent shells and

British Jurassic fossils, under certain restrictions, in the Society's Museum, so as to make it available for purposes of reference.

A large proportion of time during the past session has been devoted to the editing of the "Canadian Naturalist." Delays in the appearance of the journal have occurred more frequently than might be wished, this has been owing to the difficulty of getting sufficient original matter in time. It is hoped that the volume for the past year. notwithstanding some almost inevitable shortcomings, is, nevertheless, on the whole, creditable alike to the Society and to the Editing Committee. Attention has been given, as in former years, to the publication of abstracts of our proceedings in the public press, and in the "Naturalist." Copies of these reports have been punctually sent to the scientific journals in England, by whom they have been reprinted. In the library, as much work has been done as our limited means would allow; a few standard works have been added; some of our incomplete sets of periodicals have been completed and bound; and the two new microscopical journals, so far complete, have been added.

J. F. WHITEAVES, F.G.S., &c.

The following financial statement was submitted by the Treasurer, James Ferrier, jr. :—

DR. THE NATURAL HISTORY SOCIETY OF MONTREAL IN ACCOUNT WITH JAMES FERRIER, JR., TREASURER. CR.

1869 '70.	
To Cash paid Mr. J. F. Whiteaves, salary	$400.00
" " Mr. Hunter "	200.00
" " J. E. Pell, Commission on Collections	40.00
" " Interest	120.00
" " For Coal and Wood	167.12
" " Gas Bills	22.82
" " City Taxes, $46.40, and Water account, $40.65	40.65 46.40
" " Insurance	39.00
" " Repairs and Petty Expenses	192.35
" " Books, Printing and Advertising	173.73
" " Balance Excursion account	9.35
" " " Conversazione	66.92
" " For "Naturalist," 100 copies	200.00
1870, May 1.	
To Balance in Treasurer's hands, towards liquidation of mortgages on Building	886.15
	$2604.49

1869, May 1.	
By Balance in Treasurer's hands	$ 60.99
1869 '70.	
By Donations towards Liquidation of Debt	875.00
" Government Grant	750.00
" Members Yearly Subscriptions	780.00
" Subscriptions to "Naturalist"	30.00
" Museum Entrance Fees	21.00
" Rent of Lecture Room	37.50
" Life Member's Subscription—J. T. Molson	50.00
	$2604.49

STATEMENT OF LIABILITIES OF THE SOCIETY,

MAY 1, 1870:

Mortgage on the Society's Building, favor Royal Institution	$2000.00
Samuel Robertson's Account, Carpenter Work	16.20
Thomas Robinson's " Glazing	13.71
Gas Account	15.84
	$2045.75

Errors and Omissions excepted,

JAMES FERRIER, JR.

Montreal, 1st May, 1870.

It was then moved by Dr. John Bell, seconded by E. E. Shelton, and unanimously resolved:

"That the reports just read be adopted, printed and distributed to the members."

The following resolution, having been moved by John Leeming and seconded by Dr. Smallwood, was carried by acclamation:

"That the thanks of this meeting and of the Natural History Society be presented to Rev. Dr. De Sola, acting President, for his able and interesting address, also to the officers of the Society for the past session, and especially to Mr. J. F. Whiteaves as Scientific Curator, and for the deposition of his valuable collection of shells and fossils in the Society's Museum under the very reasonable restrictions which he has placed thereunto."

The following gentlemen were elected officers for the session 1870-71, Messrs. Ritchie and Marler acting as scrutineers.

OFFICERS FOR 1870-71.

President.—Principal Dawson L.L.D., F.R.S.

Vice-Presidents.—Dr. T. Sterry Hunt, F.R.S.: Rev. A. De Sola L.L.D.: Dr. P. P. Carpenter: E. Billings F.G.S.: C. Smallwood, M.D., L.L.D., D.C.L.: A. Selwyn: John Leeming: G. Barnston: Sir. W. E. Logan L.L.D., F.R.S.

Treasurer.—On motion of Dr. T. Sterry Hunt, seconded by Dr. Trenholme, James Ferrier Esq. Jun. was re-elected by acclamation, the form of balloting being dispensed with.

Corresponding Secretary.—Prof. P. J. Darey M.A., B.C.L.

Curator and Recording Secretary.—J. F. Whiteaves F.G.S., &c.

Council.—G. L. Marler: D. A. P. Watt: M. H. Sanborn: A. S. Ritchie: J. H. Joseph: D. R. McCord, M.A., B.C.L.: Dr. J. Baker Edwards F.C.S.: Champion Brown, and E. Hartley F.G.S.

The library and membership commitee of the past session were re-elected.

It was moved by Dr. T. Sterry Hunt, seconded by E. Hartley and duly resolved:

"That the meeting do now adjourn."

GEOLOGY AND MINERALOGY.

Cephalaspis Dawsoni.—Mr. E. Ray Lankester describes this species in the *Geological Magazine* for September as follows:—

Principal Dawson, of Montreal, Canada, has placed in my hands for description a remarkably interesting specimen, indicating a species of the genus *Cephalaspis* in transatlantic Silurio-Devonian beds. He writes, "The specimen was found by one of my assistants, Mr. G. T. Kennedy, B.A., when collecting with me, in a bed charged with remains of *Psilophyton*, on the north side of Gaspé Bay. The geological horizon is below the middle of the Gaspé Sandstones, but several hundreds of feet above their actual base, so that the specimen may be regarded as either Lower Devonian or Lower Middle Devonian. It occurred in beds containing *Psilophyton princeps* and *P. robustus*, and also drift-trunks of *Prototaxites Logani*, the latter in the sandstones associated with the coarse shaly bed containing the *Cephalaspis*. In these sandstones there are also spines of *Machairacanthus sulcatus* of Newberry—a large fish characteristic of the Devonian of Ohio. No marine remains were found in the bed holding the *Cephalaspis*, which is blackened with vegetable matter and holds many fragments of land plants; but in shales at no great vertical distance there are shells of *Lingula* and *Modiomorpha*, resembling species found in the Hamilton group of New York."

The specimen presents in slight relief a small *Cephalaspis*, with head-shield and greater part of the body, and is much flattened. The shield appears to be larger in proportion to the body than in any British species. The orbits are not shown, and the matrix has not preserved the scales of the body with much distinctness, though it is possible to make out the lateral and marginal series. No trace of pectoral, dorsal, nor caudal fins is to be made out. This species clearly belongs to the section *Eu-cephalaspis* as defined in my Monograph of *Cephalaspidæ*. Its best character as a species is to be found in the very fine, almost granular, tubercles which are preserved on some parts of the surface, and represent the apparently universally present tubercular ornament of the *Osteostraci*. These fine tubercles are more minute than on any British *Cephalaspid*, and, though seemingly not very well shown in this specimen, furnish a specific mark. Amongst other fragments from this bed, which Dr. Dawson has submitted to me, is a small piece of tubercle ornament, possibly belonging to the same species of *Cephalaspis*. In this, the tubercles are very sharply moulded and nearly hemispherical. Various other fragments which cannot be identified, but are probably bits of fish bones, etc., are amongst the collection.

A very fine fish-spine—the *Machairacanthus sulcatus*—was also obtained in the sandstones associated with the shale which furnished the *Cephalaspis*. This sandstone is not unlike the sandstone of Glamis, and other parts of Perthshire and Forfarshire which furnish *Cephalaspis*; whilst the shale strongly recalls the Forfarshire shale, which has furnished Mr. Powrie with his beautiful *Cephalaspis Pagei*.

The spines which occur in the Cornstones of Herefordshire, which have not yet been worked out, are of various forms and are usually "lumped" as *Onchus*. None, however, appear to resemble *Machairacanthus*, with its remarkable keeling like the petiole of a sweet-pea. I propose to call the new American *Cephalaspis* after the illustrious geologist who has allowed it to be figured here: *Cephalaspis Dawsoni*.

EMBRYOLOGY OF LIMULUS.—Dr. Packard has presented to the American Association a very interesting account of the early stages of the development of the *Limulus polyphemus* of the American coast. In one of its earlier stages it bears a remarkable resemblance to such Trilobites as *Trinucleus*. In a subsequent stage the abdominal segments became consolidated, and it resembles not the adult but the larva of *Trinucleus*. The development in these two groups is thus in opposite directions—that of Limulus tending to the consolidation of the abdominal segments, that of Trilobites to the addition of new segments between the original head (cephalothorax?) and abdomen. In this way Dr. Packard's facts raise new questions as to the grade and affinities of Trilobites, especially when taken in connection with Mr. Billings' observations as to their feet. The alliance between the two forms is evidently very close. Dr. Packard thus sums up his conclusions:—

Conclusions.—The eggs are laid in great numbers loose in the sand, the male fertilizing them after they are dropped. This is an exception to the usual mode of oviposition in Crustacea;

Squilla and a species of *Gecarcinus* being the only exception known to me to the law that the Crustacea bear their eggs about with them. Besides the structureless, dense, irregularly laminated chorion, there is an inner egg membrane composed of rudely hexagonal cells; this membrane increases in size with the growth of the embryo, the chorion splitting and being thrown off during the latter part of embryonic life. Unlike the Crustacea generally the primitive band is confined to a minute area, and rests on top of the yolk, as in the spiders and scorpions, and certain Crustacea, *i.e.*, *Eriphia spinifrons*, *Astacus fluviatilis*; *Palæmon adspersus*, and *Crangon maculosus*, in which there is no metamorphosis.

The embryo is a Nauplius; it sheds a Nauplius skin about the middle of embryonic life.

This Nauplius skin corresponds in some respects to the "larval skin" of German embryologists.

The recently hatched young of Limulus can scarcely be considered a Nauplius, like the larvæ of the Phyllopoda, Apus and Branchippus, but is to be compared with those of the trilobites, as described and figured by Barrande which are in *Trinucleus* and *Agnostus* born with only the head and pygidium, the thoracic segments being added during after-life. The circular larva of *Sao hirsuta*, which has no thorax, or at least a very rudimentary thoracic region, and no pygidium, approaches nearer to the Nauplius form of the Phyllopods, though we would contend that it is not a Nauplius.

The larva passes through a slightly marked metamorphosis. It differs from the adult simply in possessing a less number of abdominal feet (gills), and in having only a very rudimentary spine. Previous to hatching it strikingly resembles *Trinucleus* and other trilobites, suggesting that the two groups should, on embryonic and structural grounds, be included in the same order, especially now that Mr. E. Billings* has demonstrated that Asaphus possessed eight pairs of five-jointed legs of uniform size. The trilobate character of the body, as shown in the prominent cardiac and lateral regions of the body, and well marked abdominal segments of the embyro, the broad sternal groove, and the position

*Proceedings of the Geological Society of London. Reported in "Nature." June 2, 1870. In this communication Mr. E. Billings announces the important discovery of a specimen of *Asaphus platycephalus*, showing that the animal possessed eight pairs of five-joined feet, widely separated as their insertions by a broad sternal groove.

and character of the eyes and ocelli, confirm this view. The organization and the habits of Limulus throw much light on the probable anatomy and habits of the trilobites. The correspondence in the cardiac region of the two groups shows that their heart and circulation was similar. The position of the eyes shows that the trilobites probably had long and slender optic nerves, and indicate a general similarity in the nervous system. The genital organs of the trilobites were probably very similar to those of Limulus, as they could not have united sexually, and the eggs were probably laid in the sand or mud, and impregnated by the sperm cells of the male, floating free in the water.

The muscular system of the trilobites, must have been highly organized as in Limulus, as like the latter they probably lived by burrowing in the mud and sand, using the shovel-like expanse of the cephalic shield in digging in the shallow palæozoic waters after worms and stationary soft bodied invertebrates, so that we may be warranted in supposing that the alimentary canal was constructed on the type of that of Limulus, with its large, powerful gizzard and immense liver.

Cope's Synopsis of the Extinct Batrachia and Reptilia of America.—The second part of this admirable monograph has appeared, and includes the known species of fossil Birds, in addition to the reptiles. It affords an invaluable guide to the student of American Fossil Reptilia, and places for the first time before those who have been engaged in this study, a conspectus of what is known, with the addition of many new discoveries, and profound general observations of the author, who has long been engaged in studies of this kind, more especially in New Jersey and Pennsylvania, and has made himself completely master of his subject. Prof. Cope thus states in his preface his aims and results:—

"It is not designed in the present essay to give descriptions of the known remains of the Batrachia, Reptiles and Birds, which have been more or less fully made known by others. This is left for the day when our knowledge shall more nearly approach completeness. While the subject is in its infancy, I have thought best to describe only those species and types which are new, and those portions of imperfectly known forms which will throw additional light on their relations and affinities. In adhering to this plan, I have been able to add no little to the history of the

Reptiles already described by my predecessors—Leidy, Owen, Dawson, Wyman, Lea, etc. Where, however, I have had nothing to add, I have referred to their published descriptions, which are numerous and well-known. The literature of the subject will then be found under the respective specific heads."

"In the course of these investigations, prosecuted during the past six years, with reference to the structure and relations of the extinct Reptilia, the following general conclusions have been attained to, besides many of lesser significance.

First—That the Dinosauria present a graduated series of approximations to the birds, and possess some peculiarities in common with that class, standing between it and the Crocodilia.

Second—That serpents exist in the Eocene formations of this country.

Third—That the Chelydra type was greatly developed during the American Cretaceous, and that all the supposed marine turtles described from it are really of the first named group.

Fourth—That the Reptilia of the American Triassic are of the Belodon type.

Fifth—The discovery of the characters of the order Pythonomorpha.

Sixth—The development of the characters of numerous members of the Batrachian Sub-order Microsauria in the United States."

Marine Crustaceans in Lakes.—Several years ago Prof. Loven discovered in fresh-water lakes in Sweden forms of crustacea previously found only in the sea, and inferred that these species had been left behind in the upheaval of the land, and were thus living witnesses of the great subsidence and re-elevation of the land in the Post-pliocene period. It was, we believe, suggested at the time in this Journal that our Canadian Lakes afforded an admirable opportunity to extend these observations; but in so far as we know this has not been done until last summer, when Dr. Stimpson, by dredging in the deeper parts of Lake Michigan, obtained a species of *Mysis* closely allied to one of the Swedish species; thus apparently indicating a former marine condition of the basin of our great lakes. The subject deserves further attention, and would well repay the exertions of any of our Canadian naturalists residing in the vicinity of the lakes, in the deeper parts of which the dredge would no doubt discover many curious forms of aquatic life, which, if of marine types, might be of great interest with reference to the history of this continent in the Post-pliocene period; and might also help to account for some of the alleged migrations of the fishes of the lakes. Such facts might also illustrate the possibility of the continued residency in lakes of fishes usually migrating to the sea, since in the depths of the lakes they might find food similar to that which they could obtain by visiting the ocean.

Figures of Characteristic British Fossils.—The second number of this extremely useful work, by Mr. Bailey, of the Geological Survey of Ireland, appeared some time ago. It continues the series of illustrations up to the Wenlock; and is most interesting and useful to Canadian students, as showing in the clearest manner to the eye the similarity of the succession of fossils in the series in Britain and in this country. Being composed almost entirely of names and figures, the work does not afford materials for quotation, but as a means of comparison it should be in the hands of all students of Canadian geology. Besides the figures and lists of species, there are useful introductory explanations of the structure of the principal types of fossils, with the terms applied to their parts.

BOTANY AND ZOOLOGY.

British Edible Fungi. — Mushrooms and their congeners seem never to have been in good repute since Agrippina employed one of the tribe to poison her husband, and Nero with villanous pleasantry called it the "food of the Gods." With proverbial tenacity the bad name thus incurred has clung to the whole family of Agarics, and what within certain limits might be called a wholesome dread has become a deep-rooted and irrational prejudice, excluding from popular use a really valuable class of vegetable esculents. We cannot altogether go along with those enthusiastic mycophagists who recognize a substitute for meat in every edible fungus, and dilate on the ozmazome and other nutritious properties of the tribe; but we readily acknowledge that their merits as secondary sources of food-supply have hitherto been unduly neglected. The great difficulty always felt in advocating the claims of the class to more extensive use has arisen from the want of some definite rules, some formula at once simple in expression and universal in application, by which to distinguish the noxious from the innocent members. Pliny, in his Natural History, goes so far as to say that the first place amongst those things which are eaten with peril must be assigned to agarics, and he expresses his surprise at the pleasure which men take "in so doubtful and dangerous a meat." But his observations show that fungi of all sorts, including even such growths as the *Fistulina hepatica*, were known to his countrymen and eaten by them without scruple. Indeed, in one particular the wisdom of the ancient Romans seems to have been superior to that of their descendants, for, while Horace lays down the rule:—

Pratensibus optima fungi
Natura est; aliis male creditur—

the modern Ædiles of the Roman market condemn to instant destruction every specimen of the meadow mushroom (*A. campestris*) which comes within their reach. Although, however, it is not always easy to distinguish the wholesome from the unwholesome fungus, and the organs of sight and smell require some training before they can be wholly trusted in the matter, yet the dangers have been greatly exaggerated, and, as a matter of fact, hogweed is more often mistaken for parsnip and aconite for horse-radish than are *Boletus satanas* and *Amanita verna* for their innocent brethren. No better opportunity for engaging in the study of this branch of natural history could be found than that which the present season affords; and if the treatises of Mr. Berkeley, Dr. Badham, or Mr. Worthington Smith be not at hand, the following notes on the chief edible fungi which are now to be met with may prove acceptable to some of our readers.*

With the ordinary meadow mushroon (*A. Campestris*) and its near relative the horse mushroom (*A. arvensis*), every one is familiar, and both of them have occurred in profusion this autumn. Against the latter an unfounded prejudice prevails in some districts, but its larger size and coarser texture require only a

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* At the conclusion of "Mushroom Culture, its Extension and Improvement" (London: Warne, 1870), Mr. W. Robinson gives some useful information, derived chiefly from the above authorities, and from the Proceedings of the Woolhope Field Club.

little extra cooking to develop the flavour and correct indigestibility. In spite of all that has been said to the contrary, we maintain that these agarics are entitled to the first place, and for the second much rivalry exists between the orange-milk mushroom (*Lactarius delicious*) and the Parasol Agaric (*Agaricus procerus*). Both are readily distinguishable, and may be eaten with equal impunity. The former is chiefly found in plantations of Scotch fir and larch, is of an orange-brown colour, and firm flesh, and yields, when bruised, an exudation of orange-red milk, which turns green after a few minutes' exposure. The latter is common in the pastures, and may be recognized by its tall habit, the stalk gradually enlarging at the base, the umbo of a brownish colour with spots or patches, and the gills white and unconnected with the stem. The plum mushroom (*A. prunulus*) is for the autumn months what the St. George's mushroom (*A. gambosus*) is for the spring—a large fleshy fungus, delicate in flavour, though not so choice as the *Orcella*, for which it is often mistaken. It is to be found in shady places pretty generally throughout England, and is conspicuous from its whiteness. The gills are close together and of a pale rosy hue, and the smell of the plant has been compared to that of fresh meal.

We must mention two other fungi, common enough and easily recognised, but of their culinary virtues we do not entertain a very high opinion. These are the puff-ball, and the maned agaric (*Coprinus comatus*). The former needs no description, and perhaps others may be more fortunate than we have been in detecting the latent flavour of omelette which it is said to possess. The latter is called by Dr. Bull the "agaric of civilisation." We have met with it in farm yards, on lawns, on railway-cuttings, and, in fact, in nearly every waste place. It looks like an attenuated cocoon, snow-white at first, but gradually changing in colour and splitting upwards in a dozen places. The gills, white at first, become pink and then black; the last stage, which is very quickly reached, presaging the immediate dissolution of the plant, which gradually deliquesces into an inky-black fluid.

It would be easy to amplify this list, but we desire to avoid all risks of confusing tho tyro's mind with too many details, and have purposely confined our remarks to those fungi which belong to the autumn season.

One caution must be added. All agarics are more wholesome fresh than stale, and with some the neglect of this rule may lead to unpleasant consequences. It is rigidly enforced in the Roman market, where all specimens which are "muffi, guasti," or "verminosi" are seized and thrown into the Tiber, and it should be distinctly understood in every English kitchen into which even the common mushroom is allowed to enter. The fungus which to-day successfully simulates a sweetbread, may to-morrow simulate with equal success a handful of snuff.—*C. J. Robinson, in "Nature."*

NOTES ON CANADIAN BIRDS.

The following species, more or less rare, have been obtained in the Province of Quebec, with the exception of two species, during the summer of 1870 :—

Falco anatum, Bonaparte. The Duck Hawk.—A fine adult male of this species was obtained by Mr. Marcel at St. Lambert's, near Montreal.

Buteo lineatus, Jardine. The Red-shouldered Hawk.—A nest of this species, containing four eggs, was taken in May, by Mr. C. A. Craig, at Longue pointe, near Montreal. The nest was placed in an elm tree, about 50 feet from the ground, the tree itself being 80 feet high. It was large, and roughly constructed of cedar twigs and leaves, and lined with moss. One of the eggs is in the Society's collection. An egg which closely resembles that obtained of Mr. Craig, was given me by Master E. A. W. Kittson, who informs me that it was taken in a wood near Sorel.

Otus Wilsonianus, Lesson. The Long-eared Owl.—Mr. Craig has been so fortunate as to find a nest of this species also, this summer, at Hochelaga (near Montreal) containing four eggs. He informs me that it was built on the branch of a spruce tree some 25 feet high, about 18 or 20 feet from the ground. The nest was like that of a crow's, but larger, and made roughly of twigs and moss. Two of these eggs have been secured for the collection of the Society.

Butorides virescens. Green Heron.—One specimen of this species was shot by a friend of Mr. Craig' s at St. Genevieve. This is the first time, so far as we are aware, that this species has been obtained in the Province of Quebec.

Phalaropus Wilsonii, Sabine. Wilson's Phalarope.—A specimen of this species was shot near the Victoria bridge, in August last. Mr. Craig says that he has met with it not very unfrequently on the Island of Montreal.

Cygnus buccinator, Richardson. Trumpeter Swan.—The late Dr. A. Hall, in this Journal, Vol. 7, page 414, describes the *American* Swan, Cygnus *Americanus*, from a specimen then and now in the Society's collectien, which was shot at Longueuil. The individual in question is a young individual of the Trumpeter Swan.

Fulix affinis, Baird. The Lesser Scaup, "Blue Bill," or "Little Black Head"—Occurs occasionally in the neighbourhood of Montreal, in company with the common Scaup Duck.

Aythya vallisneria, Bonaparte. Canvass-back Duck.—Two specimens of this species were shot this autumn at Dundee, by Mr. James Hopkins, and are now in the Society's collection. The species seems rare in Eastern Canada. The pair in question occurred in a flock of the closely-allied red-headed duck.

Bucephala Islandica, Baird. Barrow's Golden Eye.—Rare on, or near, the Island of Montreal; a few were shot in the autumn of 1869, and stragglers are occasionally to be met with among the common species. The male is easily distinguished from the common golden-eye, but to separate the females of the two species is much more difficult: a careful study of the shape and coloring of the bill will enable the student to separate them.

J. F. W.

ON THE GULLS OF THE NOVA SCOTIAN COAST. BY J. MATTHEW JONES, F. L. S.—According to the catalogue of North American Birds published by the Smithsonian Institution, I find the following species of *Laridæ* inserted, as having been observed on the North-east coast of this continent. 1. Pomarine Skua (*Stercorarius pomarinus*, Temm.) 2. Glaucous Gull (*Larus glaucus*, Brünn.) 3. White-winged Gull (*L. leucopterus*, Fabr.) 4. Great Black-backed Gull (*L. marinus*, Linn.) 5. Herring Gull (*L. argentatus*, Brünn.) 6. Ring-billed Gull (*L. Delawarensis*, Ord.) 7. Bonaparte's Gull (*Chroicocephalus Philadelphia*, Ord.) 8. Kittiwake (*Rissa tridactyla*, Linn.) 9. Ivory Gull (*Pagophila eburnea*, Kaup.) 10. Fork-tailed Gull (*Xema Sabinii*, Bon.) 11. Wilson's Tern (*Sterna Wilsoni*, Bonap.) 12. Arctic Tern (*S. macroura*, Naum.) 13. Least Tern (*S. frenata*, Gambel.) Of this list of thirteen species nine have been identified by myself, and one by Major Wedderburn, (late 42nd Highlanders,) as occurring on the coast of Nova Scotia, and seven of these are in my own cabinet. The ten species identified as Nova Scotian up to the present time, are *Stercorarius pomarinus*; *Larus glaucus*; *L. marinus*; *L. argentatus*; *L. Delawarensis*; *Chroicocephalus Philadelphia*; *Rissa tridactyla*; *Pagophila eburnea*; *Sterna macroura*; *S. Wilsoni*. To this list, it is probable, several other species may be added in the course of time, but in a country like this where the naturalist must rely almost entirely upon his own exertions, to secure specimens and note their haunts and habits, the task of forming anything like a complete list of the several members of any zoological family is not an easy one. I therefore trust my present brief account of the Laridæ frequenting the coast of Nova Scotia may merely be received as the commencement of one more complete.—*Nova Scotia Institute of Natural Science.*

Position of the Brachiopoda in the Animal Kingdom.—For some time past Mr. Edward S. Morse has had reasons for believing that the Brachiopods, with the Polyzoa, had greater affinities with the worms than with the mollusks. He has studied attentively *Terebratulina* and *Discina* as well as their early stages, and in all points of their structure interprets articulated characters, and not molluscan characters. Without entering into particulars at this time, he states that in the structure of the shell he finds the greatest resemblance to the shell of crustacea, both as regards the peculiar tubular structure, and the scale-like appearance, and its chemical composition. In *Lingula*, while the carbonate of lime amounts to only six per cent., the phosphate of lime amounts to forty-two per cent. The horny setæ which fringe the mantle are remarkable worm-like. In worms the bristles are enclosed in muscular sheaths, while in other articulate animals the hairs are simple tubular prolongations of the epidermal layer. In the Brachiopods these bristles are secreted by follicles and are surrounded by muscular fibres, and are freely moved by the animal. The structure of these setœ differs but little, if at all, from those of the worms. The lophophore with the cirri is to be compared to similar parts in the tubicolous worms, and the mantle which covers and conceals their arms is to be compared to the cephalic collar, as seen in Sabella, for instance, where we find it split laterally, and a portion reflected. If this were greatly developed so as to cover the expanded fronds of cirri, we should recognize quickly the relation between the two. Dr. Gratiolet has compared the circulatory system of the Brachiopods to that of the crustacea, and Burmeister has shown a resemblance between the respiratory apparatus of certain cirripedes and that of Lingula. In the reproductive system there is a close similarity existing between the oviducts of Brachipoda, with their trumpet-shaped openings, and similar organs in the worms. In the little knowledge we have of their embryology, the strongest proofs exist of their affinity with the worms. Lacaze-Duthiers figures the embryo of Thecidium, and it is a little animal with four segments. Fritz Muller figures an early stage of Discina, and we have recalled to us a positive articulate and worm-like character. From the body of this embryo prominent bristles project. Smitt figures the same in the embryo of Lepralia, wherein he describes six bristles that appear locomotive; and Claparède figures the embryo of Nerine, a worm, in which we find similar bristles projecting from the body. In this connection it is interesting to note that in the winter eggs, or statoblasts, of Polyzoa we have a relation to similar characters among the lower crustacea, the ephippia of Daphnia and the winter eggs of Rotifers for example. Leuckart places the Polyzoa with the worms, and the close affinity of the Polyzoa with the Brachipoda is now freely admitted, and we now recall those peculiar worms, or early stages of them, which so strongly resembles in almost every essential point of their structure the hippocrepian Polyzoa. As many of the foregoing points need ample illustration, and as the writer has in preparation a memoir on the subject, he will now only call attention to the facts supporting these views, evolved from the study of living Lingulæ. It is but justice to state that six months previous to the observations made on Lingula, he had come to conclusions herein expressed, and had freely argued it with his colaborators. He saw the necessity of examining Lingula, however, before advancing these views, and for this sole purpose had visited North Carolina in company with Dr. A. S. Packard, junr., who with his observations on the worms and crustacea of that region yet found time to follow the writer, step by step, in his studies of Lingula, and was deeply impressed by the disclosures there made. His sincerest gratitude is due to Dr. Elliott Coues, U.S.A., and Major Joseph Stewart, U.S.A., commandant at Fort Macon, North Carolina, for their constant aid and sympathy in furtherance of the object of his visit there. After nearly a week's fruitless search, Lingulæ were found in a sand shoal, left at a low tide. They were found buried in the sand. The peduncle, which was about six times the length of the shell, being encased in a *sand tube* differing in no respect from the sand tubes of neighbouring annelids. In many instances the peduncle was broken in sifting them from the sand, yet the wound was quickly healed and a new sand-tube promptly formed. When placed on the surface of the sand they were noticed to move quite freely, by the sliding motion, in all directions, of the dorsal and ventral plates, aided at the same time by the rows of setæ or bristles, which swung back and forth like a galley of oars, leaving a peculiar track in the sand. The peduncle was hollow, and the blood could be seen coursing back and forth in this channel. It was distinctly regularly ringed, and presented a remarkably worm-like appearance. It had layers of circular and longitudinal muscular fibre, and coiled itself in numerous folds or unwound at full length. It was contractile, also, and quickly jerked the body beneath the sand when alarmed. But the most startling discovery in connection with this interesting animal was the fact that its blood was *red*. This was strongly marked in the gills, which were found in the shape of a series of rows of simple lamellæ, hanging from the internal surface of the mouth; thus proving the correctness of Vogt's observations from alcoholic specimens. At times the peduncle would become congested, and a deep rose blush was markedly distinct. The sexes were distinct. The writer believes the Brachiopods to be true articulates, having certain affinities with the crustacea, but properly belonging to the worms, coming nearest the tubicolous annelids. They may better be regarded as forming a comprehensive type, with general articulate features. Possibly they have affinities with the mollusks, through the homologies pointed out by Allman as existing between the Polyzoa and Tunicates. It is interesting to remember that Lingula, though one of the earliest animals created, has yet remained essentially the same through all geological ages to the present time.—*American Naturalist.*

At a meeting of the Brighton and Sussex Natural History Society, held June 9th, 1870, a paper "On Diptera and their Wings," by Mr. Peake, was read in the absence of that gentleman by Mr. Wonfor, Hon. Secretary.

While wings are common to the whole order of insects, the Diptera consists entirely of two-winged flies, which, instead of a second or hinder pair, have little thread-like bodies terminated by knobs and called *halteres*, originally considered balancers, supposed now by some to be organs of hearing, and by others *olfactory* organs. From many points of resemblance, he thought they were analogous to the hind wings of other insects, and that, at present, their special use had not been ascertained. Besides these halteres they had also winglets (*alulæ*), which were thought to be only appendages to the fore-wings. Among the Diptera three classes of fliers were found, differing in the form of their bodies and shape of their wings; first, the slender flies, such as the gnats, having long bodies, narrow wings, and long legs, but without winglets; secondly, those whose bodies, though slender, were more weighty, as the Asilidæ, having larger bodies, shorter legs, and very minute winglets; lastly, those like the house-fly, with short, thick, and often very heavy bodies, furnished with proportionate wings, shorter legs, and conspicuous winglets. From these circumstances it might be inferred that the long legs of the light-bodied flies acted as rudders, while the winglets helped the wings in flying. The wings consisted of two laminæ united by veins or nervures, and upon their arrangement and the form of the antennæ, as seen in the great groups Nemocera and Brachycera, the distinguishing characters of the Diptera are founded. The several parts of the wings and their nerves, and their differences as seen in the two above-mentioned groups, were next pointed out, and the paper illustrated by very beautiful drawings and microscopic preparations of wings.—*Monthly Microscopic Journal.*

GLEANINGS FROM THE BRITISH ASSOCIATION MEETING OF 1870.

—Mr. R. McAndrew, F.R.S., presented a report on the *Marine Mollusca of the Gulf of Suez.* This report gives the general result of a dredging excursion to the Gulf of Suez in February and March 1869. Mr. E. Fielding accompanied the author. Leaving Suez on the 10th February in a boat of about twelve tons burthen, with one about five tons for dredging, and a small boat for landing, the party reached Tur in about three weeks' time. Their crew consisted of Maltese and Neapolitans, an Arab, who proved an excellent diver, and a native of Tur, who acted as pilot. From Tur they crossed over to the Point of Zeite and the desolate islands situated towards the western side of the Straits of Jubal. After working about a week among these, and finding it a very rich collecting ground, they bore away to Ras Mahommed, where they ended their labours, proceeding from this to Tur, from whence they went by land to Suez. The number of species obtained (not including the Nudibranchiates) was 818. Of these 619 have been identified, the remaining being still undetermined. About 355 have not previously been recorded as from the Red Sea. Of these, 53 species, including three genera, are new to Science, and have been described by Messrs. H. and A. Adams. Professor Issel, of Genoa, records 640 species as from the Red Sea, and his list includes 100 new species. Some of these were figured but not described in Savigny's "Description de l'Egypt." Mr. McAndrew dwelt on the extraordinary dissimilarity between the Fauna of the Red Sea and that of the Mediterranean; the number of species common to Japan, the Philippines, Australia, and to the Red Sea, is worthy of further observation. In addition to the Mollusca, a collection of Echinoderms, Crustacea, and Corals, was made and divided among the British, Edinburgh, and Liverpool Museums. The sponges collected were sent to Dr. Bowerbank, except one, which had been described by Mr. Carter as a new genus under the name of *Grayella*.

ON THE STRUCTURE OF THE SHELL IN THE PEARLY NAUTILUS.—Mr. H. Woodward. After referring to the great interest attaching to the *Nautilidæ* on account of their vast geological and geographical range, the author proceeded to describe the structure of the shell with its septa and siphuncle, the latter structure being only found in the Cephalopoda and nearly confined to the Tetrabranchiate division of the class. The camerated structure, however, is found both among the Bivalves and Gasteropoda, and the author suggested that if any incipient character could be found leading up as it were to the siphuncle, we might fairly infer that that structure was only a more highly differentiated form of shell-growth. Such incipient structure occurs in the *Ostræadæ* and *Spondylus*, in which the shell-muscle dips down from layer to layer, offering a rough similarity to the siphuncle in *Aturia* and some other *Nautili*. Mr. Woodward described the structure of the shell, and showed by actual dissection that no vascular system exists between the shell and the animal by means of the siphuncle. The siphuncle proves only to be a pearly tube, within which is another composed of an extension of the periostracum, and quite destitute of vascular or cellular structure. Shell structure proves, when once formed, to be dead matter, destitute of change, and can only be repaired when in contact with the mantle of the shell.

CHEMISTRY AND PHYSICS.

UNDERGROUND TEMPERATURE. — Shortly after the meeting of the British Association, the secetary of the Underground Temperature Committee addressed a letter to Prof. Henry, secretary of the Smithsonian Institution, United States, requesting his co-operation in furthering the object which the committee have in view, at the same time forwarding one of their protected thermometers. In June of the present year an answer was received from Prof. Baird, assistant secretary in charge, to the effect that Prof. Henry's ill-health during the present season had prevented his communicating to us the results of his labours in response to request. The letter addressed to Prof. Henry made special reference to an artesian well of extraordinary depth which was understood to be in course of sinking at St. Louis, and at the same time a letter was addressed, and a special thermometer sent, to Mr. C. W. Atkeson, the superintendent of the work of boring at St. Louis. No reply has been received from Mr. Atkeson, who appears to have left St. Louis before the letter arrived; but letters have been received through the Smithsonian Institution from Dr. Chas. W. Stevens, superintendent of the County Insane Asylum at St. Louis, this being the institution for whose uses the well was sunk, together with a very interesting newspaper cutting, consisting of Mr. Atkeson's report on the works. The boring of the well was commenced (at the bottom of a dug well 71½ feet deep) on the 31st of March, 1866, and was continued till the 9th of August, 1869, when the work was stopped at the enormous depth of 3,843½ feet, exceeding by more than one-half the depth of Dukinfield Colliery. The strata penetrated consisted in the aggregate of 63 feet of clay, 6 feet of coal, 380 feet of shales, 2,725 feet of limestone, and 620 feet of sandstone. A cast-iron tube of 11½ inches bore was first put down, reaching from the top and secured in the limestone at the bottom. This tube was then lined inside with a wooden tube, reducing the bore to 4½ inches. A 4½-inch drill was put down through this tube on the above-mentioned date. The bore was afterwards enlarged to 6 inches, and subsequently to 11½ inches to a depth of 131½ feet. A sheet-iron tube was then put down, extending from the top to this depth, and the bore below was enlarged, first to 6 and afterwards to 10 inches diameter, to the depth of 953 feet. A sheet-iron tube, 79 feet long, was then put down, which rests on the offset at the bottom of the 10-inch bore. The 4½-inch bore was then enlarged to 6 inches to the depth of 1,022 feet, and a wrought iron tube of 5 inches bore, weiging more than six tons, was introduced, reaching from the top and resting of the offset at the bottom of the 6-inch bore, thus securing the work to this depth, and reducing the bore to a convenient size to work in. The 4½-inch bore has been continued to the depth of 3,843 feet 6 inches without further tubing. At the depth of 3,029 feet the first observation of temperature was taken, and the reading of the thermometer was 107° F. This first observation is stated by Dr. Stevens to be specially worthy of confidence, as having been confirmed by several repetions, or rather, to use Dr. Steven's own words, "this was the maximum of several trials." It was taken, as well as those that followed it, by means of a registering thermometer (kind not mentioned); but in answer to our inquiries, Dr. Stevens states, upon the authority of the carpenter who attached the thermometer to the pole by which he was lowered, "that no means were taken to defend the bulb from pressure." In the absence of further information (and Mr. Atkeson himself has not yet spoken), we can place no reliance upon the temperature recorded, as the thermometer had to bear the pressure of ⅗ of a mile of water. The temperature registered at lower depths, the deepest being 800 feet lower, were all, strange to say, somewhat lower than this, a circumstance which is all the more remarkable because the pressure (which tends to make the reading higher) must have increased with the depth. At the bottom, or rather at 3,837 feet, being 6½ feet from the bottom, the temperature indicated was 105°. Either of these results, taken apart from the other and compared with the surface temperature, would give a result not improbable in itself. The mean temperature of the air at St. Louis appear to be about 53°, but it seems desirable to avoid publishing calculations till the data are better established. Unfortunately, the apparatus which was employed in boring has all been removed, after the insertion of two wooden plugs, with an iron screw at the upper end of each, one at the offset at a depth of 1,022 feet, and the other at the offset at the depth of 953 feet, for the purpose of separating the fresh from the salt waters. These plugs were driven in with great force, and can only be withdrawn with the aid of a series of poles and other appliances, such as were used in boring, which will be rather costly. The poles alone are estimated to cost $1,152, or £200. If the plugs were withdrawn—and, according to Dr. Stevens, there is nothing but the expense to prevent—the whole well would be available for observation. The committee will make every effort to prevent so rare an opportunity from being lost.—*From third report of the Underground Temperature Committee submitted to the British Association in* 1870.

MISCELLANEOUS.

SCRAPS FROM "NATURE."

—We are glad to be able to state that Dr. Wyville Thompson has entirely recovered from the attack of gastric fever which prevented his taking part in the *Porcupine* expedition this summer. He is at present going over the zoological collection brought home in that vessel, at the University of London, with Dr. Carpenter, and he reports some very remarkable additions to his new group of vitreous sponges, mainly from the coast of Spain and Portugal. These, with some others procured by Mr. Saville Kent, in Dr. Marshall Hall's yacht, will nearly double the number of known forms referred to the order. They are no pigmies. One of them forms a lovely lace-like vase upwards of three feet in diameter at the lip!

—Owens College, Manchester, has lately received a very valuable donation to its large geological collection, in the shape of a collection of fossil Marsupials from Australia. This collection was to have been presented to the British Museum, but the donor ultimately decided to bestow it on Manchester instead.

—In the aquarium of the Dublin Zoological Gardens there are several specimens of the blind fish (*Amblyopsis spelœus*) lately brought from the Kentucky caves by Prof. Mapother. The small specimens, being very transparent, show the vertebral column, the heart, and the optic bulbs very distinctly. In the largest there are dark red spots over the optic bulbs, probably due to their having been kept in an iron vessel, which may have given colour for a rudimentary pigment membrane.

—The *American Journal of Science and Arts*, which has from its commencement been the leading vehicle for the original papers of the scientific men of America, will be continued after the close of the present year as a monthly journal. This increased frequency of publication will, it is believed, meet a wish often expressed by authors for a more rapid interchange of views, and an earlier knowledge of the progress of research; and the editors hope that the friends and patrons of science will aid in promoting its wider circulation. We believe that there are many public and private libraries and reading-rooms, throughout the country, which are not yet supplied with this journal, which is certainly one of the most important of existing scientific publications.

— The expedition of Yale College students, under the leadership of Prof. O. E. Marsh, spent several months in the Rocky Mountain regions, investigating its flora and fauna, and collecting for the Yale Museum as fine collections as possible of the extinct animal remains found in such abundance in the tertiaries and cretaceous deposits of Nebraska, Dakota, and Wyoming. Leaving this region they will visit California, and after investigating the geology of the Pacific coast, will return through Colorado and Kansas, reaching New Haven, if possible, in November. We have since learned that their endeavours have been crowned with great success. They spent three weeks examining the geology of the country between the north and south branches of the River Platte, and discovered in Northern Colorada an extensive tertiary deposit, abounding in fossil remains. The formation is identical with the "Mauvaises terres" deposit of Dakota, and apparently forms the south-western border of some ancient fresh-water lake. These beds were traced to the north, and along the North Platte River; several thousand specimens were collected, and among them a number of new species of tertiary mammals.

— There has just been started in the city of Baltimore, U.S., a society of fifteen members, called "The Maryland Academy of Sciences." It is intended to pay special attention to microscopy. The principal officers are Philip T. Tyson, President; John G. Morris, Vice-president; Edwin A. Dalrymple, Correspouding Secretary.

— Prof. Verrill, of New Haven, has just returned from an expedition to the Bay of Fundy. The greatest depth encountered in dredging even as far as fifty miles from the coast, was not beyond 120 fathoms. Very large collections were made, many rare and about sixty new species were discovered, the number of species in Prof. Stimpson's list being more than doubled. We hope soon to have a catalogue of the fauna of the bay from Prof. Verrill.

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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

CANADIAN PHOSPHATES CONSIDERED WITH REFERENCE TO THEIR USE IN AGRICULTURE.

By GORDON BROOME, F.G.S., of the Geological Survey of Canada.

Among the numerous sources of wealth included within the vast thickness of the Laurentian system,—those ancient metamorphic rocks developed on such a grand scale in our Canadian geology,—few are invested with a larger amount of scientific interest than the mineral apatite, a substance already ranking among our economics, and probably destined to constitute, in the future, one of the most important of the raw materials of Canada, one of those sinews of the country, upon which her industrial advancement must ever be primarily founded.

It is, therefore, highly desirable that what is at present known of the extent and character of the apatite deposits of Canada should at once be made available; and that the attention of this and other societies in the Dominion should be, to a proper extent, directed to facts relating to a mineral, at once so interesting and so practically useful.

With this in view, we would state, first of all, what are the purposes to which the mineral is adapted; the processes by which it is rendered available; and, as far as can be ascertained, the past and present extent of its usefulness.

Apatite, although of some importance to the manufacturer of the element phosphorus, and in the preparation of certain varieties of porcelain, derives its chief interest from its power, when used in conjunction with nitrogenous substances, of restoring exhausted lands to their original fertility, and of increasing the value, for agricultural purposes, of such as have always been, more or less, sterile and unproductive.

Phosphoric acid is an essential element of all but the lowest animal structures; and the large quantities of phosphate of lime found in the chitinous tests of Lingula, as well as in the shields of the Trilobitidæ, prove that the element phosphorus possessed, from the earliest geological epochs, the same importance, in its relation to the animal kingdom, as at the present day; and, since the sole source of the phosphorus in animal organisms is from the vegetable kingdom, it is not surprizing to find that the element is equally essential to the higher orders of plants, and, more especially to those which are the most adapted to the wants of animals.

The following Table, extracted, partly from the works of S. W. Johnson, and in part derived from Emmons' Report, on the Geology of North Carolina, exhibits this relation in a very striking manner, and proves, moreover, that not only the most nutritious plants, but also the most valuable portions of the same species contain the highest percentages of phosphoric acid :—

TABLE I.

PHOSPHORIC ACID IN THE ASHES OF PLANTS.

Series A—Edible Substances.

	P. O.$_5$ per cent.		P. O.$_5$ per cent.
Rice	.53	Rice straw	1
Rye	.50	Rye straw	4
Wheat	.50	Wheat straw	3
Maize	.45	Maize straw	17
Oats	.44	Oat straw	3
Barley	.39	Barley straw	3
Beans	.38	Bean straw	7
Peas	.33	Pease straw	5
Turnips	.13	Turnip tops	9
Potatoes	.13	Potatoe tops	8
Clover	.18	Beet root	8
Cabbage	.12	Meadow grass	8

Series B—Miscellaneous substances.

		P. O.$_5$ per cent.
1	Leaves of Catawaba Grape	18.3
2	White Oak (Quercus Alba) Twigs	12·7
3	Do. do. Wood	4.5
4	Cotton (wool of)	11.6
5	Tobacco	6.5
7	Fibre of Flax	6.2
	Seaweed (average)	0.28

AUTHORITIES:
Series I. Johnson.
Series II. 1-6 inch. Emmons.
7. Way.

The phosphorus of plants appears, for the most part, to be confined to the softer and more highly organized portions of the structure: there is but little to answer to the lime and magnesia phosphates constituting the main frame-work of the hard internal skeleton of vertebrata, or to those composing the exoskeleton of crustacea and lower orders. The phosphorus of a plant would seem to correspond more closely to that of the nervous and vascular animal tissues; as, for example, to that of the brain in man,—which amounts to 0·9 per cent. of the cerebric acid,—or of the albumin and fibrin of the blood.

The following Table (II), which might be greatly amplified, has been compiled for the sake of comparison:—

TABLE II.

PHOSPHORUS IN ANIMAL SUBSTANCES.

Ox Bone	12.25	Fremy.
Human Bone	9.21	Richardson.*
Lingula ovalis (shell—recent sp.)	17.16	Sterry Hunt.†
Mastodon (fossil bone)	17.13	Pratt.‡
Casein	1.42	Mülder.
Urine (human)	1.24	Berzelius.
Cerebric Acid (human brain)	0.90	Fremy.
Milk (of cow)	0.68	Haidlen.
Fibrin (of blood)	0.58	Fownes.
Albumin (of blood)	0.40	Mülder.
Gastric Juice, Saliva, Mucus, Etc., etc.	Traces	Fownes.

From the researches of chemists and physiologists it is now fully established that the element phosphorus plays a most important part in the performance of nerve functions; that it undergoes many, at present, inexplicable changes within the bodies of vertebrate animals; and that various of its oxy-compounds, produced by such changes, as well as the phosphates resulting from the waste of the bones, are constantly rejected from the system in a soluble condition.

There is, therefore, in the history of the element phosphorus, a beautiful example of a complete circle of changes; and of a number of substances existing, at one time or

* Chemical Technology, vol. ii, Article "Soluble Phosphates."

† First discovered by Dr. T. Sterry Hunt, who, in 1854, showed the shells of Lingula to have a composition identical with the bones of vertebrates. (Silliman's Journal [2], vol. xvii., p. 235.)

‡ Report South Carolina Phosphates, 1868 About 30 per cent. organic matter lost by decomposition, while the recent Lingula examined by Dr. Hunt had previously lost 38 per cent. of organic matter by calcination.

another, in each of the three great divisions of nature, and handed on, from the world of vegetable existence to that of animal life, before being finally returned to inorganic nature, thenceforth to be subjected to a number of chemical changes, preparing them for a new round of usefulness. But, in order to enable this great principle to operate completely and effectually, one thing is necessary ; for, owing to the concentration of populations in towns and cities, one link, so to speak, in the chain, becomes faulty, and the return of phosphates to the soil must be aided by artificial means.

From whatever lands vegetable matters are removed in the annual crops, there is a constant withdrawal of the necessary mineral constituents of the plant, including, of course, the phosphoric acid ; and, although poor or exhausted lands do not shew the entire absence of phosphates, yet they have become deficient in such phosphorus salts as are available for the use of the growing plant ; and do not, especially, contain enough to suffice for the cereals, containing, as they do, a larger proportion of phosphoric acid than any other family of plants.

The grain of wheat contains about 8-10ths per cent. of phosphoric acid, which proportion amounts to 16 lbs. of the acid to each ton (=2,000 lbs.) weight of wheat. Now the amount of phosphoric acid in soil may said to average 0·2 per cent. ; although, except in clays the proportion is usually less. Taking 0·2 per cent. as the average quantity, and assuming the specific gravity of soil to be 2.5, there exists in the soil covering one acre of land, to the depth of 12 inches, about 68.6 lbs. of phosphoric acid ; or only enough to supply the phosphates to 4.16 tons of wheat. The total weight of wheat, (whether as grain, or in the state of flour) exported from the port of Montreal in 1869, amounted to about 292,534.5 tons* ; or a weight requiring the total abstraction of phosphoric acid from 70,320.8 acres (=109.8 square miles) of good average land. This withdrawal of phosphoric

* This information was kindly furnished by Wm. T. Patterson, Esq., Secretary to the Montreal Board of Trade.

acid, equalling 2,340 tons (292,534.5×16=4,680,552 lbs. =2,340 tons) would require, in order to counterbalance the loss, the annual employment of 5,850 tons of apatite, containing 88 per cent. of phosphate of lime; a quantity equivalent to 6,864 tons of apatite of 75 per cent., or to 13,728 tons of "super-phosphates" of good quality.

The corresponding money value, at $35 per ton, makes the total annual deficiency no less than $480,480.

The losses resulting from the exportation of wheat alone (either as grain or flour) have been here estimated; and the following table, compiled from Mr. Patterson's Statistical Report, will afford some idea of the approximate worth of all the phosphates contained in crops annually shipped from this port:—

TABLE III.

SUBSTANCES CAUSING LOSS OF PHOSPHORIC ACID.

Shipments in the year 1869 for Montreal.	Amount or Weight.	Equivalent Phosphoric Acid. Tons of 2,000 lbs.	Approximate Value of Phosphoric Acid.
Flour (barrels)	966,067	} 2,340.0	$480,480.00
Wheat (bushels)	6,595,332		
Corn do.	108,018	24.3	4,989.60
Peas do.	576,984	115.4	23,695.40
Barley do.	163,372	29-4	6,036.80
Oats do.	330,738	65.5	14,989.20
Totals	....	2,574.6	$530,191.00

Moreover, the exports of wheat from British North America are only about 7½ per cent. of the total amount received by Britain: so that the phosphoric acid, exported by foreign countries for consumption in England, in the shape of wheat alone, *amounts to no less than* 31,200 *tons, and represents a money value of about* $6,406,400 *annually.*

Adding to this the imports of mineral phosphates, we have a *grand total of* $15,156,400.

From these figures it is at once evident that, wherever no restorative agents containing available phosphoric acid are employed by agriculturalists, the exhaustion of lands by wheat crops is by no means a slow process; even if the utmost allowance be made for the action of springs, and of waters flowing from uncultivated lands, in bearing to the soil minute quantities of phosphates, which might retard, although they would be by no means sufficient to prevent a gradual impoverishment.

It becomes, therefore, absolutely necessary to follow the principles laid down by Liebig,* and to *restore to the soils the cinereal elements of which they have been despoiled.* Hence the utility of farmyard and vegetable manures, as well as of various products of the chemical manufactures applicable to this necessary work of restoration. In no country, however, can such a return of the valuable components of its soils be sufficient to counterbalance the constant drain required merely to furnish the elements of growth to its inhabitants: for, if the utilization of sewage-matter and of every other kind of organic residua were effected to the uttermost possible extent,—a condition very far from being realized,—there would still always be a great unavoidable waste, by which the essential constituents of the soils would, in process of time, be sensibly diminished; and, since there are but few countries whose entire vegetable product is applied to the use of the inhabitants, but that, on the contrary, a certain proportion is almost always exported for the benefit of other lands, there is usually a far greater deficiency than that resulting from irrecoverable waste. This further loss is especially great to those newly peopled lands, whose rich virgin soils have constituted them the granaries of the Old World.

Thus a very large proportion of the vegetable produce of North America, in the shape of cotton, wheat, sugar, and tobacco, is employed in ministering to the necessities of European countries; and the result is a stupendous annual withdrawal of their necessary constituents from all soils occupied in satisfying these ever-increasing demands, and this is especially true with regard to their limited quantities of the salts of phosphoric acid.

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* Agricultural Lectures, Letters, etc., by Baron Liebig.

The annexed table (No. IV.), derived from the analyses of Dr. T. Sterry Hunt,* shows how small is the proportion of phosphoric acid usually existing in soils of even the best quality ; and hence it arises that there already exist so many partially, or even wholly exhausted soils in Canada, and more especially in the Province of Quebec, which might have been still yielding large returns of wheat crops had they been, from the first, subjected to a rational system of tillage, coupled with the judicious and periodical use of phosphatic manures.

TABLE IV.

Analyses of Canadian Soils, showing the Proportions of Phosphoric Acid Present.

Character.	Locality.	PO_5 per cent.
(1) Sandy Soil	St. Charles............	.215
(2) Clayey Soil	St. Hilaire	.390
(3) do. do.	St. Dominique	.152
(4) Sandy Clay	St. Hyacinthe	.189
(5) Clay Soil	do.	.252
(6) Clay	Chambly	.126

It is true that attempts have been made to utilize the residua of the Newfoundland fisheries, and that Dr. Hunt called attention to the subject in an Essay on Fish Manures in 1857 ;† but very little success has been met with in their employment in this country, chiefly owing to a want of the necessary knowledge or spirit of enterprise amongst the farmers themselves.

On proceeding to inquire into the means adopted by various nations to prevent the impoverishment of their soils, it is somewhat surprising to find that the great principles of agriculture, in respect to manures, were understood from the earliest times, and that the practice of some, apparently less

* Canada Geological Survey Reports, 1849 and 1851 ; also, in abridgement, Report of 1863, pp. 636–642.

† Geol. Survey Report, 1857, pp. 218–229 ; and Canadian Naturalist, vol. IV.

civilized, communities was even far in advance of that existing among European nations,—at least, until the beginning of the present century, when the more systematic research of modern agriculturists was soon rewarded by a correspondingly rapid improvement in the practice of farming. From the earliest dates in their history, the Chinese appear to have been strict economists in respect to manures, the filth of the cities being most scrupulously collected for the enrichment of surrounding lands. Several passages in the Bible prove that Eastern nations were also aware of the importance of manures, and that the Romans were in the habit of employing them, is evident from the writings of Virgil; especially where, in his first Georgic,* he recommended the use of ordure, and of ashes, to fertilize the exhausted fields.

In no place, probably, are natural manures more religiously farmed than in the Channel Islands, on the coast of Normandy, celebrated for their rich pastures and excellent breed of cattle; and on the Jersey coasts, the extensive flats, existing between high and low water-mark, are actually portioned out into lots belonging to the different farmers, who, in the autumn season,—for the law only then permits its removal,—gather in the rank sea-week (termed Vrjack) as scrupulously as they harvest the produce of their fields, which mainly owe their fertility to the rich saline ashes resulting from the combustion of the sea-weed, itself a minute fragment of the enormous waste constantly poured into the sea from the rivers upon which London and other great cities are situated.† Innumerable have been the plans proposed by engineers and men of science for the utilization of this vast waste of animal products; and the partial success already attained begins to

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* "Sed tamen alteris facilis labor, arida tantum
Ne saturare fimo pingui pudeat sola, neve
Effetos cinerem immundum jactare per agros,"
Georgicon, lib. i;, lines 79-81.

† From Horace's epithet "vilior algâ," it is probable that the Romans were not aware of the fertilizing properties of sea-weed The stigma implied can no longer apply to the source of so many valuable salts, and of so much productiveness when used as a manure.

be shown in the increased productiveness of many fields and gardens upon the confines of London.

With regard to bones, their employment as fertilizers certainly dates as far back as 1770;* and the supplies at present required in England are chiefly derived from Germany, Prussia, and the Baltic coasts.† The catacombs of Egypt have actually been ransacked for their supplies of bones; and the mummies of her kings and warriors, scrupulously preserved for a thousand years, have at length been sold by their descendants, to aid in the nourishment of far off lands.‡

Of the enormous importations of guano, nothing need here be said, except that their annual amount is said to be 200,000 tons, with a value of about $12,500,000.

The attention of English merchants was first turned to purely mineral sources of manures by the statement, made by Liebig, in 1840, that, by treatment with sulphuric acid in certain proportions, they could be converted into soluble compounds;§ and, two years later, J. B. Lawes obtained a patent for the preparation of superphosphates from the mineral apatite, instead of from bones, which had even then reached a high price.|| The supply of mineral phosphates was at first drawn from the great deposits of Estramadura, in Spain, (*Vide* table VI., for analysis of the phosphates from that locality); but the better kinds of the mineral were soon, to a great extent, exhausted, and the attention of manufacturers was then directed to the coprolithic phosphates—or fossilized exuviæ of the tertiary strata of Suffolk, and the older rocks of Cambridgeshire and North Wales, all of which are comparatively poor in phosphates, containing only from 30 to 50 per cent. of phosphate of lime. In 1854, the value of the "*superphosphates*" manufactured from mineral sources in England

* See the works of Arthur Young, published about 1770.

† *Vide* Richardson and Watt's Chemical Technology, vol. ii., article "Soluble Phosphates."

‡ Had Shakespeare lived in the nineteenth century, there would have been an awful significance in the words—"*Cursed be he that moves my bones!*"

§ *Vide* Liebig's Lectures on Agricultural Chemistry.

|| *Vide* Specifications for British Patents, 1842. (No. 9,253, May 23rd.)

was as much as $8,750,000 ; and the demand for the cotton lands of the Southern States cf the American Union is now probably fully one-third of that amount.*

The coprolites are fast becoming dearer and poorer, and, consequently, owners of works in England are becoming every year more eager to satisfy themselves from foreign scources ; of which those of Canada and South Carolina only are of any considerable magnitude.

The South Carolina phosphates are very comparable in character to some of the phosphatic beds of Great Britain; their quantity is apparently very great; but they are by no means rich, and average from 25 to 60 per cent. of phosphates. Large quantities, on the other hand, of the Laurentian apatites, on the shores of L. Rideau, in Canada, can be obtained, averaging from 60 to 85 per cent.; and the only wonder is that they have not been utilized long since, comprising, as they undoubtedly do, a source of much prosperity.

It is not the object of the present paper to describe the mineralogical characters of the Canadian apatites : much information upon the subject will be found in the Reports of the Geological Survey of Canada, for 1863 and 1866 †; and as, since those dates, many new localities have been discovered, subsequent Reports will probably complete the description. In this connection, the author would desire, in an especial manner, to acknowledge his indebtedness to Dr. T. Sterry Hunt, F.R.S., who has for many years past been periodically making public, in a readily available form, the results of his systematic and admirable researches in this branch of Chemical Geology, and, more particularly, in his valuable Reports issued by the Geological Survey of Canada. Reference may especially be made to the Reports of 1848, 1863, and 1866 ; to an Essay written for the Exposition (Paris) of 1867, and to the Report of 1847-48‡ where he mentions the first

* Richardson and Watt's Chemical Technology, vol, ii., Article "Soluble Phosphates."

† Vide Geol. of Canada, 1863, and Report of Dr. T. S. Hunt, for 1866.

‡ Reports of Dr. T. S. Hunt, 1848, p. ; 1863, p. ; 1866, p. .

References to other labours in this subject will be found in the above-discovery by himself, in 1847, of the Apatite of Lanark Co., Ontario, and moreover, remarks on the probable value of the deposits, and their application to the manufacture of mineral manures,—a branch of industry then but in its infancy.

A few remarks upon the geological portion of the subject will be found in a paper read by the author at the Troy meeting of the American Association for the Advancement of Science,* in August last; as well as in a note, shortly to be laid before the Geological Society of London† : but the history of these interesting deposits is by no means complete; and it is hoped to return to the subject in a future communication to this Society.

Facts upon the *modus operandi* of the phosphatic and other mineral manures are more especially desirable; and it may be well here to briefly to discuss a few points connected with their action upon arable lands.

With regard to the relation of phosphorus to plant-life, we have, first of all, the well established fact that a deficiency of that element in the parent soils produces a corresponding diminution in the weight of the crop, and renders it, moreover, very liable to various diseases; and that the addition of phosphorus compounds, in a state fit for the nourishment of the plant, always effects a great increase of fertility. But, with regard to this increase, it has been found to be out of all proportion to the actual requirements of the growing plant with respect to phosphoric acid. The waters in contact with

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mentioned Reports, but it will be desirable to quote from that of 1847-48, now, unfortunately, almost inaccessible :—

"The phosphate of lime is largely contained in wheat, and the exhaustion of this ingredient is one great cause of the sterility of our worn-out wheat lands. In a grain-growing country like Canada, therefore, the existence of such deposits as these will prove of great importance."

"Under these circumstances, the limestone just described, which contains throughout it a large supply of this important substance, is certainly well worthy of the attention of our agriculturalists."

* On Apatites of Lanark Co., Ont., by Gordon Broome, F.G S Proc. Amer. Assoc., 1870.

† Laurentian Apatites of Canada, by the same. Quar. Jour. Geol. Soc. circ. February, 1870.

the roots may, and often do, contain a sufficiency of phosphates for maintaining unchanged the composition of the plant, and yet the addition of phosphatic manures produce a vastly increased yield. The only rational explanation of these facts, and that which the researches of agricultural chemists appear to corroborate, is that the phosphates, besides forming important elements in the actual material of the plant, are also able to act as carriers of the requisite nourishment to the growing parts; and that, just as, in the animal economy, certain substances, as, for example, the salts of iron, give a tone to the system by aiding the powers of secretion and cell-formation; so, in the vegetable world, and, more especially, in the important families of Graminaceæ and Leguminœ, phosphoric acid stimulates the assimilative powers, excites an increase of vitality, and, in consequence, augments the fecundity of the germ, and enlarges the proportional rate of increase. The consideration of certain analyses of Woods, published in the first volume of Dr. Percy's Metallurgy, and also of a series in Emmons' Report on the Geology of South Carolina for 1858, pp. 59-78, (and also the second series of Table I., *ante* p. 8) has led me to this conclusion; for such analysis shew that the twigs and leaves are richer in phosphates, and other mineral elements, than the bark or the solid wood; whilst, in the cotton-plant, Crace-Calvert has shown that more soluble acid-phosphate of magnesia exists in the pod, than in the husk or stalk.*

From Table I., it will be seen that, whilst the ashes of solid oak contain 4·5 per cent. of phosphoric acid, the quantity present in those of the young twigs amounts to 12·7 per cent., or more than 2·75 times the proportion present in the wood.

Those parts, therefore, which are pre-eminently in a state of rapid development, are the most abundantly furnished with phosphates, doubtless, having their own peculiar functions to perform in assisting the developmental process.

As to the manner in which plants derive their saline con-

* Brit. Assoc. Rep. 1869.

stituents from the soil, there is still some degree of uncertainty; whether they imbibe those salts already existing in a state of solution, and thus obtain the matter required for their growth; or whether they dissolve out certain elements from the soil, by the solvent action of their own juices.

Eichhorn's results demonstrate that *pure distilled water can dissolve from the soil much more of mineral matter than would be requisite for the supply of an ordinary crop.** The solvent powers of waters are also in almost every case, much augmented by the presence of carbonic acid, and occasionally, doubtless, by the existence in them of dissolved organic acids. † These acids do not, in all probability, exert any very important influence in dissolving food for the plant, so long as they exist in growing vegetation, but only on their being eliminated by processes of natural decay. When thus released, they are probably very active in dissolving compounds of sesquioxide of iron, and alumina; as is, indeed, abundantly proved by the occurrence in nature of such minerals as beauxite, mellite, pigotite and oxalite, compounds in which sesquioxide of iron or alumina, exist, combined with water and an organic acid.‡

The utility of decaying vegetable matters as a manure, may, consequently, be due as well to the solvent action of certain products of their decomposition, as to the fertilizing properties of their several mineral constituents.

The absorptive powers of soils tend, moreover, to concentrate within their mass certain mineral constituents, derived from small proportional quantities of them existing in infiltrating waters; and this absorption is very marked between phosphoric-acid compounds and soils of a clayey character, which seem especially adapted for their retention.

For the sake of demonstrating this fact, an experiment

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* Poggendorf Annalen, No. 9, 1858, etc.; also Johnson, in Silliman's Journal, [2] xxviii., 1869.

† Vide Chemistry of Natural Waters, by Dr. T. Sterry Hunt, in Sillimans Journal, 1865.

‡ *Ibid.*

was made upon a gray, infusible fire-clay, which proved, upon analysis, to possess the following percentage composition :—

Silicic Acid	combined silica	37·99	58·49
	free sand	20·50	
Alumina (by difference)			26·79
Iron (protox.)			traces
Lime			0·12
Magnesia			traces
Soda			1·53
Potassa			1·52
Chlorine, Ammonia, and Phosphoric Acid			traces
Organic matter			0·08
Water (Hygroscopic 1·38)			11·47
			100·00

One hundred grammes of this clay were washed upon a large filter, until the filtrate was quite free from solid matter, and a solution (containing 10 grm. to 1 litre) of phosphate of soda was then caused to filter slowly through the mass, by a syphon arrangement, in about 24 hours.

The solution extracted a quantity of humic acid, dissolved out by the action of the alkaline salt, and *contained only* 8·312 *grammes of phosphate of soda*, with a little alumina, lime, and sesquioxide of iron. Such a clay being, practically a pure silicate of alumina and water, the large absorption is in a great measure due to a reaction between the hydrated silicate of alumina, or clay, and the phosphate of soda, resulting in the formation of a phosphate of alumina, and the fixing of a portion of soda at the same time by the aluminous silicate.

This power of clay was first explained by Way and Thomson ;* though it was remarked by the Dean of Westminster in 1849,† who suggests that it is shown by the concentration of phosphates occurring in certain clayey nodules, termed Septaria, common in the Lias of England.

It is probable, that the formation of many great phosphatic deposits, of marine origin, including perhaps the Canadian apatites, is most reasonably explicable by referring to these

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* R. Agric. Soc. Journn. Eng. (xi. 68-74 xii. 317-380 ; xiii. 123-140.)

† Brit. Assoc. Report, 1849.

absorptive powers; and this is rendered the more likely by the fact that all of the mineral waters occurring in the Palœozoic rocks of Canada, which Dr. Hunt beautifully designates as fossil sea-waters,* contain traces of phosphoric acid, resembling in this respect the waters of modern seas.

The absorptive powers of soils are due to a combined chemical and molecular action, the completeness of which is, to a very great extent, dependont upon the mechanical condition of the mass.

Soluble phosphates of lime, when thrown over the surface of the land, are quickly converted into the insoluble tribasic salt, by the action of carbonates and basic compounds; but the product, being in a state of extreme division, is readily dissolved by water charged with carbonic acid, and also, as shown by Liebig, by solutions of ammoniacal salts, or of the chlorides and nitrates of the alkalies.

These modes of solution are exceedingly important from an agricultural point of view, since they shew the advantage of compound manures, formed by the addition of ammonia or potash salts to the ordinary "super-phosphates." In an experiment, recently made by me, for the purpose of ascertaining the solubility of apatite in carbonic-acid water, it was found that, by digestion of the finely pulverized mineral for twenty-four hours, at a temperature of 60° F., agitating frequently, a saturated solution of carbonic acid is capable of dissolving $\frac{1}{2857}$ parts of the mineral. Similarly conducted experiments with solutions of sal ammoniac, and of potassic chloride, gave respectively, the proportions $\frac{1}{1828}$ and $\frac{1}{1141}$.†

Alkaline carbonates also dissolve apatite, with the formation of carbonate of lime and a phosphate of the alkali; and these reactions explain the existence of phosphate of lime in sea-water, a fact long since demonstrated by Clemm and Forchammer.‡

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* Vide Geology of Canada, 1863, pp. 561–564.

† Portions of a fine sea-green prismatic crystal of the Burgess apatite were used in these trials. For its composition, see Analysis on p. 18.

‡ J. fur Prakt. Chim. xxxiv., 185; also Berzelius, Jahresb, xxiv., 393.

By means of sulphurous acid, also, in a state of aqueous solution, apatite may be dissolved to the extent of about $\frac{1}{1388}$ parts, under the above conditions; but this last reaction has not such an important bearing upon the theory of agriculture as those already described.

The researches of Thénard, upon the action of clays on phosphate of lime in carbonic-acid solution, show that insoluble phosphate of alumina is formed, whilst the solution contains all the lime, as carbonate*; but, as the alumina in clays is not in the free state, an acid silicate of alumina is probably at the same time produced.

Thénard also stated (*loc. cit.*) that, by the action of an aqueous solution of silicate of lime upon phosphate of alumina, silicate of alumina is precipitated, whilst tribasic phosphate of lime (separable by means of carbonic acid) is also produced. By repeating Thénard's experiment, a solution was obtained, containing .011 gm. of lime silicate to the litre of water, which was completely decomposed in the manner indicated by Thénard, by long boiling with pure artificial phosphate of alumina, or with the clay previously used, which contains some phosphoric acid. Since, however, heat is requisite to the success of this reaction, it is more probable that, in nature, double silicates of alkalies with lime or magnesia, play the part here assigned to solution of simple silicate of lime.

Dehérain † asserts that the reverse of this reaction results between phosphate of sesqui-oxyd of iron and carbonate of lime: and it is probable that the surrounding conditions, as to temperature, relative amounts, and mechanical division, determine the nature of the resulting change. This was notably the case in Eichhorn's remarkable experiments upon the solubility of chabazite and natrolite in various saline solutions; and, on the whole, it would seem that the numerous known instances of departure from a regular order of affinities in such reactions tend to show that the relations of many bodies, with regard to their mutual affinities, are disposed to vary in

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* Compt. Rend. de l'Acad. des Sciences, Feb. 1, 1868.

† Quoted by Johnson, in the paper previously cited.

obedience to changes in the physical conditions under which they may be brought together.

Finally, in concluding this branch of our enquiries, it may be stated that, reasoning from the researches of Thénard, Eichhorn, Way, and others, Johnson was led to conclude that the efficiency of mineral manures is, in most cases, to be abscribed to their indirect action, and not, as had been previously supposed, to their direct influence as sources of food to the growing plant.

We may now pass on to consider the manufacture of "superphosphates" from the mineral apatite, which is at present in progress at but one factory in the Dominion of Canada, namely, at the Brockville Chemical Works, under the management of Mr. A. Cowan, to whose kindness I am indebted for the sample of "superphosphate," the analysis of which will be found below, as well as for valuable information with regard to the process employed. An engine of about fifteen-horse power suffices for grinding the mineral, for turning the agitator during the digestion of the apatite with crude oil of vitriol, and for supplying steam to the sulphuric-acid chambers, which are adjacent to the mills. The quantity of superphosphate of lime obtained does not, at present, exceed six tons per diem, owing to the insufficient yield of the acid chambers. The quality of the product will be seen from the following complete analysis recently made upon a fresh sample:

TABLE V.

ANALYSIS OF "SUPERPHOSPHATE," OF LIME,

(From Brockville Chemical Works, Nov., 1870.)

	Per cent.
Superphosphate of Lime $= Ca\,O, 2\,H\,O, P\,O_5$.	20 . 33
Tribasic Phosphate of Lime $= {}_3\,Ca\,O, P\,O_5$.	2 . 39
Phosphate of Iron $(Fe_2\,O_3)$	2 . 23
——— Alumina	0 . 43
——— Magnesia	tr.
Dihydrated Sulphate of Lime Gypsum$=Ca\,O, S\,O_3 + 2\,H\,O$.	63 . 84
Insoluble in Hydrochloric Acid, (principally Mica)	3 . 59
Chloride of Sodium	0 . 45
Water	5 . 50
Alkaline Sulphates and loss	1 . 24
Total	100 . 00

Soluble Phosphoric Acid ($P\ O_5$)..............	12 . 33
Insoluble (anhydrous)	2 . 12
	14 . 45

To produce this fertilizer equal weights of crude sulphuric acid (of chamber strength,) and of the finely divided mineral, are thoroughly mixed in a suitable vat, or tub, until the conversion is deemed complete, when a trap is raised at the bottom of the vessel, and the thick, pasty mass allowed to flow over the floor, where it soon becomes sufficiently consolidated to be packed in barrels. * English manufacturers are in the habit of storing their "superphosphates" in pits or cellars built for the purpose, and they thus obtain a fertilizer containing a comparatively small quantity of water. They also employ somewhat stronger acid, and agitate the mixture in covered vessels.

Table III shows the composition of six apatites, representing the pure mineral of different districts ; the first analysis being one made upon a crystal of pure translucent sea-green apatite, from the "crystal vein," on lot 5, of the fifth concession of N. Burgess, which had a specific gravity of 3.209.

TABLE VI.

COMPARATIVE ANALYSIS OF APATITES AND PHOSPHORITE.

	I.	II.	III.	IV.	V.	VI.
Phosphoric Acid............	41 39	41.25	43.01	41.99	37.18	42.34
Lime	49.79	53.84	55.24	55.95	54.0	55.08
Alumina	—	0.38	—	—	—	—
Calcium	4.18	—	—	—	—	—
Iron ($Fe_2\ O_3$)	tr.	Alks 0.17 .29	0.09	—	3.15	0.04
Silicic Acid	tr.	0.82	—	—	1.70	—
Chlorine	0 38	4.10	0.05	0.01	0.20	0.34
Fluorine	3 58	und.	und.	4.20	2.16	und.
Water (Air dried)	—	0.42	—	—	—	—
Totals..........	99.32	101.81	98.69	102.15	98.47	97 80

I. Burgess, Canada.--Broome.
II. Krageroë, Norway.—Volckler.
III. Faldigl, Tyrol.—Joy.
IV. Tokovaia, Ural.—Pusirevski.
V. Estramadura, Spain.-Daubeny.
VI. Hurdstown, New Jersey, U. S. —Jackson.

I., II., III., and IV., Fluor-Apatites.
II. Chlor-Apatite. V. Phosphorite

* Each of which contains 286 lbs.

Apart from all associated matters, the apatite employed at the Brockville works may be said to contain 92 per cent. of phosphate of lime, and 7.2 per cent. of fluoride of calcium. When such a mineral, commingled with its gangue of calcite, is digested with a proper proportion of sulphuric acid, three separate reactions result:—

(*a.*) The tribasic phosphate yields up two-thirds of its lime to the free acid, the remaining atom forming, with the whole of the phosphoric acid present, the super-phosphate of lime (acid phosphate of lime).

(*b.*) The calcite is wholly converted into gypsum, with evolution of carbonic acid.

(*c.*) The fluoride is decomposed, with formation of hydrofluoric acid and gypsum.*

These reactions may be represented as follows:—

(*a.*) $3\ Ca\ O, PO_5 + 2\ HO, SO_3 = 2\ Ca\ O, SO_3 + Ca\ O, HO, PO_5$.

(*b.*) $Ca\ O, CO_2 + HO, SO_3 = Ca\ O, SO_3 + HO + CO_2\dagger$.

(*c.*) $Ca\ F + HO, SO_3 = Ca\ O, SO_3 + HF\dagger$.

From the consideration of the atomic weights of these substances, it will appear that 100·00 parts of phosphate of lime (tribasic) will require 51·61 parts of anhydrous acid (SO_3), to convert it completely into the acid phosphate; that 100·00 parts of fluoride of calcium requires 99·00 parts of the same anhydrous acid (or, in round numbers, an equal amount) to produce the reaction shewn in equation (*c*); and that 100·00 parts of calcspar will require 66·00 parts of acid for its complete decomposition.

One part of apatite, of the percentage indicated as representing the pure mineral of the Brockville works, will require $\cdot 92 + (\cdot 5161 \times \cdot 07.) = \cdot 545$ parts of anhydrous sulphuric acid exactly to effect the desired changes.

The following table (Table No. VII.), compiled from these

* This irritates the workmen's lungs so greatly that they are in the habit of using rude respirators, formed of sponge. It is much more obnoxious in foggy, still weather, than when any breeze is blowing, which soon frees the works from the most penetrating and disagreeable odour.

data, exhibits the amounts of anhydrous acid, and also of acid, of specific gravity 1.712 (*i.e.*, of the usual chamber strength), necessary for the complete conversion of one hundred parts, by weight, of mineral containing various percentages of apatite, of the above composition, with a wholly calcareous matrix :—

TABLE VII.

ACID REQUIRED TO CHANGE APATITES TO "SUPERPHOSPHATES."

100 parts of Mineral composed of Apatite.	Calcite	Acid Anhydrous.	Acid Specific Gravity 1.712=134°T.
100	0	.... 54.5	.... 90·8 ....
98	2	. .. 55.0	.... 91.7 ....
96	4	.... 55.5	.... 92.5 ....
94	6	.... 56.0	.... 93.3 ....
92	8	.... 56.5	.... 94.2 ....
90	10	.... 57.0	.... 95.0 ....
88	12	.... 57.5	.... 95.8 ....
86	14	. 58.0	.... 96.7 ....
84	16	.... 58.5	.... 97.5 ....
82	18	.... 59.0	.... 98 3 ....
80	20	.... 59.5	.... 99.1 ....
78	22	.... 60.0	.... 100.0 ....
76	24	.... 60.5	.... 100.9 ....
74	26	.... 61.0	.... 101.7 ....
72	28	.... 61.5	.... 102.5 ....
70	30	.... 62.0	.... 103 3 ....
68	32	.... 62.5	.... 104.2 ....
66	34	.... 63.0	.... 105-0 ....
64	36	.... 63.5	.... 105 9 ....
62	38	.... 64.0	.... 106.7 ....
60	40	.... 64-5	.... 107-5 ....

The use of this table is that it ought to prevent any danger of having free sulphuric acid in the product, or of proceeding further than the complete conversion of apatite into soluble phosphate. By means of a table of specific gravities, the quantity of acid, of any required strength, may be easily estimated for treatment of a given mineral.

The conversion of apatite into acid phosphate of lime may may also be effected by the use of hydrochloric acid, and, under certain circumstances, this method may be preferable to the use of the oil of vitriol. For 36·5 parts of hydrochloric acid (HCl.) will convert the same amount of phosphate into a soluble form as 40·0 parts of sulphuric acid (SO_3); whilst in the case of an apatite, *a further amount of vitriol is employed in the decomposition of fluoride of calcium.* By the employment of oil of vitriol to form hydrochloric acid, by acting on common salt, and using the product for the conversion of apatite, one part of vitriol may be made to answer to 1·14 parts of vitriol applied by a direct method; and, in the decomposition of calcite, one part of hydrochloric acid will answer to 1·096 parts of sulphuric acid.*

The saving of the acid employed, by the adoption of this method, would more than counterbalance the extra expense, and the chance of further loss by a multiplication of the operations; and another advantage over the ordinary process would result from the lime salt produced being the soluble chloride, and not insoluble (comparatively) gypsum, which, by mechanically protecting a portion of the apatite from complete conversion, doubtless accounts for the presence of 2·39 per cent. of unmodified lime-phosphate in the product analysed.†

The deliquescent properties of chloride of calcium have, however, been found, by many English manufacturers, to constitute a serious objection to the employment of hydrochloric acid: the product being apt to remain in a moist unsaleable condition.

It will not, however, be difficult to understand, from the remarks already made, that combined ammoniacal, or potassic, and phosphatic manures possess many advantages over simple "superphosphates," and that such composts are likely more and more to replace the ordinary soluble phosphates. English and German manufacturers are, indeed, fast learning to produce such compounds; and numerous nitrogenous substances have been utilized for this purpose, including products

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* 40 parts of SO_3 will produce from Na. Cl. 36·5 parts of H. Cl.

† Corrosion of chambers or vessels, and accessibility of the acid must in all cases be taken into account.

obtained from blood, or animal refuse, (as for example, the waste of the enormous butcheries at Chicago); others from the refuse of tan-yards; from the ammoniacal products of gas-works; and a number of the residua resulting from various chemical manufactories. "Superphosphates," produced by the action of muriatic acid upon apatites, might readily be dried up by these materials; thus overcoming the objections arising from the pastey condition of the product, and, at the same time nearly doubling the value of the fertilizer.*

Sulphurous acid, also, produced directly from the roasting of pyrites, has been applied successfully for the formation of "superphosphates" from animal sources; but further experiments on the subject are necessary, to shew whether it would, or would not, be applicable for the conversion of apatites or other mineral phosphates.

Before concluding the subject, one very ingenious process, patented by MM. M. L. Henrionnet and L. C. Boblique, in Nov. 1860, † (see Patent Abridgements, in Appendix to Richardson and Watt's Chemical Technology) may be noticed, in which hydrochloric acid, generated during the process itself, by the reaction taking place between steam, silicic acid, and common salt, is employed in the manufacture of soluble phosphates.

The finely pulverized apatite, mixed with 2-3rds parts of common salt, and about 18 per cent. of silica, is heated, in a current of steam, upon the bed of a reverberatory furnace; when the following reactions are produced:

(a) $Si\,O_2 + Na\,Cl + H\,O = H\,Cl + Na\,O,\,Si\,O_2$

(b) $3\,Ca\,O, PO_5 + 2\,H\,Cl = Ca\,O,\,2\,HO,\,PO_5 + 2\,Ca\,Cl.$

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* Sawdust, previously saturated with sulphuric acid, has been patented, by Messrs. Sugden and Maryatt, for the absorption of ammonia from coal-gas. When exhausted, it contains from 40 to 60 per cent. of sulphate of ammonia, and is valued at from $25 to $30 per ton of 2,240 lbs.—Vide Report on Industrial Chemistry (Paris Exposition) 1867, by J. Lawrence Smith, U. S. Commissioner.

† Berzelius Jahresbericht.

The process possesses considerable theoretical interest, and would be, if practically effective, exceedingly economical.

And here my remarks must, for the present, be drawn to a close; much that remains to be said upon this comprehensive subject being postponed for a future opportunity: but I cannot conclude without giving expression to one thought, strongly impressed upon my mind by the consideration of these topics; namely, that the comparatively dormant state of this, and many equally obvious sources of industry in Canada, arises from a great deficiency in a most important division of our national education; and that nothing, save a liberal augmentation of the ordinary courses of instruction in modern subjects, can ever prove effectual in dispelling the immense existing cloud of ignorance and prejudice. It is, therefore, sincerely to be hoped that the very able remarks, recently made by Principal Dawson upon this question, may have their desired effect; and that Canada may speedily obtain a share in the improvements that have, of late, almost revolutionized the systems of education prevailing in the universities of the mother country.

SCIENCE EDUCATION ABROAD.

(*Extracts from a Lecture by Principal Dawson, LL.D., F.R.S.*)

WHAT IS SCIENCE EDUCATION?

In speaking of science, then, I would restrict your attention to the physical sciences, or those which relate to what we call material things. In this great group of sciences we may recognize three subdivisions, distinguished by the modes in which they are pursued, though shading into each other. (1) Mathematical sciences, or those in which the methods chiefly pursued are those of mathematical reasoning and calculations, as, for instance, astronomy; (2) Experimental sciences, of which chemistry and several departments of natural philosophy may be taken as examples; (3) Observational sciences, such as zoology, botany and geology. Each of these classes of subjects must be treated according to its own methods; and unless so treated, is useless whether as a means of training or for practical application. The learning, for example, of any of the natural sciences by "getting up" a text book without actual examples and work, is not of the nature of science education; and much of the undervaluing of science studies as a means of education, on the part of practical teachers, is due to their want of acquaintance with this first truth. Natural history or experimental science taught merely from books is only an indifferent form of verbal training, and it is no wonder that those who know it only in this way should form a very low estimate of its educational value. To be usefully taught, the pupil must be familiar with the actual objects of study, and he must understand experimentally the modes of attaining to results with regard to them. He will then receive a real and valuable kind of education, the benefits of which may be summed up as follows:—(1) The student is taught to observe, compare, and reason for himself, and this in a practical manner, not so easily attainable in other subjects, and tending to give an accuracy of method and quickness of perception, and of forming conclusions most valuable in actual life. (2) Much knowledge of a useful and interesting character is acquired; and the student, while learning the uses and properties of common things, may rise to large and enlightened conceptions of the works of God, and the natural laws under which man exists. (3) Men are trained to pursue original investigations, and thus to enlarge the boundaries of science. (4) The means are afforded to utilize natural resources and improve arts and manufactures. With regard to the extent and nature of such science education, it appears to be the result of experience in all the more advanced countries; (1) That there should be special practical schools to train investigators and practical science workers in the departments most important to the welfare of the community. (2) That science study should form some part of a liberal education. (3) That the elements of some of the natural or physical sciences should be taught in all the common schools. (4) That means should be employed to train competent teachers of science. This being what I understand by science education, with reference to its nature, results and methods, let us glance at some of the efforts put forth on its behalf, more especially in the mother country.

THE ROYAL SCHOOL OF MINES, LONDON.

In London the principal institution for science education, supported directly by the Government, is the Royal School of Mines, Jermyn street, with which is associated the Royal College of Chemistry in Oxford street.

The Royal School of Mines is an outgrowth of the Geological Survey of Great Britain, whose building it shares, and whose officers are its chief directors and instructors. This association gives it great advantages in securing the influence and management of the distinguished head of the Survey, Sir R. I. Murchison, and the services of such eminent practical geologists and naturalists as Huxley, Etheridge and Smyth, as professors, in giving the students access to large and admirable collections in geology and an extensive scientific library, and in placing the young men under the immediate superintendence of those who have the best opportunities for opening up to them the paths of usefulness and success. The very atmosphere of such an institution savours of practical science, its appliances for work and study are of the most inviting description, and it has several prizes and scholarships for its more deserving stndents, and gives the title of "associate" to those who pass its final examination. Notwithstanding these advantages, though it has many occasional or partial students, the number of regular students has been much smaller than could be desired. This may in part be accounted for by its situation in a city not directly interested in mining, and remote from the great manufacturing districts; in part, perhaps, by the want of appreciation of the advantages of science training on the part of the English public. It is certain, however, that the School of Mines, though its instructing officers are second to none in the world, is inferior to the great science schools of America and the continent of Europe in its academical organization, in the completeness of its course, more especially in the direction of literary and mathematical culture, and in the standard of attainment required for entrance. Were it improved in these respects, and enabled to offer a larger number of direct prizes to students, its usefulness might be greatly increased. Still, with these limitations, the success of the school has been great. It has trained a succession of competent men for geological surveys in the United Kingdom and the colonies. Among others, the present head of the Geological Survey of Canada is one of its graduates.

It has also sent forth a number of trained men into mines and manufactures, who have been very successful, not only in introducing new improvements and inventions, but in realizing fortunes for themselves; and it is stated that the demand for these men is much greater than the supply. The course of study in the School of Mines extends over three years, and in the senior year the students are allowed options, by virtue of which they may devote themselves specially to chemistry, mining or geology.

The Royal College of Chemistry is a distinct institution, situated in a different part of the town, which is a cause of some inconvenience to the students of the School of Mines, who have to attend its lectures and classes in practical chemistry. It was established originally by a private subscription, but has been adopted by Government. Under the able management of Prof. Frankland, it is a useful institution, and always crowded with pupils. It has, however, accommodation for only 42 practical students, and this by no means of the airy and sumptuous character to be found in the laboratories of the continent of Europe and the United States. Crowded among the shops of a noisy business street, it has no room for extension, and its teachers and students have to submit to many inconveniences which might readily be obviated were it removed to a more central locality, and provided with a laboratory fitted up with modern improvements. It must, however, be admitted that the utmost possible use has been made of its too limited accommodation.

THE DEPARTMENT OF SCIENCE AND ART.

The Royal School of Mines, as well as the Royal College of Science, Dublin, and the Edinburgh Museum of Science and Art, are under the direction of the Government Department of Science and Art; but its largest sphere of operations is in the great South Kensington Museum, and the schools connected with it throughout the country. In its last report these schools and classes are stated at 525 in all, with an aggregate of 24,865 pupils. This represents much science teaching; all, however, of an elementary character, and of small amount relatively to the great population of Britain and Ireland. Much of the teaching is necessarily done by teachers of a very humble grade of scientific attainment; but the most effectual means are taken to ascertain that it is faithfully done, and to give it opportunities for improvement. The principle adopted is that of giving money aids to teachers, building grants, grants for apparatus, &c., scholarships and exhibitions, medals and prizes to pupils. All of these are awarded on the results of rigid examination, conducted by papers sent from London and reported on by examiners, among whom are some of the first scientific men in the country. The aids to teachers are at the rate of £2 per annum for each first-class pupil, and £1 for each second-class pupil; and the teacher, in order to receive aid, if not a University graduate, must have obtained at least a second class in the advanced grade of these examinations. Of the aids given to pupils a number are in the form of exhibitions in aid of attendance on higher science schools, and in the case of the higher Government schools the fees are remitted in favor of students taking these exhibitions. It would be difficult to imagine a system likely to do more good, and all that is wanted is that it should be further extended, and that more thorough means should be adopted for training the teachers.

SOUTH KENSINGTON MUSEUM.

The most conspicuous part of the establishment at South Kensington is its museum, embracing a vast collection of objects illustrative of industrial products, art and manufactures, and one of the most popular and useful places of instruction by the eye in London. It is proposed to remove to the extensive buildings at South Kensington the vast Natural History collections of the British Museum, and also the collections of the Geological Survey, so as to promote science study as well as that of art. Art education on an extensive scale is conducted at South Kensington itself, as well as in a multitude of affiliated art schools. More especially, young persons are trained as teachers, and with reference to practical applications to decorative art of every description. As illustrations of these, I was shown large collections of patterns for wall papers, table cloths, pottery, and coloured and engraved glass, prepared by the pupils for competition for prizes offered by manufacturers; while in a gallery of the museum, assistants were busy in arranging a vast collection of drawings and paintings sent in from affiliated schools for competition. In the Art training school I saw hundreds of pupils engaged in all kinds of work, from the elements of drawing to studies in painting and modelling from life. In addition to the study in the schools, the students, of whom there are between eight and nine hundred, have access to the Galleries of Art in the

Museum, and to an Art Library of 25,000 volumes, and a collection of 55,000 engravings and photographs. Last year 107 schools were conducted under the "Department" with 20,000 pupils; and in addition to these, elementary drawing was taught in 1,094 schools to 120,928 children. Though art is distinct from science, I think it proper, when speaking of South Kensington, to refer to its work in art as well as in science. Not only is science the handmaid of art, but art is also the handmaid of science, and both must flourish or decay together. More especially the study of art in its application to the wants of ordinary life, cannot fail to be auxiliary to the advancement of science. It is a matter of profound regret that the Boards of Art, organized in this country more than ten years ago, have been permitted to languish, and have not been enabled to establish here institutes on the plan of those of the Department of Science and Art in England.

THE LONDON UNIVERSITY.

University College, London, has no organized science school, but it trains men for the Bachelor of Science examination of the London University. This is a general science examination, implying the training necessary for matriculation, and subsequent studies in Physics, Chemistry, Animal Physiology, Geology, Logic, and Moral Philosophy. Bachelors of Science of two years standing can go up for an examination for the degree of Doctor of Science. These science degrees of the University of London do not lead directly to practical work, and this is an important defect in the system, but they are, no doubt, very important as stimuli to the general preparatory training required by every man of science. The Bachelor of Science degree, as offered by the Universty of London, has also undoubtedly tended to raise science to its proper status in connection with the higher education, but it is not as yet largely taken. At the graduation in May last, at which I was present, there were only eleven Bachelors in Science and seventy Bachelors in Arts. This arises in part from the want of prestige and antiquity in the degree itself, and in part from its having to compete with the honours in science which may be taken in courses in arts, and with the special science sehools.

The Birkbeck laboratory of University College accommodat 24 practical students; and I was pleased with the ingenious arrangement of its theatre, by means of which 98 students can be employed simultaneously in making experiments with tests, under the direction of Professor Williamson and his assistants. This is only one among many indications which I observed of the tendency to give to examinations and instructions in science a practical character, an evidence that its true nature is being more and more appreciated.

THE ROYAL INSTITUTION.

It would be wrong to leave London without referring to the remarkable and unique establishment known as the Royal Institution, founded in 1799, at the suggestion of Count Rumford, and celebrated throughout the world as the theatre of the labours of Davy, Faraday and Tyndall, while in London itself it is known and valued as an agreeable and popular exponent of science by means of its lectures and discourses. The Royal Institution has a good building in Albemarle street, containing its theatre, laboratories, library and reading-room. Its function is two-fold. First, it sustains as its professors eminent scientific men, and provides them with the means for prosecuting original research; secondly, it provides, by its afternoon and evening lectures, the means of presenting to the more refined and educated classes information as to the latest results of scientific discovery from the lips of the actual discoverers themselves. Its lecture-room is always filled with a cultivated and attentive audience, who have the advantage of learning orally and at first hand what others must gather from reading, or from secondary sources.

The Royal Institution thus occupies a middle place between the general public and those Scientific Societies, like the Royal, Geological and Linnean, whose objects are strictly scientific or special, and whose meetings are consequently almost entirely composed of scientific men. At the same time, it promotes original research in a manner peculiar to itself, and in the highest degree successful. It undoubtedly exerts a most important influence in keeping those who move in the higher strata of society in London abreast of the science of the day, and thus in procuring moral as well as material support for scientific researches; more especially for those which, not being of direct educational or practical utility, are liable to be neglected even by the more intelligent portion of a community engrossed in the accumulation of wealth or in the still more laborious pursuit of spending it.

OWEN'S COLLEGE, MANCHESTER.

In the great manufacturing community of Manchester, academical education rears its head in an institution of no mean repute in the matter of science education. Owen's College is, like our own McGill, based on the liberality of a wealthy merchant, whose name it bears, supplemented by numerous additional benefactions. Among these I find a sum of £10,000, subscribed by 118 merchants and others, for a chemical laboratory and a library; a sum of £9,472 subscribed by the principal engineers of Manchester and neighbouring towns, for the foundation of a chair of civil and mechanical engineering, and a fund of £200 per annum to augment the endowment of the Professorship of Chemistry. These noble benefactions remind us of the liberality of some of our Montreal merchants and professional men, and should act as a stimulus to others.

I am indebted to Principal Greenwood and Professor Williamson for enabling me to learn the nature and results of the science teaching at Owen's College, which, in many essential respects, more nearly resembles one of our Canadian colleges than any other institution which I saw in England. The department of general literature and science, or, as we should say, the course in arts, extends over three years, and, like our own, includes a certain amount of modern languages, and physical, natural, and mental science. The department of theoretical and applied science, or science course proper, also extends over three years. The first is identical with the first in arts. The second and third are occupied entirely with science subjects, along with the French or German language. The students in this department are prepared for the Bachelor of Science examination at London. This course is said to be suited to prepare "for the higher departments of manufacturing art, and for pursuits and professions purely scientific." It is also said to be "adapted for such as are hereafter to be engaged in commercial pursuits," a remarkable testimony to the ideas of education on the part of business men at Manchester, who, in this respect, come up more nearly than any others in England and her colonies to the standard of the New England cities. The Principal informed me that there were, last session, 100 students taking this science course. The third department in Owen's College is that of civil and mechanical engineering, in which students are prepared for the examinations in engineering in the Indian Public Works Department, and also for entering on the higher branches of the engineering profession. The course extends over three years. It had only twenty students last year.

Another and most interesting feature of Owen's College, suited to its position in a great manufacturing town, is the provision made for evening classes. These include the subjects of the general course, and also a pharmaceutical course intended to prepare chemists and druggists for the examinations under the Pharmacy Act. Most of the students in these classes are what we would call partial students; but some study for the degree of B.A. of London University. The intention of the college is to accommodate those whose business engagements prevent them from attending lectures in the day time; and the number of students last year was no less than 400. This is a remarkable indication of the avidity for learning on the part of the young business men of Manchester, who enter on this somewhat severe course of study as an employment for their evenings, and after the toils of the day. It is further to be considered that many of these young men have to walk or drive considerable distances in order to attend these classes; but in all the cities of England distance is much less regarded than it is in this country. Prof. Roscoe delivers a separate course of lectures on chemistry to women, which, I was informed, had been successful, though I did not note the number of students. The authorities of the college have under consideration the establishment of a regular academical course for women, which will be largely of a scientific character.

Owen's College has its class rooms at present in an old building adapted to its use; but an elegant new building is now in process of erection at a cost of £90,000, and a sum of £130,000 is said to have been raised as a building fund. The foundation stone of this building was publicly laid in September last. It is to be observed that Mr. Owen wisely prohibited any portion of his endowment fund being expended in buildings, and that the Government of Great Britain has given no aid to Owen's College, so that this large sum is a product of private munificence, chiefly in the town of Manchester.

SCIENCE TEACHING AT CAMBRIDGE.

The two great English Universities of Oxford and Cambridge are obviously not content to lie under the aspersion some time ago cast on them by an eminent scientist that their "atmosphere" is unfavourable to scientific study. Both are making rapid strides in this direction.

At Cambridge, under the kind guidance of Prof. Stokes, himself one of the most eminent of living physicists, and of the patriarchal Sedgwick, and his able assistant Seeley, I saw the improvements which in late years have been made in the means of study in natural and physical science, and which tend, with other changes, to give greater effect to the regulations in favor of the natural science tripos. Still more recent movements in this direction are the appointment of a university professor of pure physiology, and the movement in aid of a university professorship and demonstratorship of experimental physics, towards the buildings and apparatus for which, the Chancellor, the Duke of Devonshire, has offered a contribution of £6,300.

WHAT OXFORD IS DOING.

Oxford has, however, taken the lead of its sister University in this matter, and I shall therefore notice more in detail what I had the pleasure of seeing there in the way of provision for practical science teaching.

The new museum, now of world-wide reputation, is not merely a museum in the more modern sense of the term, but a series of scientific laboratories and class-rooms, attached to a magnificent library and museum. The museum proper had been largely increased and improved in its collections since my last visit in 1865, and its great central glass-roofed court, more than 100 feet square, with its surrounding galleries, is now well filled with specimens in Geology and Zoology. On the south and west sides the museum is encompassed with class-rooms and laboratories in geology, chemistry and physical science. On the north side are the laboratories and class-rooms in physiology. Prof. Phillips was absent, owing to an attack of illness, and in his department I saw only assistants engaged in laboriously piecing together the huge bones of the Cetiosaurus, a gigantic reptile with thigh bones more than five feet in length, of which a magnificent skeleton has recently been discovered in a quarry not far from Oxford. I had, however, the pleasure of seeing the students at work in the laboratory of practical chemistry, under Prof. Brodie, and of examining the admirable arrangements of Prof. Rolleston for practical work in physiology. Among other things which I saw in the physiological laboratory, were excellent dissections of mollusks and worms made by students as a part of their examinations in the honour course of Natural Science.

Though the museum contains rooms for experimental physics, the University has greatly enlarged its means of instruction in this department, by the erection in the vicinity of the museum of a physical laboratory, which I believe will cost about £40,000, and which, in the perfection and completeness of its arrangements, will surpass all similar workshops of science, not only in England, but in the world. Prof. Clifton, who himself showed me the building, and explained its plan, has endeavoured to make this laboratory in itself a model of practical science, considered as the art of doing everything in the best way, by applying in the most perfect manner every known improvement and many original inventions of his own, to secure convenience and accuracy of working. The building has a central hall for apparatus, and for certain experiments requiring large space; a class-room, which is a model of acoustic perfection and mechanical arrangement; and a number of work-rooms, in which all the most delicate kinds of operations in weighing and measuring can be carried on with the best apparatus and with every precaution against error. This laboratory was to be opened in the present autumn, and I was informed by Prof. Clifton that he expected to begin with about thirty practical students. The object of the laboratory is two-fold—(1) to train observers and experimenters more thoroughly than heretofore; (2) to undertake original physical researches with more perfect appliances than those now available.

The Oxford new Museum, with the neighbouring Physical Laboratory, thus constitutes in itself a great educational institution in physical science, managed by some of the ablest instructors and original investigators of the day, and providing for studies in experimental physics, chemistry, mineralogy, geology, physiology, and zoology, botany being otherwise provided for in connection with the Botanic Garden: It has seven large class-rooms and a multitude of working-rooms and laboratories, with the scientific department of the Radcliffe Library. These appliances are as yet large in comparison with the number of students who use them; but the number of students is increasing, and this apparently not at the expense of the literary courses of study. It is to be observed, moreover, that the aim of the Oxford Science School is high. Its object is not so much to train practical workers in science as applied to the arts, as to give the education necessary to enable those who receive it to take their places as original investigators in the advancement of theoretical science, and in connection with this to bring out the true value of physical science as a means of securing the highest mental culture. Viewed with reference to these ends, Oxford is undoubtedly an excellent Science school; and a University which offers its highest honours, in courses, in which practical chemistry and physics, and dissections of invertebrate animals, constitute important parts, cannot be regarded as unfavourable to the cultivation of science. It must be admitted however that these improvements have been effected only after severe contests between the advocates of modern science and the conservative element in the University, contests in which my valued friend, Dr. Acland, well known to many of us here, has borne an influential part.

MOVEMENT IN EDINBURGH.

Edinburgh has as yet no organized Science school, and has undoubtedly been falling behind the English schools in its reputation for training in natural science. This is, however, a relative rather than an actual decadence, and there is a very strong desire on the part of many of the friends of the University to restore its ancient reputation in this respect. In evidence of this we have the recent endowment of the Baxter Chair of Engineering, and the still more recent offer of Sir Roderick I. Murchison to give £6,000 as the endowment of a Chair of Geology, which I am informed the Government is likely to supplement with a like sum. The Department of Science and Art has also attached to the University a museum on the plan of that of South Kensington, under Prof. Archer; but few lectures are delivered in connection with it. No Institution in Great Britain has a better field for science education than Edinburgh, and it possesses many excellent teachers, but their action is to some extent paralyzed by want of facility for mutual co-operation, and by the want of some professorships necessary to complete the course of study. In the meantime, there are excellent practical classes in chemistry, experimental physics and botany, and there is an academical course for a science degree. In this course the candidate is required to have the degree of B.A., M.A., or M.D., or to hold certificates of having passed the examinations in two of the departments of the University course, or to have matriculated in the University of

London. Otherwise he must pass a preliminary examination. He must then pass a general examination in mathematics, physics, chemistry, zoology, and botany; but may omit this examination if an M.A. who has taken honours in natural science, or an M.B. or M.D. who has taken honours in natural history, and has passed the examinations in physics, higher mathematics, and logic. There is then a final examination, in which the student may select one of three branches in which to pass, viz.: (1) Mathematical science; (2) physical and experimental science; (3) natural science. On passing this examination he is entitled to the Degree of Bachelor of Science; and at the end of twelve months may come up for the degree of Doctor of Science, in the examination for which he must show profound knowledge of a special scientific subject. The number of candidates for these degrees is not as yet large, but is increasing. They might obviously be rendered much more valuable and attractive by connection with special science courses, leading to applications to the arts or to definite branches of original research.

It may be well to mention here that the Principal of Edinburgh University, in his inaugural address, has suggested the omission of Greek from the University course for M.A., to make room for science culture, and that the chairman of the endowed Schools Committee has, as already mentioned, put this idea in a practical shape before the English Universities, in an official letter to the Vice-Chancellors, in which he intimates the design of the Commissioners to establish schools in which Latin alone shall be taught, in addition to science and modern languages and literature, and invites them to open their examinations for degrees and honours to the pupils of such schools. While it is to be doubted whether any such change is required here, where classics have not been so exclusively insisted on in the schools as in England, the arguments adduced by Lord Lyttleton in his circular are well deserving of study, as indicating the strong feeling among parents and educated persons in England that science education for their children is a matter of absolute necessity, and that, if it cannot otherwise be obtained, some portion even of their cherished literary culture must be sacrificed to a want, on the supply of which even national existence may depend.

GERMANY AND SWITZERLAND.

But though much is being done in England and the United

States, science and technical education are carried to a still higher point in Germany and Switzerland, which perhaps excel all other countries in this respect. In the former country, while every one is educated, general education is made to lead to technical education in a great variety of schools, suited topersons in all conditions of life, and culminating in the great technical Universities, a kind of institution as yet unknown in the English-speaking world, unless Cornell University can be regarded as a step in this direction. In Germany there are now no less than six technical Universities, and a large number of technical colleges or higher schools to train students for these Universities, or for directly entering into employments in arts and manufactures.

TECHNICAL UNIVERSITIES.

Mr. Scott Russell, in his work on Technical Education, takes the Polytechnicon, or Technical University of Switzerland, as an example of the most perfect organization of this kind; and I may abridge from his notes the following facts as to its scope and organization. Its courses of study are arranged under 145 subjects, divided among 31 professors, 10 assistant professors, and 16 private teachers and lecturers. They consist entirely of science, applications of science to the arts, and modern languages, literature and history. Among the few subjects not included under these heads are the Swiss federal consititution and rights, and the Biblical History of Creation, a subject scarcely thought of in the English world, even in the education of theological students. The students are either regular or "free," the latter taking selected courses; but of 762 students only 173 are free or occasional. In the regular programme of study the 145 subjects above referred to are divided into eight groups: (1) Preparatory subjects necessary for those who come imperfectly prepared; (2) subjects relating to architecture and building; (3) civil engineering; (4) mechanical engineering; (5) practical chemistry; (6) agriculture and forestry; (7) subjects necessary for scientific workers, professors and teachers; (8) a general course of philosophy, statemanship, literature, art, and political economy. In aid of these courses of study the University possesses an astronomical observatory, arranged for teaching observers; a chemical and mechanical laboratory, for experiments in new inventions, &c.; a chemical laboratory, for ordinary practical teaching, which Mr. Scott Russell calls a palace of science in comparison with similar places in England; collections of drawings, models and machines; a collection of architectural models and sculpture; collections in zoology, geology, and antiquities; and a botanical garden. To the foundation of the University the Federal Government of Switzerland contributed £20,000, and the canton of Zurich £136,000. Its annual expense is very moderate, being only £13,459 sterling. From such institutions in Germany and Switzerland annually proceed numbers of educated young men who are prepared to advance every branch of art by the applications of science, who are distancing England in so many manufactures, and who are now contributing so largely to the wonderful success of the German armies. It is well for us to remember that the Technical University of Zurich ministers to the wants of a population of only two millions and a half, or considerably less than that of Canada, and that even the little state of Wurtemburg, with a population of less than two millions, has its Technical University at Stuttgardt, with no fewer than 57 professors and teachers. It is further to be observed that these Universities are but the higher principles of a complete system of technical education, descending from them to the humblest schools of practical science, for the children of labourers. It is scarcely necessary to add that they do not detract from or interfere with the great general Universities of Germany, in which scholarship and philosophy have reached so high a pitch of development.

A recent English writer thus eulogizes the Prussian system :—

"The Prussians, whatever their other qualities, are emphatically a scientific people, and to that predominating characteristic first and foremost are their recent military triumphs due. We do not mean that because they are great chemists, astronomers, and physicists, therefore are they necessarily great soldiers; so narrow a proposition would hardly be tenable. What we mean is that the spirit of science possesses the entire nation, and shows itself, not only by the encouragement given throughout Germany to physical research, but above all by the scientific method conspicuous in all their arrangements. What does the word Science, used in its wider sense, imply? Simply the employment of means adequate to the attainment of a desired end. Whether that end be the constitution of a government, the organization of an army or navy, the spread of learning, or the repression of crime, if the means adopted have attained the object, then science has been at work. The method is the same, to whatever purpose applied. The same method is necessary to raise, organize, and equip a battalion, as to perform a chemical experiment. It is this great truth that the Germans, above all other nations, if not alone amongst nations, have thoroughly realized and applied. In all the vast combinations and enterprises with which they have astonished the world, no one has been able to point to a single deficiency in any one essential element. Every post has been adequately filled and every want provided for; from the monarch, the statesman, and the strategist, to the lowest grade in the army. This is the method of science, literally the same method which teaches the chemist to prepare his retort, his furnace, and his re-agents, before commencing his experiment."

WANT OF SCIENCE TEACHING IN CANADA.

Let us now turn to our own country, and study its means and appliances for the pursuit of practical science. The task is an easy one, for with the exception of two or three small and poorly supported agricultural schools, this Dominion does not possess a school of practical science. With mining resources second to those of no country in the world, we have not a school where a young Canadian can thoroughly learn mining or metallurgy; and, as a consequence, our mines are undeveloped or go to waste under ruinous and unskilful experiments. With immense public works, and constant surveys of new territories, we have not a school fitted to train a competent civil engineer or surveyor. Attempting a great variety of manufactures, we have not schools wherein young men and young women can learn mechanical engineering, practical chemistry, or the art of design, or we are very feebly beginning such schools. We have scarcely begun to train scientific agriculturists or agricultural analysts. Our means for giving the necessary education to original scientific workers in any department, or of training teachers of science are very defective. Hitherto we have been obliged to limit ourselves to the provision of general academical courses of study, and of the schools necessary for training men in medicine, law and theology. Other avenues of higher professional life are, to a great extent, shut against our young men, while we are importing from abroad the second-rate men of other countries to do work which our own men, if trained here, could do better. Let us enquire then what we are doing in aid of science education, more especially in this commercial and manufacturing metropolis of Canada, which we may surely venture to regard as at least a Canadian Manchester, and something more important than a Canadian Zurich.

WHAT IS BEING DONE IN MONTREAL.

(1) We have at least advanced so far as to regard physical science as a necessary part of a liberal education. In McGill University some part of natural or physical science is studied in each year of the College course, and we provide for honour studies in these subjects, which are at least sufficient to enable any one who has faithfully pursued them to enter on original research in some department of the natural productions and resources of the country, and to receive some considerable portion of the training which such studies can give. We have provided in our apparatus, museum, and observatory, the means of obtaining a practical acquaintance with several important departments of science. But in a general academical course of study too many other subjects require attention to allow science to take a leading place; and it is not the proper course of educational reform to endeavour to intrude science in the place of other subjects at least quite as necessary for general culture. We require to add to our general course of instruction special courses of practical science, presided over by their proper professors, and attended by their own technical students.

(2) The lower departments of science education are to some small extent provided for by the teaching of elementary science in the schools. This, imperfect though it is, is of value, and I attribute to the partial awakening of the thirst for scientific knowledge by the small amount of science teaching in the ordinary schools in the United States and in this country much of that quickness of apprehension and ready adaptation to new conditions, and inventive ingenuity which we find in the more educated portions of the common people. The Provincial Board of Arts and Manufactures also deserves credit for the attempts which it has made, under many discouragements, to provide science and art classes for the children of artisans. Proposals are also before the Local Legislature for Schools of Agriculture. The Local Government has procured reports on this subject from the Principals of the Normal Schools, and has also sent a special agent to study and report on the Agricultural Schools of France and Belgium, which are well worthy of imitation. A still more important sug-

gestion has been made to the Dominion Government by the Director of the Geological Survey for the erection of a School of Mining.

These arrangements and proposals are valuable as far as they extend; but they fall short of providing the full measure of the higher science education, whether with reference to the training of original investigators, or of the various kinds of professional men required for the developement of the resources of the country. Let us enquire how this wider and higher science culture can be secured.

SUGGESTIONS FOR HIGHER SCIENCE TEACHING.

The higher technical and science education may be provided for in either of the following ways. (1.) We may have special schools of mining, engineering, &c., each pursuing its own course, and not connected with any general institution. The objections to this are, that it is not economical, that it cannot provide the necessary literary and general training, that the pupils of such schools are very likely to be of various degrees of excellence and very partially trained. Such objections are applicable to schools like the Royal School of Mines in London, and I think they would prove fatal to the influence of such schools in this country. (2.) We might imitate the German technical universities. This would be the most thorough course possible; and were the means forthcoming, I cannot conceive of any greater educational benefit to this country than the institution of such an University. But it may be long before we shall find in our Legislatures, general and local, the wisdom and patriotism which actuated those of Switzerland in establishing the Zurich School; and we may have to wait quite as long for the appearance of a Canadian Cornell to give and to stimulate legislative liberality by his giving. (3.) The last, and, it appears to me, the only practicable course at present, is to ask for endowments similar to those of Lawrence and Sheffield, and thus to establish special courses of Science in connection with academical institutions, on the plan so well carried out in Owens' College, Manchester, and in the Sheffield School of Yale. This has proved the course most successful in the United States and in the Mother Country, and I have no doubt will prove so here. It is to be observed in this connection that I would not propose merely the institution of a Science degree. We have in this University the means to do this now, but I doubt its expediency, more especially as our honour course in Mathematical and Natural Science is equivalent to that for such a degree and something more, and can be as readily and easily pursued. Nor could I follow the advice above referred to as given by the Principal of Edinburgh University and the chairman of the Endowed Schools Commission, to curtail the classical part of the ordinary course in favor of science studies. Such an arrangement would, I have little doubt, injure the literary part of the academical course more than it would benefit science. I would prefer a regular and definite science school, with a course extending over three or four years—the first year to be identical with or similar to that of the ordinary course, or an equivalent examination to be exacted, at least, in modern literature and science; and the remaining years to be occupied with mathematical, physical and natural science, and modern languages, branching in the closing two years into special studies leading to particular scientific professions. The staff and appliances of such an institution would depend on the extent of its range; and this, to ensure success, should not be small.

It may be asked, would students be forthcoming? I may with confidence answer the question in the affirmative. From the applications made to me on the part of young men for whom I can do little or nothing, I believe that one central well-appointed technical university in this Dominion, would be well sustained, in so far as the number of students is concerned; and that the extension of population, of mines, manufactures, railroads, and other works, would afford an ample outlet for all the men it could train, while the professional work of such men would itself tend to increase the demand.

It is certain, however, that if the Government of this country could be induced to sustain a system of elementary technical schools similar to those of the Department of Science and Art in England, or similar to those of Prussia, a double benefit would be secured, in so far as the higher science education is concerned, in finding occupation as teachers of science for some of the graduates, and in giving the necessary preliminary training to students. At the same time the effects of such schools would be of incalculable importance to the working classes of this country. Local benefactors might do something for such schools; but for a proper system the Legislature must intervene, and it can secure the end only by payment for results on the English system, under proper arrangements for examination and inspection.

THE EARTHQUAKE OF OCTOBER 20th, 1870.

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

One of the uses of this Journal is to record, in a permanent manner, any rare or unusual natural phenomena, the notices of which, in the daily and weekly press, would soon perish. This function the *Naturalist* has hitherto performed with respect to Earthquakes. In our number for October, 1860, a detailed account was given of the Earthquake of the 17th of that month, which, in many respects, resembled that of this year.

In connection with that event, a general notice of the received theories of Earthquakes was given, and also a catalogue of all the previously recorded Earthquakes felt in Eastern America, about 87 in number, of which at last 29 were felt in Canada, more or less severely—by far the most violent having apparently been that of February 5th, 1663.* The next earthquake of any importance was that of April, 1864, a detailed notice of which will be found in the *Naturalist*, Vol. 1., N.S,. p. 156.

The following extracts from newspapers show the intensity of the shock, and, approximately, its time at different places, arranged in the order of their longitudes.

Fredericktox, N. B. — Shock felt at 11.45.

Bic. — An earthquake was sensibly felt here at 11.30 this morning, lasting half a minute. The direction seems to be from West to East.

River du Loup, *en bas*, 11.13. — The shock commenced and lasted 45 seconds; appeared to come from N. W.; accompanied by rather heavy rumbling.

Point Levi, 11.15. — A dreadful shock of earthquake was felt here at 11.15.

Quebec.—At 11.17 a.m. a severe shock of earthquake was felt here. Buildings shook and bells rang; several chimneys were knocked down in Desfosses street, and two persons nearly killed.

Boston.— A shock of earthquake was felt here and all along the line from Montreal.

The Earthquake. — Inverness, P. Q., Oct. 20th. — A severe shock of earthquake was felt here to day at about 11.25 a.m., which lasted for over a minute. The course of the undulation seemed to be in an easterly direction. It caused great alarm in this vicinity.

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*Canadian Naturalist, 1st Series, Vol. V. p. 363.

SHERBOOKE.—Felt earthquake here at 11.25. Shook the office books off the table, and the clock down.

RICHMOND, 11.17 a.m.—A severe shock just felt here. Buildings at station rocked a good deal.

DURHAM, P. Q., Oct. 20.—A slight shock of an earthquake passed here about 11.15 a.m., moving north. It shook the houses quite perceptibly, and lasted several moments.

THREE RIVERS, 11.25.—A very severe earthquake has been experienced in this city. The vibrations were very severe, lasting several minutes. The people ran out of their houses.

NICOLET.—A violent earthquake was felt here at 11.19. The whole building tottered, as if about falling. It lasted about 20 seconds.

BERTHIER.—We had an earthquake very strong in Berthier at half-past eleven to-day.

SOREL, 11.14 a.m.—A shock of earthquake was distinctly felt here, of nearly a minute duration.

ST. HYACINTHE.—A strong shock of earthquake was felt here at 11.15, lasting about thirty seconds.

WATERLOO VILLAGE, P. Q., Oct. 20th.—The shock of an earthquake was felt here at 11.30 to-day; duration about fifty seconds. It commenced with a low rumbling noise. Buildings shook and trembled, and people rushed out of their houses terrified.

ROUSE'S POINT, 11.20.—Severe shock of earthquake here. The Railroad depot shook very much.

ST. JOHN'S P. Q.—Quite a severe shock of earthquake at 11.15.

MONTREAL.—The shock was felt at Quebec about 30 seconds before it reached here. The operator at Quebec was just in the act of asking his *confrere* of Montreal if any shock was felt, when wall and instrument began to rock and shake.

ALBANY.—Not felt within 16 miles from here. Felt in Schenectady, N. Y., Cambridge, N. Y., and Cooper's Town, N. Y.

NEW YORK.—A severe shock of earthquake was felt in this city this morning about 11 o'clock. Shocks were also felt in Schenectady, N. Y., Cleveland, O., Boston, Burlington, Vt., Portland, Me., Troy, Saratoga, Warrensburg and Warsaw, N. Y.

ST. ANDREWS.—Shock of earthquake this morning; lasted 30 seconds.

L'ORIGNAL, 11.15.—We felt a very severe shock of earthquake, which lasted about half a minute. It shook the Court House in which the telegraph office is.

COTEAU LANDING.—Severe shock of earthquake this morning; shook buildings.

OTTAWA, Oct. 20. — A strong shock of earthquake here this forenoon. Drizzling rain and cold.

ST. CATHERINES.—A shock of earthquake felt here.

OWEN SOUND, Oct. 20.— A shock of earthquake was felt here this morning, commencing at 10.52, and lasted about 3 minutes.

In several places it is noticed that the shock was much more severe on sandy and loose ground than on solid rock. This is an ordinary occurrence, depending on the rapid and unobstructed passage of the vibrations through solid rock. This same cause no doubt accounts for the circumstance that at some places the shock was not felt at all, while in others not far distant it was felt severely.

The following notice sent to one of the newspapers by Mr. Bennetts, of the Capel Mine, is curious, as in other cases such shocks are often felt severely in mines; but the rapid or vertical transmission of the shock may account for it in connection, perhaps, with the direction of the vein and of the workings.—"At this mine the shock of the earthquake was very plainly felt at the surface; but at the time of its occurence I was some 200 feet underground and neither the miners, of whom there were about twenty, nor myself, felt the shock or noticed anything unusual. Could it be ascertained, it would be interesting to know to what extent other mines were affected by such an unusual occurrence."

On the other hand I am informed by Mr. James Douglas, of Quebec, that in the Harvey Hill Mine, in rock not dissimilar from that at the Capel Mine, and in the same region, though more to the eastward, the shock was sufficiently violent to throw down masses of rock, and greatly to terrify the miners, then at work in the mine.

In a notice contributed to Silliman's Journal, for November, by Prof. Newton, it is stated that the first shock began at New Haven, at 11h. 19.m 45s. A.M., New Haven mean time. "It lasted 10 seconds, and its individual vibrations were about two thirds of a second in duration, or one and one third of a second for a complete double vibration. The second series of vibrations occurred after an interval of 5 seconds, and lasted 11 seconds.

The direction of vibration was NNE and SSW. It was felt at Boston a minute and three quarters before reaching New Haven. At Cleveland, Ohio, it was felt at the same time as at New Haven. "Slight vibrations were felt as far south as Richmond, Va., and as far west as Dubuque, Iowa." Prof. Bell, of the Geological Survey, informs me that the shock was felt at Sault St. Marie, and on the North Shore of Lake Superior, and was accompanied by a cracking or rending sound in the rocks.

The following account of the Meteorological Phenomena, attending the earthquake at Montreal, is contributed by Dr. Smallwood of the McGill College observatory.

"Rain fell on the 13th day, followed by a rise in the Barometer, and a splendid display of the Aurora Borealis on the night of the 14th day. Numerous and very large spots were present on the solar disc, which had been the case for some considerable time, more especially during the presence of the Aurora on the nights of the 23rd, 24th, 25th, and 26th days of last month (September.)

"The maximum reading of the Barometer at 7 a. m. on the morning of the 16th day, indicated 30.215 inches, and was succeeded by a very fine, warm day, the mean temperature of which was 63.9 degrees, wind S. W. Showers of rain fell on the 17th from 10 a. m. till 3 p. m., with a west wind and with a falling Barometer, which at 9 p. m. of that day stood at 30.000 inches. From 1 a. m. of the 18th (Tuesday) a very rapid and sudden fall was observed, viz: 0.639 of an inch in six hours, and it attained its minimum, 29.361 inches, at 7 a. m. on that day.

"From that hour a gradual and somewhat sudden rise took place accompanied by a very heavy gale of wind. The clouds were passing from the West, but the wind veered to all points of the compass. The register of the Anemometer at the Observatory shows a complete disc of concentric circles, with a velocity varying from 35 to 15 miles per hour.

"There was also a rise of 0.507 of an inch in the Barometer, with a falling temperature. Frost occurred during the night, and a good breeze continued from the West. The Thermometer at 7 a. m. showed 33.1 degrees, and the Barometer 30.070 inches.

"From this time the temperature rose and the Barometer fell, and this morning at 7 a. m., stood at 29.499 inches. Rain set in during the night, and at 7 o'clock 0.214 of an inch had fallen. Thermometer 42 degrees. Wind S. W. Mean velocity, 3.14 miles per hour.

" At 11 h. 17 m. Montreal mean time, a very considerable shock of an earthquake was felt generally throughout the city; the first series of vibrations lasted for from 10 to 15 seconds, and was succeeded by a slight interval of a few seconds, when a second shock occurred, of less duration and of less intensity, lasting from 5 to 8 seconds. No wave of sound was perceptible, and the wave of motion was undulating and in a straight line (rectilinear) and of considerable relaxation. Domestic articles rocked to and fro, but no damage to buildings has resulted.

" The magnets were very seriously affected at 10.30.

" The barometer continued to fall after the first shock. At 2 p. m. it stood at 29.299 inches; thermometer 44.8 degrees; wind S. W., with rain. Professor Kingston telegraphed me that the magnets at the Toronto Observatory showed slight shocks at 10 minutes to 11."

" As usual with Canadian earthquakes, this was felt most severely on the Lower St. Lawrence, more especially at the junction of the Lower Silurian and Laurentian formations in the vicinity of Bay St. Paul, Murray Bay, and the Saguenay. The following graphic account is given by Rev. Mr. Plamondon, Parish Priest of Bay St. Paul, in a letter to "*L'Evenement*."

" Un mot à la hâte pour vous faire connaître les désastres causés, tout à coup ici et dans les environs, par le tremblement de terre le plus étrange qui soit arrivé de mémoire d'hommes. Environ une demi-heure avant midi, un coup de foudre (c'est la seule dénomination que je puisse lui donner) une énorme détonation a jeté tout le monde dans la stupeur et la terre s'est mise non à trembler, mais à bouillonner de manière à donner le vertige, non-seulement à tous ceux qui étaient dans les maisons, mais encore à ceux qui étaient en plein air. Toutes les habitations semblaient être sur un volcan, et la terre se fendillant en cinq ou six endroits, lançait des colonnes d'eau à six, huit et peut-être quinze pieds en l'air, entraînant après elles une quantité de sable qui s'est étendu sur le sol. Presque toutes les cheminées se sont écroulées, de sorte que je ne pense pas qu'il en soit resté six debout dans tout le village. Des pans de maisons se sont abattus, et ici et là les poêles, meubles et autres objets ont été renversés, emportant avec eux les ustensiles, la vaisselle, etc.

" Notre couvent, qui était sous la direction des bonnes sœurs de la Congrégation est inhabitable pour le moment, trois cheminées et le plafond des mansardes étant démolis en partie. Trois élèves et une servante de cet établissement on été blessées par des pierres provenant de l'éboulement des cheminées : cependant aucune d'elles n'est gravement atteinte.

" L'église a beaucoup souffert ; une partie de son portail s'est écroulée, emportant un morçeau de la voûte, et le reste des murs est tellement lésardé qu'il est douteux qu'on puisse les réparer.

" La stupeur a été telle que pendant les trois ou quatre minutes qu'a duré la secousse, tout le monde pensait que c'en était fini. et que nous allions tous périr. Nous sommes encore sur le qui vive ; car de temps en temps de légères secousses se font encore sentir. Chacun redoute la nuit prochaine et se demande où il sera demain matin. Il est certain que si cette catastrophe fut arrivée pendant la nuit, nous aurions à déplorer la perte d'un grand nombre de vies.

" Il nous est venu des gens de diverses concessions, de sorte que nous avons des nouvelles d'un circuit d'environ quatre lieues et nulle part il n'est resté une habitation intacte, partout la secousse a été aussi violente. A l'heure où j'écris ces lignes, la terre tremble encore, et qui sait si je pourrai terminer. Aussi veuillez excuser le décousu de ces quelques détails que je vous donne à la hâte, ainsi que les fautes qui peuvent s'y être glissées."

Other correspondents mention the opening of chasms in the ground, from which streams of water and sand burst forth. This phenomenon arises from the landslips produced in the terraces of Post-pliocene clay which in that part of the country rest against the steep sides of the Laurentian hills. These are ready to slide downward with any slight movement of the earth, and to press the water out of the sandy layers associated with them, or give outlet to hidden springs and streams.

It is also stated, that a mass of rock 400 feet in length fell from the face of the cliff, at Cape Trinity, in the Saguenay. Cape Trinity is a cliff of Laurentian gneiss, presenting to the river a vertical front about 1500 feet high.

It will be observed that the earthquake of Oct. 20th extended over 25 degrees of longitude, from the Bay of Fundy westward, and over at least 12 degrees of latitude from the North Shore of the St. Lawrence, southward. Its extension to the northward into Rupert's Land, is not yet known.

The general direction of the vibration, as shown by the times at the different places mentioned above, and by observations of Prof. Winslow, at Cambridge, and by Mr. Douglas, at Quebec, was from north east to south west. The shock must therefore have been propagated from the Laurentian regions north of the St. Lawrence, into the Silurian and later formations to the southward. This is of interest in connection with the facts already related as to its severity at the edge of the Laurentian formation at Bay St. Paul, and elsewhere.

It is also deserving of notice, that at Bay St. Paul and Les Eboulements several shocks are recorded; and that additional shocks are stated to have occurred at the latter place on the 26th October, six days after the principal shock.

It has been observed on previous occasions that the Barometer is low at the time of the occurrence of earthquakes, in Eastern America. Dr. Smallwood, has kindly furnished the following table in illustration of this. It gives the state of the Barometer at Montreal, on the days of eleven of the most recent earthquakes felt here.

Date of Earthquake.		Barometer.
1855.	Feb. 8	29.806
—	— 19	29.800
1856.	Jan. 1	30.163
1857.	Oct. 16	29.308
1858.	Jan. 15	30.292
—	May 10	29.800
—	June 27	29.800
1860.	Oct. 17	29.964
1864.	Apr. 20	29.900
1870.	Mar. 4	30.300
1870.	Oct. 20	29.299

It will be observed that the Barometer was unusually low on the day of the late earthquake, and according to information kindly sent to Dr. Smallwood from the observatory at Washington, this was very general over the continent.

It is thus extremely probable, that, whatever the primary cause of the movement, its occurrence on the particular day in question, may have been determined by this removal of pressure from the surface of the land. It is further to be observed, that this would place the phenomena in harmony with that general cause to which the frequent small earthquakes on the Eastern Coast of America, were formerly assigned by the writer, namely the removal of material from the land, and its accumulation on the banks off the American Coast, producing unequal pressure and consequent tension of the earth's crust, and this connected with the ascertained slow subsidence of the coast, and perhaps with slight elevation of the interior of the continent.

In a notice of the earthquake in *Silliman's Journal*, for January, 1871, by Mr. A. C. Twining, the following statement occurs with reference to the intensity of the shocks at Bay St. Paul and Les Eboulements—" They are in general conformity to what has long been known to British geologists, respecting the volcanic character of the region specified," with some other remarks based on this strange statement, which has actually no foundation in fact, other than the junction, at those places, of the Laurentian and Lower Silurian rocks, and the occurrence of thick beds of Post-pliocene clay, resting on inclined rock surfaces, and therefore very liable to slip. Captain Bonnycastle's ideas on the subject, referred to by Mr. Twining, were probably founded merely on the irregular contour of the surface, the occurrence of crystalline Laurentian rocks, and the exaggerated accounts of land-slips in previous earthquakes, contained in the memoirs of the Jesuits.

NOTE.—A slight shock of Earthquake was felt at Hawkesbury on the Ottawa, on the 3rd January. Dr. Smallwood states that, though not appreciable at Montreal, it was indicated by the Seismometer.

NOTES ON THE BIRDS OF NEWFOUNDLAND.

By HENRY REEKS, F.L.S., &c.

(Continued from page 159.)

TETRAONIDÆ.

Canada Grouse, or *Spruce Partridge*, Tetrao canadensis, *Linn.* —A very rare and uncertain visitor from the mainland: two killed, and two others seen by the settlers during my residence at Cow Head.

Willow Grouse, Lagopus albus (*Gmelin*).—Common throughout the year, and the only lowland or subalpine species indigenous to Newfoundland. From my own experience I think the willow grouse invariably roost on the ground, although I have frequently shot them when feeding in the tops of birch and alder trees, more especially when the ground is covered with deep and light snow. Their food consists chiefly of the buds and tender shoots of birch, alder, black spruce (*Abies nigra*), juniper (*Larix americana*), &c., but they seem partial at other seasons to the partridge berry (*Mitchella repens*) and cranberry (*Oxycoccus palustris*). I do not possess specimens of willow grouse from Europe or northern North America (Hudson's Bay, &c.), but Professor Baird says, "I find a considerable difference in different specimens of the large ptarmigan [L. albus] before me. Those from eastern Labrador and Newfoundland appear to have decidedly broader, stouter and more convex bills than those from the Hudson's Bay and more northern countries. I think it not improbable that there may be two species. . . . ." Professor Newton, however, informs me that "none of Professor Baird's later writings have gone to strengthen the suspicion expressed by him formerly as to the existence of a second species of willow grouse," and adds, "I have compared a pretty good series of skins from many parts of North America, extending from Alaska to Newfoundland, and so far as I can judge I have no doubt they are all of one and the same species, which is further identical with the willow grouse of Europe (*Tetrao saliceti*, Temminck; *T. subalpinus*, Nilsson)." I have never suceeeded in driving the willow grouse into a bank of snow, as Sir John Richardson states in 'Fauna Boreali Americana,' vol. ii., p. 352, as being a habit peculiar to the species, nor had the settlers observed anything of the kind. They are sometimes so tame that they may be killed with a stick; at other times so wild that they will not allow you to approach within gunshot, and such is generally the case in winter when the snow is hard and crusty, and the noise of your rackets (snow-shoes) alarms them. They are shot at all seasons by the settlers, and generally when sitting on the ground although there is every excuse for doing so, especially in thick woods, for if once flushed there is rarely a chance of coming up with the covey again, and this an important consideration where food and powder and shot are not too plentiful among the poorer population. In one of my walks soon after I landed on the island I came up with a small covey of willow grouse and killed a brace, but owing to my dog—a borrowed one, which was evidently more used to rushing into the water for wounded seals and ducks, than retrieving grouse,—I was unable to get another shot at the birds. Upon showing the brace I had killed to the owner of the dog, on my return, the following conversation ensued :—" Got two *pattridges* then, sir ?" " Yes." " All there was there, I 'spose ?" " Oh, no ; there were ten in all, I think." " Then they was wild I 'spose, sir ?" " No, they allowed me to get sufficiently near to kill one with each barrel as they rose." " What, sir, you never fired at 'em to wing !" " Of course I did ; how would you have me shoot at them ?" " Why, sir, if I had been there I should have walked round and round them *pattridges* till I had got 'em all in a heap, and then I should have killed nearly all at a shot: I never heard of nobody firing at a *pattridge* to wing." If the settlers could be induced to observe a close time for these and other valuable game birds, the practice of shooting them in this apparently wholesale manner would not greatly diminish their numbers. The willow grouse is called *the* " partridge" by the settlers, and frequents beds of alder and dwarf birch in swampy places, especially on the borders of lakes and rivers. It breeds on the ground among stunted black spruce, in rather drier situations. One peculiarity in the Newfoundland bird is, that I have *very rarely* found the middle, or incumbent pair of tail-coverts " entirely white" in winter, as they are stated to be in ' Birds of North America,' p. 634.

Rock Ptarmigan, L. rupestris (*Gmelin*).—A truly alpine species in Newfoundland ; rarely found below the line of stunted black spruce, except in the depth of winter, when they descend to the low land and feed on the buds of dwarf trees, sometimes in company with the willow grouse, but I never saw this species perch on trees : it is called by the settlers the " mountain partridge."

GRUIDÆ.

I was informed by one of the settlers that a " brown crane" was killed a few years since at Codroy, Newfoundland, and some others seen. I am of opinion that they must have been " stragglers," and it is therefore hard to determine the species. Did they really belong to the genus *Grus ?*

ARDEIDÆ.

American Bittern, Botaurus lentiginosus, (*Montagu*). — A summer migrant to Newfoundland, and the only species of the heron family that I met with. A pair of bitterns are generally found frequenting the margins of wooded lakes and ponds in the lowlands throughout the summer, arriving early in May and departing again about the last of September. Yarrell describes the legs and feet as "greenish brown;" they are, however, of a pretty yellow-green, but soon lose this colour after death. The American bittern makes a curious thumping noise, very much resembling the noise made by fishermen when driving oakum into the seams of their boats; hence probably arose its popular name of "stake-driver" in the United States, and "corker" (? caulker) in Newfoundland.

CHARADRIDÆ.

American Golden Plover, Charadrius virginicus (*Borck*).—Visits Newfoundland abundantly in the autumnal migration, but very rarely, if at all, in the vernal.

Killdeer, Ægialitis vociferus (*Linn.*)—Not so common as the preceding, otherwise the remarks on that species are equally applicable here.

Ring Plover, or *Semipalmated Plover*, A. semipalmatus (*Bon.*)—A summer migrant and breeds on the coast: this and the following species are called "beach birds."

Piping Plover, A. melodus (*Ord.*)—Appeared to be a common autumn migrant, congregating in large flocks.

Grey Plover, or *Blackbellied Plover*, Squatarola helvetica (*Linn.*)—Very common in the fall of the year, but I did not meet with it in spring: the plovers evidently take some other, and probably more direct route than *viâ* Newfoundland to their breeding grounds in the far north.

HÆMATOPODIDÆ.

Turnstone, Strepsilas interpres (*Linn.*)—Abundant on the sea-shore in the fall of the year, and generally so fat that the settlers have bestowed on it the appropriate name of "fat oxen."

Of the Recurvirostridæ I did not meet with either Recurvirostra americana, Gmelin, or Himantopus nigricollis, Vieillot, although both, but more especially the former, may reasonably be expected to occur periodically.

PHALAROPODIDÆ.

Red Phalarope, Phalaropus fulicarius (*Linn.*)—Visits Newfoundland generally in the month of June, and is sometimes tolerably common, but I doubt whether it breeds on the island. This is undoubtedly our old friend Phalaropus lobatus in its nuptial dress, and the American authors have done well in restoring to it the Linnean name of fulicarius, because it is yet a matter of doubt whether the Tringa Lobata of Linnæus in Systemæ Naturæ ever applied, or was intended to apply, to this species. It is the only species of phalarope I got in Newfoundland, and was called by the settlers the "gale bird." It is wonderful to watch these pretty and delicate-looking little birds swimming and taking their tiny food from the crests of waves that would "swamp" any boat and many schooners. They are very tame, and swim almost within arm's length of the rocks, giving one the idea that the next immense wave which is fast approaching will cast them on shore, or smash them against the rocks: at such times it takes a quick shot to kill them on the water.

Scolopacidæ.

European Woodcock, Scolopax rusticola, *Linn.*—A single specimen is said to have been killed in the neighbourhood of St. Johns, in January, 1862 (See "Ibis," 1862, pp. 284, 285). If no deception has been practised here, it is certainly a very extraordinary capture, as is also that of another specimen since taken near New York. To those who have spent any length of time on the coast of North America, the problem of the occurrence of so many American birds in Europe is soon solved: it is undoubtedly caused by the prevalence, especially in the fall, of great gales of westerly winds, which probably take most of our American stragglers off the east coast of Newfoundland; but how to account for the appearance of two stray specimens of S. rusticola being killed in America—far apart, but in each case near a populous city, and by those so well up in ornithological literature as to be aware of the value of such captures, presents a difficulty by no means so easily disposed of. Of course it is probable that land birds may occasionally get blown off our west coasts by rough easterly winds, but it is equally probable that before they had gone one-third across the Atlantic they would take the wind dead ahead, which would cause them to 'bout ship and be thankful for a fair breeze home. It does not require a great stretch of the imagination to account for the appearance of an Icelandic species in Greenland, or the northern parts of the American continent, or even in Newfoundland, but if I remember right the European woodcock is not found in Iceland.

American Woodcock, Philohela minor (*Gmelin*).—Probably occurs on the island, but my accident prevented my thoroughly searching situations likely to produce this species. It would only occur as a summer migrant.

Wilson's Snipe, Gallinago Wilsoni (*Temm.*)—A common summer migrant, arriving generally about the last week in April, and soon commences breeding. When the female is sitting on her nest the male frequently rises in the air, drumming and making a peculiar rushing noise with its tail, which may be heard a considerable distance.

Gray Snipe, Macrorhamphus griseus (*Gmelin*).—A summer migrant. The remarks appended to the proceeding species appear equally applicable to this.

Gray Back; Robin Snipe, or *Knot*, Tringa canutus (*Linn.*)—Visits Newfoundland only in its periodical migrations.

Purple Sandpiper, Tringa maritina, *Brunnich.*—A summer migrant, but rather rare at Cow Head; probably more common on the southern shores of the island.

American Dunlin, T. alpina. var. americana, *Cassin.*—A summer migrant, but much more abundant in the fall of the year.

American Jack Snipe, T. maculata, *Vieill.*—A summer migrant, and tolerably common.

Least Sandpiper, T. wilsonii, *Nuttall.*—A common summer migrant.

Bonaparte's Sandpiper, T. bonapartii, *Schlegel.*—A common summer migrant, collecting in flocks in the fall of the year at the seaside, and generally so tame that a dozen to twenty may often be killed at a shot. This remark applies also to some other allied species of sandpipers and small ringed plovers which congregate on the coast every autumn, from some flocks of which upwards of sixty have been killed at a shot; giving some idea of the immense quantities of these little birds. The pretty little pigeon hawk (*Falco columbarius*) is a cruel attendant on these flocks of small Tringæ. Professor Newton informs me that "Tringa bonapartii is the Schinz's Sandpiper of Yarrell and other English authors, though not the true T. schinzi."

Sanderling, Calidris arenaria (*Linn.*)—Visits Newfoundland periodically: abundantly in the fall, but very sparingly, if at all, in the spring.

Semipalmated Sandpiper, Ereunetes petrificatus, *Illiger.*—Another common species on the coast in the fall.

Stilt Sandpiper, Macropalama himantopus (*Bon.*)—Not common at Cow Head. I killed one specimen in September, 1867, and saw a few others which appeared of the same species.

Willet, Symphemia semipalmata (*Gmelin*).—Common in the fall of the year, especially in the spotted or immature plumage.

Tell Tale, or, *Stone Snipe*, Gambetta melanoleuca (*Gmelin*).—A summer migrant, but not so common as the following species.

Yellow Legs, or *Yellowshanked Sandpiper*, G. flavipes (*Gmelin*). —A summer migrant, arriving in May and departing again in October. A great many pairs breed in the marshes, but I think the majority pass on to more northern regions, and return in August and September in increased numbers, generally at that season very fat and much appreciated for the table, but being small birds they are not usually shot at by the settlers unless four or five can be killed at a shot. Sometimes they are very tame and take little notice of men or dogs: at other times they are so wild that I know no bird more difficult of approach, and then they are a perfect nuisance to the sportsman, as they not only keep out of range themselves, but alarm every other bird by their incessant cry of "twillick," "twillick." Many a blessing (?) have I bestowed on these birds when, after crawling on my hands and knees a quarter of a mile through long wet grass on boggy soil to get a shot at a flock of black ducks (*Anas obscura*), I have heard the everlasting "twillick" and seen the ducks take wing instantly, perhaps not eighty yards from me. I fear, since my visit, many a skeleton of poor "twillick" lies bleaching in the marshes by the sea-coast near Cow Head. Provincial names of this bird are "twillick," "twillet" and "nansary"—the latter name more frequently in the south of the island.

Solitary Sandpiper, Rhyacophilus solitarius (*Wilson.*)—Not uncommon in summer, generally towards autumn.

Spotted Sandpiper, Tringoides macularius (*Linn.*)—A common summer migrant, arriving early in May: breeds on the coast, and lays its four eggs sometimes in a hollow on the bare shingle; at other times in short grass, but always just above high-water mark. Provincial name "wagtail."

Bartram's Sandpiper, Aetiturus bartramius (*Wilson*).—Visits Newfoundland periodically, but it is rarely met with during the vernal migration. I doubt if it breeds in Newfoundland, although known to do so on the mainland both north and south of that island. Like the peewit at home this species prefers inland and cultivated districts.

Buffbreasted Sandpiper, Tryngites rufescens (*Vieill*).—A summer migrant, but not very common. I did not succeed in taking eggs of this species, but I think it breeds on some of the drier spots in marshes in Newfoundland.

Marbled Godwit, Limosa fedoa (*Linn*).—Only a periodical visitor; most common in the fall. This and the following species are called "dotterels" by the settlers.

Hudsonian Godwit, L. hudsonica (*Latham*).—Visits Newfoundland in its periodical migrations, but is most common in the fall of the year, when it is generally very fat and much appreciated for the table.

Longbilled Curlew, Numenius longirostris, *Wilson*.—A periodical migrant much sought after by the settlers, who are great adepts in imitating its whistle, by which means they kill many that would otherwise pass a long distance out of range. It is a fat, good-eating bird in the fall.

Hudsonian Curlew, N. hudsonicus, *Latham*.—Frequently confounded by the settlers, under the name of "Jack Curlew," with the preceding species, with which it is about equally common, and like that visits Newfoundland in its migrations, but does not breed there.

Esquimaux Curlew, N. borealis (*Forster*).—By far the most common species of curlew, but like the preceding species is only a periodical visitor; coming by thousands in the fall, but very rarely in the spring; in fact, I think they take some other and more direct route at that season. They feed on the berries of *Empetrum nigrum*, which stain the feathers posteriorly a rich dark purple. These birds arrive in Newfoundland on their migration about the last week in August, and remain until the end of September, when they are always very fat, and delicious eating. I was told by one of the old English settlers that they were so abundant some seasons that he had himself shot fifty in one morning before sunrise.

Virginia Rail, Rallus virginianus, *Linn*.—A summer migrant, and apparently rare — I saw only one specimen; but the well known habits of the *Rallidæ*—that of concealment among reeds in marshy places—may account for a seeming paucity in individuals.

Common American Rail, Porzana carolina, *Vieill*.—A summer migrant, and, although not common, is probably more so than the preceding.

American Coot, Fulica americana, *Gmelin*.—Although this bird is perhaps a regular summer migrant to Newfoundland I never met with it, neither do I think it is *the* "Coot" of the settlers; if so, I know it is frequently confounded with *Pelionetta perspicillata (Linn.)*, the surf scoter.

ANATIDÆ.

American Swan, Cygnus americanus ? *Sharpless.*—Apparently a rare and accidental visitor to the western coast of Newfoundland: I saw only one specimen, which was an adult bird flying south in the fall of 1867.

Snow Goose, Anser hyperboreus, *Pallas.*—Very rare: I heard of one or two being obtained in the north of the island, and an equal number on the west coast.

American Whitefronted Goose, A. gambeli, *Hartlaub.*—Equally rare with the preceding, or perhaps more so. It seems extraordinary that these two common species of American geese should be so rare when we consider that Newfoundland, in one place, is only, separated by twelve or fifteen miles of water from the mainland.

Canada Goose, Bernicla canadensis (*Linn.*)—A regular summer migrant, and by far the most abundant species, arriving in April and in May by "countless thousands." The majority pass on to more northern regions to breed, although a great many remain for that purpose in Newfoundland; but, besides a general discrepancy in size, I have almost invariably found the northern migrants of this species much darker on the breast; in fact, so much so, that we used to call them the "little blackbreasted northerners." The colour of the "down" appears a good distinction between the sexes; on the male it is light gray, and on the female dark gray, almost black. This was pointed out to me by the settlers, who, however, know how to separate the sexes by the shorter bill and head of the goose. The Canada goose is greatly prized for the table, and the settlers are adepts in "toling" them within gunshot in the spring of the year, but it cannot be done in the fall, or during the autumnal migration: a dog is generally used for this purpose. The sportsman secretes himself in the bushes or long grass by the sides of any water on which geese are seen, and keeps throwing a glove or stick in the direction of the geese, each time making his dog retrieve the object thrown: this has to be repeated until the curiosity of the geese is aroused, and they commence swimming towards the moving object. If the geese are a considerable distance from the land, the dog is sent into the water, but as the birds approach nearer and nearer the dog is allowed to show himself less and less: in this manner they are easily toled within gunshot. When the sportsman has no dog with him he has to act the part of one by crawling in and out of the long grass on his hands and knees, and sometimes this has to be repeated continuously for nearly an hour, making it rather a laborious undertaking, but I have frequently known this device succeed when others have failed. The stuffed skin of a yellow fox (*Vulpes fulvus*) is sometimes used for toling geese, and answers the purpose remarkably well, especially when the geese are near the shore, by tying it to a long stick and imitating the motions of a dog retrieving the glove or stick. Foxes have frequently been observed to practice the same device in a state of nature, and the settlers who prize fur more than feathers commence toling poor Reynard within range of the fatal shot, which, strange to say, considering the general craftiness of the animal, is very easily done. The Canada goose may often be toled from a long distance when on wing, by "cronking" or imitating its cry. When these geese fly, either in pairs or in flocks, a gander invariably leads: this fact is so well known to the settlers that when firing at a pair of geese they invariably shoot at the hinder bird, not only because the goose is the fattest (in the spring), but because the gander will generally fly round and round its dead mate for some little time: such affection but too often proves fatal, especially when the shooter has the use of two barrels, but such is not generally the case among the settlers, who chiefly use the old-fashioned long duck guns, single barrelled, of ten or twelve bore. Ice-gazes and false geese are also employed on the ice for killing these beautiful birds in the spring of the year. Like the domestic goose, which has been known to live upwards of a hundred years, these birds are supposed by the settlers to live to a great age. A few years ago a specimen of the Canada goose was shot at Grasswater Bay, on the Labrador, which had a thin brass collar on its leg initialed and dated just thirty years previous to its capture. This species does not commence laying until three years old, and from examining the ovaries of several evidently young females I found them to contain from 180 to 190 eggs, which, averaging six per annum, would limit the laying period to some thirty or thirty-one years; so that, bar accidents, the birds would not probably live more than forty or forty-five years.

Brent Goose, B. brenta, *Stephens.*—Very common on the southern and western parts of Newfoundland, in its periodical migrations, but very rare farther north than St. George's Bay, in 48½ North latitude, or occasionally Port au Port, whence it crosses to Anticosti, and thence up the Labrador shore. Two specimens were said to have been seen on wing at Cow Head last spring (1868,) but the double-crested cormorant (*Graculus dilophus*) flies much like a small goose, and I fancy the birds thought to be Brents were of this species.

Mallard, or *Common Wild Duck*, Anas boschas, *Linn.*—Very rare; I only examined one normal specimen of this species, also one of the supposed hybrids, between this species and the Muscovy, (*Cairina moschata*,) which had been shot and skinned by two of the settlers a few years since, and preserved as curiosities. The larger bird was considered by them a drake of the domesticated variety, and I have certainly seen some of the descendants of the "Lincolnshire" breed much resembling it; but as I was informed no ducks, except eiders (*S. mollissima*,) were kept domesticated on the island, the bird had probably wandered north in company with a flock of some other species.

Black Duck, A. obscura, *Gmelin.*—This is the common wild duck of the island, and is abundant throughout the summer. It breeds among rushes and long grass on the borders of lakes and rivers, and lays from ten to fifteen eggs, which much resemble those of the preceding species. The black duck is much esteemed for the table, but is usually a very shy bird, and not easily approached, except from the leeward, as it will "wind you like a deer."

Pintail Duck, Dafila acuta (*Linn.*)—Very rare, but known to some of the settlers as the "long-tailed duck."

N. B. — The true "long-tailed duck" (*Harelda glacialis*) is called a "hound" in Newfoundland.

Green-winged Teal, Nettion carolinensis (*Gmelin.*)—A summer migrant, and appears to be the "common teal" of the island.

Blue-winged Teal, Querquedula discors (*Linn.*)—Rare in the neighbourhood of Cow Head, and probably nowhere on the island so common as the preceding species.

Shoveller, Spatula clypeata (*Linn.*)—A summer migrant, and generally distributed over the island, but is by no means common. It is called "Pond diver" by the settlers.

Gadwall, or *Gray Duck*, Chaulelasmus streperus (*Linn.*)—Rare: does not breed on the island, but is occasionally killed during its periodical migration.

Baldpate, or *American Widgeon*,* Mareca americana (*Gmelin.*)—A common summer migrant, and when fat one of the best flavoured of American ducks. The adult male of this species, which is called a "Cock Widgeon" by the settlers, is, in summer plumage and fresh killed, one of the handsomest ducks in Newfoundland.

English Widgeon, M. Penelope? (*Linn.*)—Although only a straggler to the continent of North America, it is not improbable that this species occasionally occurs in Newfoundland, especially *en route* from Greenland to the United States, whence most of the captures are recorded.

Scaup Duck, or *Big Blackhead*, Fulix marila (*Linn.*)—A very rare struggler to the N. W. coast.

American Scaup Duck, F. affinis, (*Eyton*).—Occasionally shot in spring or fall, but rarely seen at Cow Head.

Ring-necked Duck, F. collaris (*Donovan*).—Equally rare with the preceding species.

Aythya americana (*Eyton*) and A. vallisneria (*Wilson*) may reasonably be expected to occur in Newfoundland.

American Golden Eye, Bucephala americana (*Bon.*)—A very common summer migrant; one of the first to arrive in spring and remains until frozen out in the fall. Breeds in holes in trees, sometimes near the ground, but very frequently fifteen or twenty feet high, and often a considerable distance from water. The hole is generally made in a rotten tree, and I think always by the bird itself: it is called the "pie duck" by the settlers, and the young birds are considered good eating.

Buffel-headed Duck, or Butter Ball, B. albeola (*Linn.*)—Rare; at least at Cow Head, where it is called the "Spirit Duck."

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* A male *Mareca* which I obtained in Newfoundland differs from type specimens in being of an uniform dark brown on the back, without the ordinary tranverse bars; in its smaller size (*barely* 19 inches; wing 10; tarsus 1.10); legs and feet blue; irides WHITE; culmen less convex; and by having a broad conspicuous white band on the wings. Mr. G. R. Gray and Professor Newton are unable to refer the specimen to any other species than *M. americana.*—H. R.

Harlequin Duck, Histrionicus torquatus (*Linn.*)—A common summer migrant, and breeds on the borders of lakes and rivers flowing into the sea, frequently many miles in the country, whence it brings its young in July. The male of this species, which is called a "lord" in Newfoundland, is decidedly the handsomest little duck inhabiting those cold regions, and is a most expert diver. It seems extraordinary that any bird when quietly settled on the water, and within twenty yards of you, should escape by diving from the shot of a percussion gun; but how far more astonishing is it that birds on the wing, and within easy range, should employ the same device, and yet the little "lords" and "ladies" (females) frequently escape by doing so! The amateur sportsman, unacquainted with this fact, is amazed at his own prowess, when, having shot at eight or ten of these birds on the wing, he sees the whole flock drop apparently "stone dead" into the water; but his vexation perhaps exceeds his amazement when, in a few seconds, he again sees his little flock of harlequins on wing, and that too just out of range for his second barrel. The harlequin duck is frequently found sitting on rocks many feet above the water, but, from its small size and resemblance to the parti-coloured rocks, is very difficult to see in time to get a shot by stalking. Adult males are generally distinguished as "old lords," and females as "jennies."

Long-tailed Duck, Harelda glacialis (*Linn.*)—This handsome species is very common all along the coast in fall and spring,—in fact, as long there is any open water throughout the winter; but I think does not breed anywhere in Newfoundland, although I have an adult male, in summer plumage, which was shot at Cow Head on the 13th of June, 1868.

To the naturalist and sportsman there can be few more interesting sights than seeing several hundreds of "hounds," as these birds are called by the settlers, in a flock, and hearing their clamorous cry of "Cow-cow-wit;" "Cow-cow-wit," which, when borne on the breeze from a distance, has a fancied resemblance to a pack of hounds in full cry, and, however fanciful the comparison, it always proved sufficiently obvious to recall many pleasant reminiscences of bygone days. The longtailed ducks usually frequent shoals and beds of "killup" (kelp) in one to five fathoms of water, but I have seen them diving for food in thirty fathoms of water. Like many other oceanic birds they are expert divers, and it is sometimes almost impossible to kill them when sitting on the water; and I really think the nearer you are to them the more likely are they to evade the shot, but, of course, everything depends on the day; if dull and cloudy, or with snow on the ground, they dive at the flash with the rapidity of lightning, while on bright sunny days they are shot as easily as any non-diving birds. On the 12th of October, 1867, I killed two males of this species at a shot. It was a lovely day, frosty in the morning but the thermometer marked 50 degrees Fahr. at noon, and the ducks which were fishing side by side, at the distance of about forty yards, made no attempt to dive. "Old Wife" is another provincial name for this species.

Labrador Duck. Camptolæmus labradorius (*Gmelin*).—Probably occurs on some parts of the coast, but I did not meet with it during my stay at Cow Head.

Velvet Duck, Melanetta velvetina (*Cassin*).—Common, and probably breeds on the island, as individuals may be seen throughout the summer; although supposing the birds to assume the adult plumage the *second* year, which I have reason to doubt they may be non-breeding birds, as they certainly do not breed until the *third* year. Provincial name "Whitewinged diver."

Surf Duck, Pelionetta perspicillata (*Linn.*)—Common, especially during the migratory season. The remarks on the plumage and breeding habits of the preceding species applies equally to this and the following species. Provincial names "Bottle-nosed diver" and "Bald coot."

American Scoter, Œdemia americana (*Swainson*).—Very common throughout the year; at least until driven from the coast by drift ice, which is not usual until the first week in January. It is called the "sleepy diver" and "little black diver" when adult, by the settlers.

American Eider Duck,* Somateria mollissima? (*Linn*).—By far the most abundant species of duck in Newfoundland, but not so plentiful now as a few years since, owing in a measure to an increase in population, but more particularly to a wholesale robbery of eggs which is carried on with impunity from the islands along the coast, and others in the straits of Labrador and Belle Isle.

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* Professor Newton is of opinion that the American eider differs from the European far more strikingly than do some other so-called American species of ducks (especially the genus *Œdemia*), and I quite agree with him.—H. R.

Several hundreds of these beautiful ducks breed on some islands in the Bay of St. Paul, about five miles west of Cow Head, and are strictly preserved by an old Englishman, the only human resident in the bay. So abundant were these birds in Newfoundland a few years ago that a man living at Cow Head killed *one hundred and ten* eiders at *two* shots in one day, and on another occasion *fifty-three* at *one* shot: forty, also, had frequently been killed at a shot, and I saw a youth, seventeen years of age, knock down twenty at a shot in January, 1868, but even this last number is now rarely obtained so easily. To the sportsman who is content with a duck to each barrel this comparative scarcity is of small import, but to the poor settlers it is a matter of great consideration. The common eider does not breed or assume the adult plumage until the third year: it is called the "sea duck" by the settlers. The young males resemble the females, but lack the tinge of reddish brown which is characteristic of adult females of this and the following species.

King Eider, S. spectabilis (*Linn.*)—The adult male of this species is a large handsome bird and much sought for by ornithologists, especially those who go to the trouble and expense of visiting either its summer or winter haunts. The king eider, which is called "king bird" in Newfoundland, is tolerably common during its periodical migrations, and is frequently shot in company with the preceding species. On the 17th of December, 1867, I obtained an adult male "king biid;" and on the 19th an immature male: the latter was one of two killed at a shot with eight of the common eider. King eiders are more abundant some seasons than others: in 1865 twenty of these birds were killed at a double shot by one of the settlers at Cow Head. Young males the first year resemble the females, but in the second year have the throat and neck copiously spotted with white. The adult female of this species is easily separated from its congener, (*S. mollissima*) by its much smaller size, its shorter bill, and by having a more decided rufous tinge on the upper plumage.

Ruddy Duck, Erismatura rubida (*Wilson*).—A rare and uncertain visitor on the north-west coast.

Goosander, Mergus americanus, *Cassin*.—A summer migrant and tolerably common: it breeds on the margins of lakes and rivers, and is called the "gozzard" by the settlers.

Redbreasted Merganser, M. serrator, *Linn.*—A very common summer migrant, remaining in Newfoundland as long as any open water can be found. At early morning the redbreasted mergansers fly out to sea in large flocks, but return to fresh water in the evening : its provincial name is "shell bird."

Hooded Merganser, Lophodytes cucullatus (*Linn.*) Apparently rare on the north-west coast, and generally obtained in the immature plumage.

(*To be Continued.*)

ON THE ORIGIN AND CLASSIFICATION OF ORIGINAL OR CRYSTALLINE ROCKS.

By Thomas Macfarlane.

(*Continued from June Number.*)

IV.—CHEMICAL COMPOSITION.

Crystalline or original rocks have been hitherto regarded and described as aggregates of minerals. No doubt the larger number of them may be correctly enough thus characterised, but it is doubtful whether the description applies to all the original rocks. For instance, obsidiau has always been classed among these, and, on all hands, it is admitted that no minerals are discernable in it, that it is perfectly vitreous, as much so as bottle or window glass. A similar vitreous substance, unresolvable by the microscope, forms, according to Vogelgesang, part of the matrix of all true porphyries. Then we have many instances of rocks, almost impalpable in texture, belonging to various families, in which the microscope certainly reveals the presence of separate minerals, but, frequently, leave their nature and, always, their composition undetermined. Besides the uncertainty which thus very frequently surrounds our knowledge of the mineralogical constitution of fine-grained rocks, there are other considerations which tend to shew that the composition of a rock is not ascertained even after its constituent minerals have been determined. In the first place, the relative quantities of these present cannot be ascertained, and, secondly, even when this is done approximatively, the uncertain composition of the mineral species renders the chemical composition of the rock almost as doubtful as before. It would therefore appear simpler and tend to a juster view of the nature of original rocks, to regard them not so much as aggregates of minerals, as mixtures of their chemical components, alkaline and earthy silicates, which, during crystallisation, arranged themselves into compounds of more definite atomic composition, namely, into minerals.

As has been already remarked, the primary source of all original rocks must have been the original fluid globe, and also that part of it, which, until the present day, has remained in a state of igneous fluidity. The elements which originally composed the fluid-globe must have been the same as those which enter into the composition of the earth at the present day. If, however, we leave out of consideration those volatile and gaseous elements which, from their nature, must have gone to form the primitive atmosphere, and also the greater bulk of the metals, which, from their gravity, must have accumulated at the centre of the earth, we have the following list of substances, which in all likelihood, constituted the upper zone of the original fluid-globe:—Silicic, boracic, phosphoric, stannic, titanic, niobic, tungstic, and tantalic acids: among bases, potash, soda, lithia, lime, magnesia, alumina, ferric oxide, zirconia, manganic oxide, manganous oxide, ferrous oxide, glucina, ceria, yttia, oxides of zinc, lanthanum and uranium. All of these substances make their appearance in original rocks, many of them however in comparatively minute quantity and entering only into the composition of their so-called accessorial constituents. If we, for the sake of clearness, leave these rarer substances aside for the present, we have the following, which may be regarded as the essential chemical constituents of original rocks:

Silicic Acid. ......Alumina....................Protoxide of Iron.
Magnesia,........Lime,........Soda,........Potash.

These substances, we may suppose, were, in the original fluid magmas from which original rocks crystallised, present in the same manner in which we see them combined together in furnace slags or glass. Each of these constituents, the alkalies excepted, is of a most refractory nature by itself, but, when several of the earths unite with the silica, compounds result of various degrees of fusibility. In this there is merely a repetition of the well-known phenomena of chemical combination, where elements the most antagonistic combine to form a substance innocent of any of the properties of its constituents. The silica or quartz, infusible and chemically indifferent as it may appear under ordinary circumstances, acts in this case as an acid, and, with the aid of heat, combines with the equally refractory bases, forming readily fusible compounds. The simple silicates, formed by the union of silica or silicic acid with one base, are not always fusible. Those of the alkalies and iron oxides are, but the silicates of alumina (clay), magnesia (serpentine), and lime (wollastonite), are almost or completely infusible. Nevertheless, the three latter combined form the scoriae of most frequent occurrence in the arts, namely, those of iron furnaces. In these slags the proportion of silica present often mounts as high as 75 per cent., while those from puddling furnaces do not contain more than 35. The former are termed very acid or siliceous, and the latter very basic slags. Such variations in the silica contents of these compounds are accompanied by corresponding changes in their chemical and physical properties. Basic slags are more easily fused than siliceous slags, although the latter do not solidify as rapidly as the former.

The same variations in the quantity of silica which occur in furnace slags are also to be found in original rocks, and just as furnace scoria have been ranged under different chemical formulæ, so, likewise, it has become possible to classify original rocks in a similar manner. When the student of chemistry has gradually added an acid to an alkali, or other base, until the mixture neither reddens litmus nor browns turmeric paper, he has formed a neutral salt consisting of one atom of base to one of acid, such as sulphate of iron ($FeO\ S.O_3$) and nitrate of potash ($KO\ N.O._5$). The salts of the peroxides, although frequently possessing acid properties, are, nevertheless, also regarded as neutral or normal and contain, for every atom of base, three of acid, such as persulphate of iron ($Fe_2\ O_3\ 3\ SO_3$) or tersulphate of alumina ($A_2\ O_3\ 3\ SO_3$). Similarly in mineralogy those silicates are regarded as neutral which contain one atom of monoxide combined with one of silica acid or silica, or one atom of sesquioxide combined with three of silica. Thus the mineral leucite, which consists of one atom of potash, one of alumina, and four of silicic acid, may be regarded as the type of a neutral mineral. Its formula is $KO.\ Al_2\ O_3.\ 4\ Si.\ O_2$ and it will be observed that its bases contain four while its acid contains eight equivalents of oxygen. Neutral or monosilicates, therefore, are those in which the proportion of oxygen in the bases, to that in the acid, is as 1 is to 2. If we search among crystalline rocks for those in which this oxygen ratio exists, we shall find them to be well-defined rock species which are not usually considered from a chemical point of view at all. These rock species are syenite, melaphyre and andesite, which respectively represent the neutral development of the granular, porphyritic, and trachytic orders of original rocks. If, from among the syenites, melaphyres and andesites which have been subjected to analysis, we select those whose oxygen ratio best corresponds to neutrality, we have the following:—

	Oxygen of bases.	Oxygen of acid.	Quantity of Silica in 100 parts rock.
I. Syenite from the Steilen Stiege, in the Hartz,—Fuchs.........	1	1·848	56·36
II. Syenite from Monte Margola, near Predazzo,—Kjerulf......	1	2·229	58·05
III. Syenite from the Schönberger Thal in the Bergstrasse,—G. Bischof....................	1	2·051	58·90
IV. Syenite from Plauenschen Grund, near Dresden,—Zirkel.	1	2·288	59.83
Average	1	2·104	58.28
I. Melaphyre from Schneidmüllersberg, in Ilmenthal, near Ilmenau,—Von Richthofen...	1	1·938	55·54
II. Rhombic porphyry of Vettakollen, classed with the melaphyres, by Naumann, Delesse Kjerulf.....................	1	2·017	56·—
III. Melaphyre from Bahrethal, near Ilfeld,—Streng	1	2·011	56·22
IV. Melaphyre from Leuchtburg, in the Thüringian Forest,—Sochting...................	1	2·133	59·18
Average	1	2·024	56·73
II. Augitic andesite from Lowenburg, in Siebengebirge,—Kjerulf	1	1·868	55·63
II. Hornblendic Andesite, from Merapi, in Java,—Prolss......	1	1·975	57·60
III. Hornblendic Andesite from Stary Swietlan,—Tschermak.	1	2·091	58·92
IV. Hornblendic Andesite, from Stenzelberg, in Siebengebirge, —Rammelsberg	1	2·332	59·22
Average.....	1	2·066	57·85

It would seem therefore from these figures, that those rocks which, in composition, are neutral or monosilicates, contain an amount of silica averaging 57.62 per cent.

As in chemistry we have acid salts, in which one atom of base is combined with more than one atom of acid, so in lithology we have rocks in which the silica is present in much larger quantity than is required for monosilicates. A very well defined series of rocks is known in which the silica is present in such excess as to give them the composition of bi-silicates, in which two atoms of silica are present for every one of mon-oxide, and six for every two of sesqui-oxide, or in which the oxygen ratio between bases and acid is as one to four. The granular, porphyritic and trachytic developements of those rocks are respectively represented by granite, felsitic porphyry and rhyolite. Proceeding in the same manner as with the neutral rocks we find the following among this series to approach most closely in composition to bi-silicates:

	O. RATIO.		Quantity of silica in 100 parts rock.
	Bases.	Silica.	
I. Granite from Heidelberg,—Streng	1	3 893	72.11
II. Granite from Doochary Bridge. Donegal,—Houghton	1	3.760	72.21
III. Granite of Fox Rock, near Dublin,—Houghton...	1	4.077	73
IV. Granite of Striegan near Silesia, —Streng....................	1	4.364	73.13
V. Granite of Blackstairs Mountian, Wexford,—Houghton ...	1	3.953	73.20
Average	1	4 009	72.73
I. Felsitic porphyry from Mühlberg near Halle,—Laspeyres	1	4.051	72.24
I. Quartzose trachyt from Hohenburg, near Berkum, opposite the Siebengebirge, Bischof ..	1	3.824	72.25
II. Quartzose trachyte from the Island of Ponza.—Abich	1	4.152	73.46
Average	1	3.988	72.86

It appears, therefore, that the oxygen ratio 1 to 4 corresponds to an average silica percentage of 72.61, and to such bi-silicate rocks the name silicic might be applied.

But besides this silicic series of rocks there is found another series of very different chemical constitution, and in which the bases, and not the silica, preponderate. It is only, however, in rare instances among these rocks that the silica disappears to such an extent as to form a disilicate, *i.e.*, a compound of one equivalent of silica with two of base, or in which the quantities of oxygen contained in acid and base are equal. A very well marked series of basic rocks may, however, be pointed out in which two equivalents of silica are combined with three of base, and in which the oxygen ratio is as $1\frac{1}{3}$ to 1. The rocks which represent this basic development of the porphyritic and trachytic textures, are, respectively, augitic porphyry and nephelinite. The following are instance of these rocks in which the oxygen ratio most closely approaches 1·333=1 :—

	Oxygen ratio. Bases.	Oxygen ratio. Silica.	Quantity of Silica in 100 parts rock.
Augitic porphyry from Fassathal in Tyrol	1	1·391	45·05
Nephelinite from Wickenstein in Lower Silesia,—Lowe	1	1·347	41·87

The number of analyses of these basic rocks being somewhat limited, it is not possible to arrive at their average silica contents so closely as in the case of the neutral and silicic rocks. These instances, however, shew that the oxygen ratio 1·333:1 corresponds to a percentage of about 43.46 silica. Rocks thus constituted being two-third silicates, might be conveniently called sub-silicates, and, in contradistinction to the silicic series, might be termed the basic rocks.

Between the basic and neutral rocks, on the one hand, and the latter and the silicic rocks on the other, there exist many other rocks of intermediate composition and forming gradual transitions between each of the series, which have been more minutely referred to in the foregoing. It thus becomes possible to point out a series of rocks passing gradually from the basic extreme to that of acidity in composition, not only for each of the granular porphyritic and trachytic order of rocks, but also for every variety of texture specified in the preceding chapter. The following Table gives an arrangement of these various series of rocks and an exhibition of the distinctive characters as to texture and chemical composition possessed by each. In constructing this table, it has been found that by limiting the variations in silica contents of each family to 7 per cent. very correct lines of separation may be drawn betwixt them:—

TABLE I,

Showing the General Chemical Composition of the Families of Original Rocks.

Order of Texture.	Basic Rocks, (subsilicates), containing less than 49 per cent. Silica.	Basous Rocks containing from 49 to 55 per cent. Silica	Neutral Rocks, (monosilicates) containing from 56 to 63 per cent. Silica.	Siliceous Rocks, containing from 63 to 70 per cent. Silica	Silicic Rocks, containing more than 70 per cent. Silica
I. Coarse and small-grained...............	Anorthosite.	Greenstone.	Syenite.	Granitite.	Granite.
II. Schistose	Basic schst.	Hornblende chist.	Syenite schist.	Gneiss.	Gneissite.
III. Slaty...............	....	Greenstone slate.	Clay slate.	Siliceous slate.	Silicic slate.
IV. Porphyrite.........	Augitic porphry.	Greenstone porphyry.	Melaphyre.	Porphyrite.	Felsitic porphyry.
V. Variolite...............	....	Variolite.	Var. basaltite	....	Sphærolite,
VI. Fine-grained	Basalt.	Trap.	Basaltite.	Eurite.	Felsite.
VII. Trachytic.........	Nephelinite.	Dolerite.	Andesite.	Trachyte.	Rhyolite,
VIII Volcanic.........	Nephelinite lava.	Dolerite lava	Andesite lava.	Trachytic lava.	Obsidian.

Before proceeding to explain the foregoing table, it may be mentioned that no new names have been used in its construction; that names to which definite ideas as to mineralogical constitution are attached, have been, as much as possible, excluded. Such names as trap, greenstone, and melaphyre, which have been, in the early history of the science, much abused and misapplied, and more recently condemned as useless for the purpose of indicating any special rock, are introduced into our table, and advantageously used in designating the families of rocks to which they were originally applied. If it were made a rule in the science to exclude from it all names which have been at one time or other misused, very few petrological terms would escape obliteration; and the fact that the names above mentioned, in spite of their condemnation by some lithologists, continue in common use, sufficiently proves that they possess a certain degree of usefulness and applicability.

It will be observed that in the table the terms basic and basous, silicic and siliceous, are used in a manner analogous to that in which the stronger and weaker bases and the stronger and weaker acids are indicated in chemical nomenclature. A bas*ic* slate always contains a larger percentage of bases than a bas*ous* one, and a silic*ic* porphyry in the same way contains more silica than a silic*eous* one. It will next be observed that we have in the table eight different horizontal series of rocks, or rather rock families, corresponding to the eight different varieties of texture which have been before particularized. On passing in each of these series from left to right, we pass from the basic to the siliceous extremes, through rock families gradually increasing in silica contents, as the figures at the head of the vertical columns shew. With this increase in the amount of silica a corresponding change in the nature of the bases with which it is combined takes place. Towards the basic extreme these are principally magnesia, lime, and protoxide of iron; but as the silica increases these bases diminish, and alumina with the alkalies increase until, at the silicic extreme, alumina and potash become the preponderating bases. We have also in the table five different vertical series, among which the neutral, basic and silicic groups already referred to, occupy places in the middle and at the sides, while the intermediate groups, which were also mentioned above, and which have been called the basous and siliceous rocks, occupy positions immediately to the left and right of the central column. The rock families of each of these vertical series, although they may differ widely as regards their texture, all possess a similar chemical composition. The chemical nature, texture, and affinities of any original rock or rock family are seen from this table at a glance. Thus, porphyrite appears as the porphyritic developement of the siliceous group of rocks; as less siliceous than felsitic porphyry, and more so than melaphyre. Basalt is seen to be the most basic member of the fine-grained order, and to contain less than forty-nine per cent. of silica. The affinities of any rock may be ascertained by observing the names of the rocks placed next to it, for in almost every case it is into these that it is most prone to graduate.

There are other of the general relations among original rocks visible from this table than those which refer to their composition texture and affinities. Not only do the rock families mentioned in each vertical column resemble each other in chemical composition, but they also exhibit similar coincidences as regards their general colour, hardness and fusibility, and gradual transitions in each of these respects are found to exist from rock to rock along each horizontal series. The basic rocks are generally darker coloured, less hard, and more readily fusible than the rocks which correspond to them in texture but differ from them in containing a larger percentage of silica. On the other hand the more siliceous a rock is, the lighter it will generally be found to be in colour, the harder and more difficult to penetrate or excavate, and the more refractory on exposure to high temperatures.

There is yet another physical property belonging to those original rocks, in which they show a similar correspondence with their chemical composition. Still speaking generally, the more siliceous a rock the lighter it is, not only in colour, but in weight; the more basic the rock, the heavier it becomes. Thus it is the case that, in each order of texture on passing from the siliceous to the basic rocks, a gradual increase of density takes place, and, on the other hand, the transition from the basic rocks to the more siliceous exhibits a gradual diminution of specific gravity. So constant is this relation that it may be taken advantage of in determining the general composition of a rock. To take as an instance the coarsely granular series of rock families the general range of their specific gravities may be said to be as follows:—

Granite - - - - -	2.65 and under.
Granitite - - - -	2.65 to 2.8.
Syenite - - - - -	2.8 to 2.875.
Greenstone - - - -	2.875 to 3.—

This part of the subject is one of very great interest, but it would be premature at present to discuss it minutely.

(To be continued.)

NOTES ON THE BOTANY OF A PORTION OF THE COUNTIES OF HASTINGS AND ADDINGTON.

By B. J. Harrington, B.A.,

During a portion of the summer of 1869, I accompanied Mr. Vennor as his assistant in his exploration, among the Laurentian rocks of Ontario, and although my labours were of necessity for the most part geological, I could not resist the temptation of taking an occasional botanical stroll, and jotting down the names of a few old and familiar friends. While many other Townships were entered, it was principally in those of Elzevir, Kaladar and Barrie that attention was given to Botany. The hilly and broken character of the Laurentian country is well known, and this, together with the imperfect drainage of the crystalline rocks, and the frequently scanty and light soil arising from their disintegration, cannot well fail to exert a marked influence upon the vegetation. Thus, among the granitic hills of Elzevir, Caprifoliaceæ are exceedingly abundant, fourteen species being represented. Of the genus Viburnum there were five species, several of these being very common. In the lower ground Ericaceous shrubs, and in some places, more particularly in cedar (*Thuja occidentalis*) swamps, several species of northern Orchids were found. I say low ground, but there is much of the country having this character which is in reality elevated, the imperfect drainage, mentioned above, causing the formation of bogs, marshes and lakes in the hollows among the hills.

On the 10th June we left Belleville by stage for Bridgewater, a village about thirty miles back. The road for the first twenty miles passes through a beautiful farming country, with here and there a grove of Maples and Beech (*Fagus ferruginea*). In clumps along the fences, the Dogwood (*Cornus stolonifera*), with its red stems and newly-opened flowers, was occasionally to be seen, and just before reaching the bridge over the Moira, we saw the May-Apple (*Podophyllum peltatum*) with its umbrella-like leaf. Next morning found us among the Laurentian hills at Bridgewater, with the river Scutomatto ("turbulent water") rolling past, in the low ground near which we found two species of Crow-foot (*Ranunculus recurvatus et abortivus*): a Meadow-Rue (*Thalictrum dioicum*), the Cranberry Tree (*Viburnum Opulus*), an Elder (*Sambucus pubens*), the Choke-cherry (*Prunus Virginiana*) and Red Cherry (*P. Pennsylvanica*) were in full bloom, and a little higher up, the showy Bunch-berry (*Cornus Canadensis*), the Service-berry (*Amelanchier Canadensis*), the Barren Strawberry (*Waldsteinia fragarioides*), the Indian Turnip (*Arisaema triphyllum*) and the Wild Sarsparilla (*Aralia nudicaulis*). Close to the river the Star-Lily (*Smilacina stellata*) grew, its starry flowers looking all the whiter over the black mud, and a short distance from the bank several species of Horsetail were waving like plumes in the breeze, the most common being *Equisetum sylvaticum*. Here and there a Trillium (*T. grandiflorum*) was expanding its petals to receive the sunshine after being watered by nearly a week's rain, and two Violets (*Viola cucullata et blanda*) dotted the meadow with their tiny flowers. On the road-side some of the usual stragglers (*Cynoglossum officinale*, *Verbascum Thapsus* and *Capsella Bursa-pastoris*) were growing in abundance, as if preferring the society of man to the retirement of the forest; and hard by in a swamp I gathered the three Flowering Ferns (*Osmunda regalis*, *O. Claytoniana* and *O. cinnamomea*), the fertile fronds of the last standing straight as soldiers on duty. Alongside these grew the Sensitive Fern (*Onoclea sensibilis*), and, where the ground was dryer, the Bracken (*Pteris aquilina*). On a ridge of granitic gneiss to the East, we found the Fly-Honeysuckle (*Lonicera ciliata*), the Wild Gooseberry (*Ribes Cynosbati*), the Fringe-Jointed Knotweed (*Polygonum cilinode*) and the Sheep Sorrel (*Rumex Acetosella*). On the highest point of the rock, the common Polypody (*Polypodium vulgare*) seemed to find sufficient nourishment to grow quite luxuriantly, while its less aspiring brother (*P. Dryopteris*) had chosen a more congenial spot in the hollow at the base. The delicate Bladder Fern (*Cystopteris fragilis*) peeped out from crevices in the rock, while two Shield-Ferns (*Aspidium spinulosum* and *A. marginale*) and the Lady-Fern (*Asplenium Filix-fœmina*) clothed the borders of a little brook. In the dry fields the Plantain-leaved Everlasting (*Antennaria plantaginifolia*) was everywhere abundant.

Throughout the Laurentian country the soil upon limestone bands is in general much richer than that upon other kinds of rock, and its influence upon the vegetation is very marked. The Pines and other evergreens which generally accompany gneissose rocks, give place to hard-wood trees; the shrubs, and other plants, too, are those which are usually found in rich, moist woods. The following list of plants, collected on the 12th of June, while following the Bridgewater limestone southwards, makes this evident:—

Acer rubrum,
—— saccharinum,
—— spicatum,
Aquilegia Canadensis,
Sanguinaria Canadensis,
Osmorrhiza brevistylis,
Actæa spicata,
Uvularia grandiflora,
Smilacina bifolia,
—— racemosa,
Dicentra Canadensis,
Caulophyllum thalictroides.
Aralia trifolia,
Mitella diphylla,
Tiarella cordifolia.
Trillium erectum,
Trientalis Americana,
Dentaria diphylla,
Ampelopsis quinquefolia.
Viola Canadensis,
Viburnum lantanoides,
Polygonatum biflorum,
Streptopus roseus,
Adiantum pedatum,
Aspidium acrostichoides,
Polypodium Phegopteris, and
Botrychium Virginianum.

On the 13th June, we followed the limestone in the opposite direction from the day before, and found other circumstances coming in to alter the character of the vegetation. The limestone occupied a depression, bordered on either side by high ridges of gneiss, and the water accumulating in this hollow had formed a Cedar and Black Ash (*Fraxinus sambucifolia*) swamp, which would be well nigh impenetrable to any but an enthusiastic naturalist. On the borders of this swamp we found *Aspidium Thelypteris* and *A. cristatum*, and just within its dismal confines gathered *Asplenium thelypteroides*. A little further and the Clintonia (*C. borealis*) spread its broad leaves over the moss, and seemed to tinkle its bell-like flowers, and the delicate Twin-flower (*Linnæa borealis*) covered the stumps as if to conceal their rottenness, scarce leaving room for the little Goldthread (*Coptis trifolia*). Here and there might be seen the downy little Dalibarda (*D. repens*), and but a short distance beyond, the northern green Orchis (*Platanthera hyperborea*) stood as stiff and straight as an obelisk. In a spot a little more open, but still wet and mossy, I gathered a Coral-root (*Corallorhiza Macraei*) in full bloom; it was not again met with during the summer. Club-Mosses (*Lycopodium dendroideum, L. annotinum* and *L. clavatum*) were there very abundant.

Returning by the road, we found among the rocky hills a Sumach (*Rhus typhina*) growing in abundance, also the Blackberry (*Rubus villosus*) and Red Raspberry (*R. strigosus*). On the borders of a moist wood, the little *Hepatica triloba* grew in the shade of a Basswood (*Tilia Americana*). The long, green racemes hung like earrings from the Striped Maple (*Acer Pennsylvanicum*), contrasting strongly with the broad, white cymes of a Cornel (*Cornus alternifolia*). Within the wood we found *Pyrola secunda, Medeola Virginica, Circaea alpina* and *Gaultheria procumbens.* In the fields near the road the Crowfoot (*Ranunculus acris*), Chickweed (*Cerastium vulgatum*), and Dandelion (*Taraxacum Dens-leonis*) were growing everywhere.

On the day following, I found the first Strawberry (*Fragaria Virginiana*) of the season, and among the granitic hills on the Flinton Road, *Corydalis glauca, Geranium Carolinianum,* and *Diervilla trifida,* all three in flower. In the swampy depressions, before mentioned, the white blossoms of the Choke-berry (*Pyrus arbutifolia*) were now and then to be seen.

From Bridgewater to Flinton (a small settlement in Kaladar) is a distance of about twelve miles by the direct road; there is, however, another, known as the Old Flinton Road, which is more circuitous, and passes through the corner of Hungerford. Upon this road, about five miles from Bridgewater, the following plants were collected on the 16th of June:—

Mitchella repens,
Chimaphila umbellata,
Calla palustris,
Cicuta maculata,
Sium lineare,
Sanicula Marilandica,
Rubus odoratus,
Physalis viscosa,
Geum rivale,
Galium triflorum,
Iris versicolor,
Eupatorium purpureum,
Naumburgia thyrsiflora,
Senecio aureus,
Myosotis arvensis, and
Erigeron Philadelphicum.

A few days later, in crossing over to the village of Madoc, we left the road and took a short cut through the woods, where we found the Yellow Wood-Sorrel (*Oxalis stricta*). On reaching the river Moira, the Persicaria (*Polygonum amphibium*) was growing in the shallow water, its elliptical leaves floating upon the surface, and not far off the Water Plantain (*Alisma Plantago*).

The road from Bridgewater to Queensborough (a small village near the western boundary of Elzevir) follows for the most part the course of the green dioritic rocks which succeed the great granitic area of Elzevir. The soil is light and sandy nearly all the way, but there are occasional marshy spots. Along this road the following plants were collected on the 25th of June:—

Ledum latifolium,
Caltha palustris,
Eupatorium perfoliatum,
Triosteum perfoliatum,
Galium circæzans,
Viburnum nudum,
Nepeta Cataria,
Leucanthemum vulgare,
Tanacetum vulgare,
Gnaphalium polycephalum, and
Anemone Pennsylvanica.

At a place called Hasard's Corners, a few miles from Queensborough, we saw a few Butternut trees (*Juglans cinerea*). This was the only place in which this tree was met with during the summer, and the reason of its occurrence here is probably to be found in the deposits of drift, which form a richer soil than that derived from the wear of the metamorphic rocks.

Proceeding, we took the direct road across the granitic area of Elzevir, gathering by the way a number of plants. On a sandy hill, near Bridgewater, we found *Viburnum pubescens*, and on the road sides *Erigeron strigosum*, *Potentilla norvegica* and *Silene noctiflora*. In the depressions among the granitic hills, the Common Meadow-Sweet (*Spiræa salicifolia*) was exceedingly abundant, and *S. tomentosa* not uncommon. The shrubbery was composed of different species of Arrow-wood, and in addition to those already mentioned, the *Viburnum acerifolium*. The white blossoms of the Mountain-Ash (*Pyrus Americana*) were here and there to be seen, and where fire had been at work, the great Willow-herb (*Epilobium angustifolium*). Growing upon the almost bare rock, we found everywhere the Bristly Sarsparilla (*Aralia hispida*). On the borders of a little pond were growing the *Galium trifidum* and the *Sarracenia purpurea*, and in the water, *Nuphar advena*. In a moist wood on the eastern side of the granitic area, we found the Wood-Sorrel (*Oxalis Acetosella*), the Gossamer-Fern (*Dicksonia punctilobula*) and the Moose-wood (*Dirca palustris.*)

The day following, June 29th, we started to survey the old road from Flinton towards Bridgewater. A considerable portion of this road passes through dry Pine woods (*Pinus Strobus*); here we found Honeysuckles (*Lonicera hirsuta*) in full bloom, and *L. parviflora* in fruit; also *Pyrola rotundifolia* both in flower and fruit. The Goldenrod (*Solidago squarrosa*) was seen occasionally, but had not yet spread its showy rays; but the Loosestrife (*Lysimachia quadrifolia*) grew in abundance. On the way back to Flinton, we saw in the sandy fields the common Yarrow (*Achillea millefolium*).

At the beginning of July we left for the Township of Barrie, and on the Addington Road found the following species:—

Epilobium coloratum,	Laportea Canadensis,
—— palustre,	Verbena hastata,
Apocynum androsæmifolium,	Polygonum Convolvulus, and
Thalictrum Cornuti,	Alnus incana.

Barrie is studded with numerous and beautiful lakes, and much of our time was spent in following their shores in canoes—this being the easiest way of obtaining sections across the Township. The first lake visited is known by the name of 'Mazinaw,' or, among the settlers, 'Michinog'; it is about nine miles long, varying greatly in width. On the eastern side the Mazinaw Cliff rises from the water to a height of about 200 feet perpendicular, at one part slightly overhanging. The Red-man gazes with awe upon this rock, and, if you question him, tells you that it is the abode of the Evil Spirit. In years long past he has ventured to approach the base in his birch canoe, and paint upon it figures of men and various animals. The oldest settlers say that the figures were there when they were young, but that they still retain their original brightness. Much as we had desired to see them, we only obtained a glimpse of the top of an Indian's head, since a dam had been built at the foot of the lake, raising the water several feet. The settlers have much to tell about the rock; they say that it contains wealth untold, and that in days gone by the silver could be seen hanging from the face like great icicles. Some persons have spent weeks of search, but have always been obliged to come to the conclusion that the rock is nothing but a great mass of granitic gneiss, and that whatever silver may have been there in the past, the Evil Spirit has since appropriated. As we paddled along, we could not wonder at the superstitions of the savage, for we were awed to silence by the grandeur of the scene. Our tiny craft seemed to grow more and more tiny as we advanced; we felt like pigmies, and feared lest the plash of the paddle might arouse the ire of the Spirit who had chosen the rock for his abode. The summit of the rock is covered with evergreens, and on the steep sides a little Evergreen or a Birch (*Betula papyracea*) is here and there seen struggling for a foothold. By a clear spring which trickled down the rock, the Poison Ivy (*Rhus Toxicodendron*) trailed, and along the face of the rock the Harebell (*Campanula rotundifolia*) nodded in the breeze. *Pentstemon pubescens* was very abundant, and here and there we saw tufts of *Woodsia Ilvensis* and of *Cystopteris fragilis.*

In the neighbourhood of Lake Mazinaw, we found at different times during the month of July, the following plants :—

Corallorhiza multiflora,
Pinus resinosa,
Moneses uniflora,
Pyrola chlorantha,
Monotropa Hypopitys,
Platanthera orbiculata,
—— bracteata,
—— psycodes,
Sambucus Canadensis,
Cephalanthus occidentalis,
Corylus Americana,
Œnothera pumila,
—— biennis,
Aster puniceus,
—— cordifolius,
Lysimachia stricta,
Hypericum perfoliatum,
Scutellaria galericulata,
Brunella vulgaris,
Shepherdia Canadensis,
Adlumia cirrhosa,
Potentilla palustris,
Geum strictum,
Fragaria vesca,
Ribes prostratum,
Saxifraga Virginiensis,
Aralia racemosa,
Cornus circinata.
Sagittaria variabilis,
Aspidium Noveboracense,
Betula excelsa,
Quercus rubra,
Larix Americana,
Kalmia glauca,
Andromeda polifolia,
Cassandra calyculata.
Diplopappus umbellatus,
Hypericum ellipticum, and
Ulmus Americana.

On the 4th of August we crossed from Mazinaw to Buckshot Lake. If any one would test his powers of endurance, let him shoulder his pack and try this "portage," much of which passes through swamps and beaver-meadow, where the mud and water are knee deep, and the mosquitos make their onset with a ferocity beyond description. Here we found —

Potentilla fruticosa,
Pontederia cordata,
Monotropa uniflora,
Cypripedium acaule,

Campanula apariniodes,
Clematis Virginiana,
Rosa Carolina,
Goodyera pubescens, and
Lycopodium complanatum.

While spending a few days on and about the Frontenac Road, near the Mississippi River. we found the following plants:—

Lobelia inflata,
—— ardinalis,
Mimulus ringens.
Scutellaria lateriflora.
Lycopus Europæus,
Eupatorium ageratoides,
Solidago Canadensis,
—— altissima,
Agrimonia Eupatoria, and
Asclepias incarnata.

Such, then, is an imperfect account of the plants collected from the middle of June until the latter part of August, in a small portion of our Laurentian country. The lists were not intended for publication, but were kept merely for private gratification, otherwise they might and would have been more complete. Being fully aware of their imperfection, I have only been persuaded to publish them in the hope that they may be of some small service to those who are studying the distribution of plants in Canada.

MEETING OF THE BRITISH ASSOCIATION,

Held at Liverpool in September, 1870.

THE PRESIDENT'S ADDRESS.

My Lords, Ladies, and Gentlemen,—It has long been the custom for the newly-installed President of the British Association for the advancement of Science to take advantage of the elevation of the position in which the suffrages of his colleagues had, for the time, placed him, and casting his eyes around the horizon of the scientific world, to report to them what could be seen from his watch-tower; in what directions the multitudinous divisions of the noble army of the improvers of natural knowledge were marching; what important strongholds of the great enemy of us all, Ignorance, had been recently captured; and, also, with due impartiality, to mark where the advanced posts of science had been driven in, or a long-continued siege had made no progress.

I propose to endeavour to follow this ancient precedent, in a manner suited to the limitations of my knowledge and of my capacity. I shall not presume to attempt a panoramic survey of the world of Science, nor even to give a sketch of what is doing in the one great province of Biology, with some portions of which my ordinary occupations render me familar. But I shall endeavour to put before you the history of the rise and progress of a single biological doctrine; and I shall try to give some notion of the fruits, both intellectual and practical, which we owe, directly or indirectly, to the working out, by seven generations of patient and laborious investigators, of the thoughts which arose, more than two centuries ago, in the mind of a sagacious and observant Italian naturalist.

It is a matter of every-day experience that it is difficult to prevent many articles of food from becoming covered with mould; that fruit, sound enough to all appearance, often contains grubs at the core; that meat left to itself in the air, is apt to putrefy and swarm with maggots. Even ordinary water, if allowed to stand in an open vessel, sooner or later becomes turbid and full of living matter.

The philosophers of antiquity, interrogated as to the cause of these phenomena, were provided with a ready and a plausible answer. It did not enter their minds even to doubt that these low forms of life were generated in the matters in which they made their appearance. Lucretius, who had drunk deeper of the scientific spirit than any poet of ancient or modern times except Goethe, intends to speak as a philosopher, rather than as a poet, when he writes that "with good reason the earth has gotten the name of mother, since all things are produced out of the earth. And many living creatures, even, now spring out of the earth, taking form by the rains and the heat of the sun." The axiom of ancient science, "that the corruption of one thing is the birth of another," had its popular embodiment in the notion that a seed dies before the young plant springs from it; a belief so widespread and so fixed, that St. Paul appeals to it in one of the most splendid outbursts of his fervid eloquence:—"Thou fool, that which thou sowest is not quickened, except it die." (1 Corinthians, xv. 36.) The proposition that life may, and does, proceed from that which has no life, then, was held alike by the philosophers, the poets, and the people of the most enlightened nations, eighteen hundred years ago; and it remained the accepted doctrine of learned and unlearned Europe, through the Middle Ages down even to the seventeenth century.

It is commonly counted among the many merits of our great countryman, Harvey, that he was the first to declare the opposition of fact to venerable authority in this, as in other matters; but I can discover no justification for this wide-spread notion. After careful search through the 'Exercitationes de Generatione,' the most that appears clear to me is, that Harvey believed all animals and plants to spring from what he terms a "*primordium vegetale*," a phrase which may now-a-days be rendered "a vegetative germ"; and this, he says, is "*oviforme*," or "egg-like"; not, he is careful to add, that it necessarily has the shape of an egg, but because it has the constitution and nature of one. That this "*primordium oviforme*" must needs, in all cases, proceed from a living parent is nowhere expressly maintained by Harvey, though such an opinion may be thought to be implied in one or two passages; while, on the other hand, he does, more than once, use language which is consistent only with a full belief in spontaneous or equivocal generation. In fact, the main concern of Harvey's wonderful little treatise is not with generation, in the physiological sense, at all, but with developement; and his great object is the establishment of the doctrine of Epigenesis.

The first distinct enunciation of the hypothesis that all living matter has sprung from pre-existing living matter, came from a contemporary, though a junior, of Harvey, a native of that country, fertile in men great in all departments of human activity, which was to intellectual Europe, in the sixteenth and seventeenth centuries, what Germany is in the nineteenth. It was in Italy, and from Italian teachers, that Harvey received the most important part of his scientific education. And it was a student trained in the same schools, Francesco Redi—a man of the widest knowledge and most versatile abilities, distinguished alike as scholar, poet, physician, and naturalist,—who, just 202 years ago, published his 'Esperienze intorno alla Generazione degl' Insetti,' and gave to the world the idea, the growth of which it is my purpose to trace. Redi's book went through five editions in twenty years; and the extreme simplicity of his experiments, and the clearness of his arguments, gained for his views, and for their consequences, almost universal acceptance.

Redi did not trouble himself much with speculative considerations, but attacked particular cases of what was supposed to be "spontaneous generation" experimentally. Here are dead animals, or pieces of meat, says he; I expose them to the air in hot weather, and in a few days they swarm with maggots. You tell me that these are generated in the dead flesh; but if I put similar bodies, while quite fresh, into a jar, and tie some fine gauze over the top of the jar, not a maggot makes its appearance, while the dead substances, nevertheless, putrefy just in the same way as before. It is obvious, therefore, that the maggots are not generated by the corruption of the meat; and that the cause of their formation must be a something which is kept away by gauze. But gauze will not keep away aëriform bodies, or fluids. This something must, therefore, exist in the form of solid particles too big to get through the gauze. Nor is one long left in doubt what these solid particles are; for the blow-flies, attracted by the odour of the meat, swarm round the vessel, and, urged by a powerful but, in this case misleading instinct, lay eggs, out of which maggots are immediately hatched, upon the gauze. The conclusion, therefore, is unavoidable; the maggots are not generated by the meat, but the eggs which give rise to them are brought through the air by the flies.

These experiments seem almost childishly simple, and one wonders how it was that no one ever thought of them before. Simple as they are, however, they are worthy of the most careful study, for every piece of experimental work since done, in regard to this subject, has been shaped upon the model furnished by the Italian philosopher. As the results of his experiments were the same, however varied the nature of the materials he used, it is not wonderful that there arose in Redi's mind a presumption, that in all such cases of the seeming production of life from dead matter, the real explanation was the introduction of living germs from without into that dead matter—(Redi, *Esperienze*, pp. 14–16). And thus the hypothesis that living matter always arises by the agency of pre-existing living matter, took definite shape; and had henceforward a right to be considered and a claim to be refuted, in each particular case, before the production of living matter in any other way could be admitted by careful reasoners. It will be necessary for me to refer to this hypothesis so frequently, that, to save circumlocution, I shall call it the hypothesis of *Biogenesis*; and I shall term the contrary doctrine—that living matter may be produced by not living matter—the hypothesis of *Abiogenesis*.

In the seventeenth century, as I have said, the latter was the dominant view, sanctioned alike by antiquity and by authority; and it is interesting to observe that Redi did not escape the customary tax upon a discoverer, of having to defend himself against the charge of impugning the authority of the Scriptures (Redi, *l. c.* p. 45, *Esperienze*, p. 120); for his adversaries declared that the generation of bees from the carcase of a dead lion is affirmed, in the Book of Judges, to have been the origin of the famous riddle with which Samson perplexed the Philistines:

> Out of the eater came forth meat,
> And out of the strong came forth sweetness.

Against all odds, however, Redi, strong with the strength of demonstrable fact, did splendid battle for Biogenesis; but it is remarkable that he held the doctrine in a sense which, if he had lived in these times, would have infallibly caused him to be classed among the defenders of "spontaneous generation." "Omne vivum ex vivo," "no life without antecedent life," aphoristically sums up Redi's doctrine; but he went no further. It is most remarkable evidence of the philosophic caution and impartiality of his mind, that, although he had speculatively anticipated the manner in which grubs really are deposited in fruits and in the galls of plants, he deliberately admits that the evidence is insufficient to bear him out; and he therefore prefers the supposition that they are generated by a modification of the living substance of the plants themselves. Indeed, he regards these vegetable growths as organs, by means of which the plant gives rise to an animal, and looks upon this production of specific animals as the final cause of the galls and of, at any rate, some fruits. And he proposes to explain the occurrence of parasites within the animal body in the same way.

It is of great importance to apprehend Redi's position rightly; for the lines of thought he laid down for us are those upon which naturalists have been working ever since. Clearly he held Biogenesis as against Abiogenesis; and I shall immediately proceed, in the first place, to inquire how far subsequent investigation has borne him out in so doing.

But Redi also thought that there were two modes of Biogenesis. By the one method, which is that of common and ordinary occurrence, the living parent gives rise to offspring which passes through the same cycle of changes as itself—like gives rise to like; and this has been termed Homogenesis. By the other mode, the living parent was supposed to give rise to offspring which passed through a totally different series of states from those exhibited by the parent, and did not return into the cycle of the parent: this is what ought to be called Heterogenesis, the offspring being altogether, and permanently, unlike the parent. The term Heterogenesis, however, has unfortunately been used in a different sense, and M. Milne-Edwards has therefore substituted for it Xenogenesis, which means the generation of something foreign. After discusing Redi's hypothesis of universal Biogenesis, then, I shall go on to ask how far the growth of science justifies his other hypothesis of Xenogenesis.

The progress of the hypothesis of Biogenesis was triumphant and unchecked for nearly a century. The application of the microscope to anatomy, in the hands of Crew, Leeuwenhoek, Swammerdam, Lyonet, Vallisnieri, Reaumur, and other illustrious investigators of nature of that day, displayed such a complexity of organization in the lowest and minutest forms, and everywhere revealed such a prodigality of provision for their multiplication by germs of one sort or another, that the hypothesis of Abiogenesis began to appear not only untrue, but absurd; and in the middle of the eighteenth century, when Needham and Buffon took up the question, it was almost universally discredited. ('Nouvelles Observations,' p. 169 and 176.)

But the skill of the microscope-makers of the eighteenth century soon reached its limit. A microscope magnifying 400 diameters was a *chef-d'œuvre* of the opticians of that day; and, at the same time, by no means trustworthy. But a magnifying-power of 400 diameters, even when definition reaches the exquisite perfection of our modern achromatic lenses, hardly suffices for the mere discernment of the smallest forms of life. A speck, only $\frac{1}{25}$ of an inch in diameter, has, at ten inches from the eye, the same apparent size as an object $\frac{1}{10000}$th of an inch in diameter, when magnified 400 times; but forms of living matter abound, the diameter of which is not more than $\frac{1}{40000}$th of an inch. A filtered infusion of hay allowed to stand for two days, will swarm with living things, among which, any which reaches the diameter of a human red blood-corpuscle, or about $\frac{1}{3200}$th of an inch, is a giant. It is only by bearing these facts in mind, that we can deal fairly with the remarkable statements and speculations put forward by Buffon and Needham in the middle of the eighteenth century.

When a portion of any animal or vegetable body is infused in water, it gradually softens and disintegrates; and as it does so, the water is found to swarm with minute active creatures, the so-called Infusorial Animalcules, none of which can be seen except by the aid of the microscope; while a large proportion belong to the category of smallest things of which I have spoken, and which must have all looked like mere dots and lines under the ordinary microscopes of the eighteenth century.

Led by various theoretical considerations, which I cannot now discuss, but which looked promising enough in the lights of that day, Buffon and Needham doubted the applicability of Redi's hypothesis to the infusorial animalcules, and Needham very properly endeavoured to put the question to an experimental test. He said to himself, if these infusorial animalcules come from germs, their germs must exist either in the substance infused, or in the water with which the infusion is made, or in the superjacent air. Now the vitality of all germs is destroyed by heat. Therefore, if I boil the infusion, cork it up carefully, cementing the cork over with mastic, and then heat the whole vessel by heaping hot ashes over it, I must needs kill whatever germs are present. Consequently, if Redi's hypothesis hold good, when the infusion is taken away and allowed to cool, no animalcules ought to be developed in it; whereas, if the animalcules are not dependent on pre-existing germs, but are generated from the infused substance, they ought, by-and-by, to make their appearance. Needham found that, under the circumstances in which he made his experiments, animalcules always did arise in the infusions, when a sufficient time had elapsed to allow for their developement.

In much of his work Needham was associated with Buffon, and the results of their experiments fitted in admirably with the great French naturalist's hypothesis of "organic molecules," according to which, life is the indefeasible property of certain indestructible molecules of matter, which exist in all living things, and have inherent activities by which they are distinguished from not living matter. Each individual living organism is formed by their temporary combination. They stand to it in the relation of the particles of water to a cascade or whirlpool; or to a mould, into which the water is poured. The form of the organism is thus determined by the reaction between external conditions and the inherent activities of the organic molecules of which it is composed; and, as the stoppage of a whirlpool destroys nothing but a form, and leaves the molecules of the water, with all their inherent activities intact, so what we call the death and putrefaction of an animal or a plant ia merely the breaking up of the form, or manner of association, of its constituent organic molecules, which are then set free as infusorial animalcules.

It will be perceived that this doctrine is by no means identical with *Abiogenesis*, with which it is often confounded. On this hypothesis, a piece of beef or a handful of hay is dead only in a limited sense. The beef is dead ox, and the hay is dead grass; but the "organic molecules" of the beef or the hay are not dead, but are ready to manifest their vitality as soon as the bovine or herbaceous shrouds in which they are imprisoned are rent by the macerating action of water. The hypothesis, therefore, must be classified under Xenogenesis rather than under Abiogenesis. Such as it was, I think it will appear, to those who will be just enough to remember that it was propounded before the birth of modern chemistry and of the modern optical arts, to be a most ingenious and suggestive speculation.

But the great tragedy of science—the slaying of a beautiful hypothesis by an ugly fact—which is so constantly being enacted under the eyes of philosophers, was played almost immediately, for the benefit of Buffon and Needham.

Once more, an Italian, the Abbé Spallanzani, a worthy successor and representative of Redi in his acuteness, his ingenuity, and his learning, subjected the experiments and the conclusions of Needham to a searching criticism. It might be true that Needham's experiments yielded results such as he had described, but did they bear out his arguments? Was it not possible, in the first place, that he had not completely excluded the air by his corks and mastic? And was it not possible; in the second place, that he had not sufficiently heated his infusions and the superjacent air? Spallanzani joined issue with the English naturalist on both these pleas; and he showed that if, in the first place, the glass vessels in which the infusions were contained were hermetically sealed by fusing their necks, and if, in the second place, they were exposed to the temperature of boiling-water for three quarters of an hour (see Spallanzani, 'Opere' vi. pp. 42 and 51), no animalcules ever made their appearance within them. It must be admitted that the experiments and arguments of Spallanzani furnish a complete and a crushing reply to those of Needham. But we all too often forget that it is one thing to refute a proposition, and another to prove the truth of a doctrine which implicitly, or explicitly, contradicts the proposition; and the advance of science soon showed that though Needham might be quite wrong, it did not follow that Spallanzani was quite right.

Modern Chemistry, the birth of the latter half of the eighteenth century, grew apace, and soon found herself face to face with the great problems which Biology had vainly tried to attack without her help. The discovery of oxygen led to the laying of the foundations of a scientific theory of respiration, and to an examination of the marvellous interactions of organic substances with oxygen. The presence of free oxygen appeared to be one of the conditions of the existence of life, and of those singular changes in organic matters which are known as fermentation and putrefaction. The question of the generation of the infusorial animacules thus passed into a new phase. For what might not have happened to the organic matter of the infusions, or to the oxygen of the air, in Spallanzani's experiments? What security was there that the developement of life which ought to have taken place had not been checked, or prevented, by these changes?

The battle had to be fought again. It was needful to repeat the experiments under conditions which would make sure that neither the oxygen of the air, nor the composition of the organic matter, was altered, in such a manner as to interfere with the existence of life.

Schulze and Schwann took up the question from this point of view in 1836 and 1837. The passage of air through red-hot glass tubes, or through strong sulphuric acid, does not alter the proportion of its oxygen, while it must needs arrest, or destroy, any organic matter which may be contained in the air. These experimenters, therefore, contrived arrangements by which the only air which should come into contact with a boiled infusion should be such as had either passed through red-hot tubes or through strong sulphuric acid. The result which they obtained was that an infusion so treated developed no living things, while if the same infusion was afterwards exposed to the air such things appeared rapidly and abundantly. The accuracy of these experiments has been alternately denied and affirmed. Supposing them to be accepted, however, all that they really proved was, that the treatment to which the air was subjected destroyed *something* that was essential to the developement of life in the infusion. This "something" might be gaseous, fluid, or solid; that it consisted of germs remained only an hypothesis of greater or less probability.

Contemporaneously with these investigations a remarkable discovery was made by Cagniard de La Tour. He found that common yeast is composed of a vast accumulation of minute plants. The fermentation of must, or of wort, in the fabrication of wine and beer, is always accompanied by the rapid growth and multiplication of these Torulæ. Thus fermentation, in so far as it was accompanied by the developement of microscopical organisms in enormous numbers, became assimilated to the decomposition of an infusion of ordinary animal or vegetable matter; and it was an obvious suggestion that the organisms were, in some way or other, the causes both of fermentation and putrefaction. The chemists, with Berzelius and Liebig at their head, at first laughed this idea to scorn; but in 1843, a man then very young, who has since performed the unexampled feat of attaining to high eminence alike in Mathematics, Physics and Physiology,—I speak of the illustrious Helmholtz,—reduced the matter to a test of experiment by a method alike elegant and conclusive. Helmholtz separated a putrefying, or fermenting liquid, from one which was simply putrescible, or fermentable, by a membrane, which allowed the fluids to pass through and become intermixed, but stopped the passage of solids. The result was, that while the putrescible, or the fermentable, liquids became impregnated with the results of the putrescence, or fermentation, which was going on on the other side of the membrane, they neither putrefied (in the ordinary way) nor fermented; nor were any of the organisms which abounded in the fermenting, or putrefying, liquid generated in them. Therefore the cause of the developement of these organisms must lie in something which cannot pass through membrane; and as Helmholtz's investigations were long antecedent to Graham's researches upon colloids, his natural conclusion was, that the agent thus intercepted must be a solid material. In point of fact Helmholtz's experiments narrowed the issue to this: that which excites fermentation and putrefaction, and at the same time gives rise to living forms in a fermentable, or putrescible fluid, is not a gas and is not a diffusible fluid; therefore it is either a colloid, or it is matter divided into very minute solid particles.

The researches of Schroeder and Dusch in 1854, and of Schroeder alone, in 1859, cleared up this point by experiments which are simply refinements upon those of Redi. A lump of cotton-wool is, physically speaking, a pile of many thicknesses of very fine gauze, the fineness of the meshes of which depends upon the closeness of the compression of the wool. Now, Schroeder and Dusch found, that, in the case of all the putrefiable materials which they used (except milk and yolk of egg), an infusion boiled, and then allowed to come in contact with no air but such as had been filtered through cotton-wool, neither putrified nor fermented, nor developed living forms. It is hard to imagine what the fine sieve formed by the cotton-wool could have stopped except minute solid particles. Still the evidence was incomplete until it had been positively shown, first, that ordinary air does contain such particles; and, secondly, that filteration through cotton-wool arrests these particles and allows only physically pure air to pass. This demonstration has been furnished within the last year by the remarkable experiments of Prof. Tyndall. It has been a common objection of Abiogenists that, if the doctrine of Biogeny is true, the air must be thick with germs; and they regard this as the height of absurdity. But nature occasionally is exceedingly unreasonable, and Prof. Tyndall has proved that this particular absurdity may nevertheless be a reality. He has demonstrated that ordinary air is no better than a sort of stirabout of excessively minute solid particles; that these particles are almost wholly destructible by heat; and that they are strained off, and the air rendered optically pure, by being passed through cotton-wool.

But it remains yet in the order of logic though not of history, to show that, among these solid destructible particles, there really do exist germs capable of giving rise to the developement of living forms in suitable menstrua. This piece of work was done by M. Pasteur in those beautiful researches which will ever render his name famous, and which, in spite of all attacks upon them, appear to me now, as they did seven years ago ('Lectures to Working Men on the Causes of the Phenomena of Organic Nature,' 1863, to be models of acurate experimentation and logical reasoning. He strained air through cotton-wool, and found, as Schroederand Dusch had done, that it contained nothing competent to give rise to the developement of life in fluids highly fitted for that purpose. But the important further links in the chain of evidence added by Pasteur are three. In the first place, he submitted to microscopic examination the cotton-wool which had served as strainer, and found that sundry bodies, clearly recognizable as germs, were among the solid particles strained off. Secondly, he proved that these germs were competent to give rise to living forms by simply sowing them in a solution fitted for their developement. And, thirdly, he showed that the incapacity of air strained through cotton-wool to give rise to life was not due to any occult change effected in constituents of the air by the wool, by proving that the cotton-wool might be dispensed with altogether, and perfectly free access left between the exterior air and that in the experimental flask. If the neck of the flask is drawn out into a tube and bent downwards, and if, after the contained fluid has been carefully boiled, the tube is heated sufficiently to destroy any germs which may be present in the air which enters as the fluid cools, the apparatus may be left to itself for any time, and no life will appear in the fluid. The reason is plain. Although there is free communication between the atmosphere laden with germs and the germless air in the flask, contact between the two takes place only in the tube; and as the germs cannot fall upwards, and there are no currents, they never reach the interior of the flask. But if the tube be broken short off where it proceeds from the flask, and free access be thus given to germs falling vertically out of the air, the fluid, which has remained clear and desert for months, becomes, in a few days, turbid and full of life.

These experiments have been repeated over and over again by independent observers with entire success; and there is one very simple mode of seeing the fact for oneself, which I may as well describe.

Prepare a solution (much used by M. Pasteur, and often called "Pasteur's solution") composed of water with tartrate of ammonia, sugar, and yeast-ash dissolved therein. Infusion of hay treated in the same way, yields similar results; but as it contains organic matter, the argument which follows cannot be based upon it. Divide it into three portions in as many flasks; boil all three for a quarter of an hour; and, while the steam is passing out, stop the neck of one with a large plug of cotton-wool, so that this also may be thoroughly steamed. Now set the flasks aside to cool, and when their contents are cold, add to one of the open ones a drop of filtered infusion of hay which has stood for twenty-four hours, and is consequently full of the active and excessively minute organisms known as Bacteria. In a couple of days of ordinary warm weather, the contents of this flask will be milky, from the enormous multiplication of Bacteria. The other flasks, open and exposed to the air, will, sooner or later, become milky with Bacteria, and patches of mould may appear in it; while the liquid in the flask, the neck of which is plugged with cotton-wool, will remain clear for an indefinite time. I have sought in vain for any explanation of these facts, except the obvious one, that the air contains germs competent to give rise to Bacteria, such as those with which the first solution has been knowingly and purposely inoculated, and to the mould Fungi. And I have not yet been able to meet any advocate of Abiogenesis who seriously maintains that the atoms of sugar, tartrate of amonia, yeast-ash and water, under no influence but that of free access of air and the ordinary temperature, re-arrange themselves and give rise to the protoplasm of Bacterium. But the alternative is to admit that these Bacteria arise from germs in the air; and, if they are thus propagated, the burden of proof, that other like forms are generated in a different manner, must rest with the asserter of that proposition.

To sum up the effect of this long chain of evidence:—

It is demonstrable, that a fluid eminently fit for the developement of the lowest forms of life, but which contains neither germs nor any protein compound, gives rise to living things in great abundance, if it is exposed to ordinary air; while no such developement takes place if the air with which it is in contact is mechanically freed from the solid particles, which ordinary float in it, and which may be made visible by appropriate means.

It is demonstrable, that the great majority of these particles are destructible by heat, and that some of them are germs, or living particles, capable of giving rise to the same form of life as those which appear when the fluid is exposed to unpurified air.

It is demonstrable, that inoculation of the experimental fluid with a drop of liquid known to contain living particles, gives rise to the same phenomena as exposure to unpurified air.

And it is further certain that these living particles are so minute that the assumption of their suspension in ordinary air present not the slightest difficulty. On the contrary, considering their lightness and the wide diffusion of the organisms which produce them, it is impossible to conceive that they should not be suspended in the atmosphere in myriads.

Thus the evidence, direct and indirect, in favour of Biogenesis for all known forms of life must, I think, be admitted to be of great weight.

On the other side, the sole assertions worthy of attention are, that hermetically sealed fluids, which have been exposed to great and long-continued heat, have sometimes exhibited living forms of low organization when they have been opened.

The first reply that suggests itself is the probability that there must be some error about these experiments, because they are performed on an enormous scale every day, with quite contrary results. Meat, fruits, vegetables, the very materials of the most fermentable and putrescible infusions, are preserved to the extent I suppose I may say, of thousands of tons every year, by a method which is a mere application of Spallanzani's experiment. The matters to be preserved are well boiled in a tin case provided with a small hole, and this hole is soldered up when all the air in the case has been replaced by steam. By this method they may be kept for years, without putrefying, fermenting, or getting mouldy. Now this is not because oxygen is excluded, inasmuch as it is now proved that free oxygen is not necessary for either fermentation or putrefaction. It is not because the tins are exhausted of air, for Vibriones and Bacteria live, as Pasteur has shown, without air or free oxygen. It is not because the boiled meats or vegetables are not putrescible or fermentable, as those who have had the misfortune to be in a ship supplied with unskillfully closed tins well know. What is it, therefore, but the exclusion of the germs? I think that Abiogenists are bound to answer this question before they ask us to consider new experiments of precisely the same order.

And in the next place, if the results of the experiments I refer to are really trustworthy, it by no means follows that Abiogenesis has taken place. The resistance of living matter to heat is known to vary within considerable limits, and to depend, to some extent, upon the chemical and physical qualities of the surrounding medium. But if, in the present state of science, the alternative is offered us, either germs can stand a greater heat than has been supposed, or the molecules of dead matter, for no valid or intelligible reason that is assigned, are able to re-arrange themselves into living bodies, exactly such as can be demonstrated to be frequently produced in another way, I cannot understand how choice can be, even for a moment, doubtful.

But though I cannot express this conviction of mine too strongly, I must carefully guard myself against the supposition that I intend to suggest that no such thing as Abiogenesis ever has taken place in the past, or ever will take place in the future. With organic chemistry, molecular physics, and physiology yet in their infancy, and every day making prodigious strides, I think it would be the height of presumption for any man to say that the conditions under which matter assumes the properties we call "vital" may not, some day, be artificially brought together. All I feel justified in affirming is, that I see no reason for believing that the feat has been performed yet.

And, looking back through the prodigious vista of the past, I find no record of the commencement of life, and therefore I am devoid of any means of forming a definite conclusion as to the conditions of its appearance. Belief, in the scientific sense of the word, is a serious matter and needs strong foundations. To say, therefore, in the admitted absence of evidence, that I have any belief as to the mode in which the existing forms of life have originated, would be using words in a wrong sense. But expectation is permissible where belief is not; and if it were given to me to look beyond the abyss of geologically recorded time to the still more remote period when the earth was passing through physical and chemical conditions, which it can no more see again than a man may recall his infancy, I should expect to be a witness of the evolution of living protoplasm from not living matter. I should expect to see it appear under forms of great simplicity, endowed, like existing Fungi, with the power of determining the formation of new protoplasm from such matters as ammonium carbonates, oxalates and tartrates, alkaline and earthy phosphates, and water, without the aid of light. That is the expectation to which analogical reasoning leads me; but I beg you once more to recollect that I have no right to call my opinion anything but an act of philosophical faith.

So much for the history of the progress of Redi's great doctrine of Biogenesis, which appears to me, with the limitations I have expressed, to be victorious along the whole line at the present day.

As regards the second problem offered to us by Redi, whether Xenogenesis obtains, side by side with Homogenesis; whether, that is, there exist not only the ordinary living things, giving rise to offspring which run through the same cycle as themselves, but also others, producing offspring which are of a totally different character from themselves, the researches of two centuries have led to a different result. That the grubs found in galls are no product of the plants on which the galls grow, but are the result of the introduction of the eggs of insects into the substance of these plants, was made out by Vallisnieri, Reaumur, and others, before the end of the first half of the eighteenth century.

The tapeworms, bladderworms and flukes continued to be a stronghold of the advocates of Xenogenesis for a much longer period. Indeed, it is only within the last thirty years that the splendid patience of Von Siebold, Van Beneden, Leuckart, Kuchenmeister, and other helminthologists, has succeeded in tracing every such parasite, often through the strangest wanderings and metamorphoses, to an egg derived from a parent actually or potentially like itself; and the tendency of inquiries elsewhere has all been in the same direction. A plant may throw off bulbs, but these, sooner or later, give rise to seeds or spores, which develope into the original form.

A polype may give rise to Medusæ, or a pluteus to an Echinoderm, but the Medusa and the Echinoderm give rise to eggs which produce polypes or plutei, and they are therefore only stages in the cycle of life of the species.

But if we turn to Pathology, it offers us some remarkable approximations to true Xenogenesis.

As I have already mentioned, it has been known since the time of Vallisnieri and of Reaumur that galls in plants and tumours in cattle are caused by insects, which lay their eggs in those parts of the animal or vegetable frame of which these morbid structures are outgrowths. Again, it is a matter of familiar experience to everybody that mere pressure on the skin will give rise to a corn. Now the gall, the tumour, and the corn are parts of the living body, which have become, to a certain degree, independent and distinct organisms. Under the influence of certain external conditions, elements of the body, which should have developed in due subordination to its general plan, set up for themselves, and apply the nourishment which they receive to their own purposes.

From such innocent productions as corns and warts there are all gradations to the serious tumours which, by their mere size and the mechanical obstruction they cause, destroy the organism out of which they are developed; while, finally, in those terrible structures known as cancers, the abnormal growth has acquired powers of reproduction and multiplication, and is only morphologically distinguishable from the parasitic worm, the life of which is neither more nor less closely bound up with that of the infested organism.

If there were a kind of diseased structure, the histological elements of which were capable of maintaining a separate and independent existence out of the body, it seems to me that the shadowy boundary between morbid growth and Xenogenesis would be effaced. And I am inclined to think that the progress of discovery has almost brought us to this point already. I have been favoured by Mr. Simon with an early copy of the last published of the valuable 'Reports on the Public Health,' which, in his capacity of their Medical Officer, he annually presents to the Lords of the Privy Council. The Appendix to this Report contains an introductory essay 'On the intimate Pathology of Contagion,' by Dr. Burdon Sanderson, which is one of the clearest, most comprehensive, and well-reasoned discussions of a great question which has come under my notice for a long time. I refer you to it for details and for the authorities for the statements I am about to make.

You are familiar with what happens in vaccination. A minute cut is made in the skin, and an infinitesimal quantity of vaccine matter is inserted into the wound. Within a certain time, a vesicle appears in the place of the wound, and the fluid which distends this vesicle is vaccine matter, in quantity a hundred or a thousand-fold that which was originally inserted. Now what has taken place in the course of this operation? Has the vaccine matter by its irritative property produced a mere blister, the fluid of which has the same irritative porperty? Or does the vaccine matter contain living particles, which have grown and multiplied where they have been planted? The observations of M. Chauveau, extended and confirmed by Dr. Sanderson himself, appear to leave no doubt upon this head. Experiments, similar in principle to those of Helmholtz on fermentation and putrefaction, have proved that the active element in the vaccine lymph is non-diffusible, and consists of minute particles not exceeding $\frac{1}{20000}$ of an inch in diameter, which are made visible in the lymph by the microscope. Similar experiments have proved that two of the most destructive of epizootic diseases, sheep-pox and glanders, are also dependent for their existence and their propagation upon extremely small living solid particles, to which the title of *microzymes* is applied. An animal suffering under either of these terrible diseases is a source of infection and contagion to others, for precisely the same reason as a tub of fermenting beer is capable of propagating its fermentation "by infection," or "contagion," to fresh wort. In both cases it is the solid living particles which are efficient; the liquid in which they float, and at the expense of which they live, being altogether passive.

Now arises the question, are these microzymes the results of *Homogenesis* or of *Xenogenesis;* are they capable, like the *Torulæ* of yeast, of arising only by the developement of pre-existing germs; or may they be, like the constituents of a nut-gall, the results of a modification and individualization of the tissues of the body in which they are found, resulting from the operation of certain conditions? Are they parasites in the zoological sense, or are they merely, what Virchow has called "heterologous growths"? It is obvious that this question has the most profound importance, whether we look at it from a practical, or from a theoretical, point of view. A parasite may be stamped out by destroying its germs, but a pathological product can only be annihilated by removing the conditions which give rise to it.

It appears to me that this great problem will have to be solved for each zymotic disease separately, for analogy cuts two ways. I have dwelt upon the analogy of pathological modification, which is in favour of the xenogenetic origin of microzymes; but I must now speak of the equally strong analogies in favour of the origin of such pestiferous particles by the ordinary process of the generation of like from like.

It is, at present, a well-established fact that certain diseases, both of plants and of animals, which have all the characters of contagious and infectious epidemics, are caused by minute organisms. The smut of wheat is a well-known instance of such a disease, and it cannot be doubted that the grape-disease and the potato-disease fall under the same category. Among animals, insects are wonderfully liable to the ravages of contagious and infectious diseases caused by microscopic Fungi.

In autumn, it is not uncommon to see flies, motionless, upon a window-pane, with a sort of magic circle, in white, drawn round them. On microscopic examination, the magic circle is found to consist of innumerable spores, which have been thrown off in all directions by a minute fungus called *Empusa muscæ*, the spore-forming filaments of which stand out like a pile of velvet from the body of the fly. These spore-forming filaments are connected with others, which fill the interior of the fly's body like so much fine wool, having eaten away and destroyed the creature's viscera. This is the full-grown condition of the Empusa. If traced back to its earlier stages, in flies which are still active, and to all appearance healthy, it is found to exist in the form of minute corpuscles which float in the blood of the fly. These multiply and lengthen into filaments, at the expense of the fly's substance; and when they have at last killed the patient, they grow out of its body and give off spores. Healthy flies shut up with diseased ones catch this mortal disease and perish like the others. A most competent observer, M. Cohn, who studied the development of the Empusa in the fly very carefully, was utterly unable to discover in what manner the smallest germs of the Empusa got into the fly. The spores could not be made to give rise to such germs by cultivation; nor were such germs discoverable in the air, or in the food of the fly. It looked exceedingly like a case of Abiogenesis, or, at any rate, of Xenogenesis; and it is only quite recently that the real course of events has been made out. It has been ascertained, that when one of the spores falls upon the body of a fly, it begins to germinate, and sends out a process which bores its way through the fly's skin; this, having reached the interior cavities of its body, gives off the minute floating corpuscles which are the earliest stage of the Empusa. The disease is "contagious," because a healthy fly coming in contact with a diseased one, from which the spore-bearing filaments protrude, is pretty sure to carry off a spore or two. It is "infectious" because the spores become scattered about all sorts of matter in the neighbourhood of the slain flies.

The silkworm has long been known to be subject to a very fatal contagious and infectious disease called the Muscadine. Audouin transmitted it by inoculation. This disease is entirely due to the development of a fungus, *Botrytis Bassiana*, in the body of the caterpillar; and its contagiousness and infectiousness are accounted for in the same way as those of the fly disease. But of late years a still more serious epizootic has appeared among the silk worms; and I may mention a few facts which will give you some conception of the gravity of the injury which it has inflicted on France alone.

The production of silk has been, for centuries, an important branch of industry in Southern France, and in the year 1853 it had attained such a magnitude, that the annual produce of the French sericulture was estimated to amount to a tenth of that of the whole world, and represented a money value of 117,000,000 francs, or nearly five millions sterling. What may be the sum which would represent the money-value of all the industries connected with the working up of the raw silk thus produced, is more than I can pretend to estimate. Suffice it to say, that the City of Lyons is built upon French silk, as much as Manchester was upon American cotton before the civil war.

Silkworms are liable to many diseases; and even, before 1853, a peculiar epizootic, frequently accompanied by the appearance of dark spots upon the skin (whence the name of "Pébrine" which it has received), had been noted for its mortality. But in the years following 1853 this malady broke out with such extreme violence, that, in 1856, the silk-crop was reduced to a third of the amount which it had reached in 1853; and, up till within the last year or two, it has never attained half the yield of 1853. This means not only that the great number of people engaged in silk-growing are some thirty millions sterling poorer than they might have been; it means not only that high prices have had to he paid for imported silk-worm-eggs, and that, after investing his money in them, in paying for mulberry-leaves and for attendance, the cultivator has constantly seen his silk-worms perish and himself plunged in ruin,—but it means that the looms of Lyons have lacked employment, and that, for years, enforced idleness and misery have been the portion of a vast population which, in former days, was industrious and well to do.

In 1858 the gravity of the situation caused the French Academy of Sciences to appoint Commissioners, of whom a distinguished naturalist, M. de Quatrefages, was one, to inquire into the nature of this disease, and, if possible, to devise some means of staying the plague. In reading the Report (Etudes sur les Maladies Actuelles des Vers à Soie, p. 53) made by M. de Quatrefages, in 1859, it is exceedingly interesting to observe that his elaborate study of the Pébrine forced the conviction upon his mind that, in its mode of occurrence and propagation, the disease of the silk-worm is, in every respect, comparable to the cholera among mankind. But it differs from the cholera, and, so far, is a more formidable disease, in being hereditary, and in being under some circumstances contagious, as well as infectious.

The Italian naturalist, Filippi, discovered in the blood of the silkworm affected by this strange disease, a multitude of cylindrical corpuscles, each about $\frac{1}{6000}$ of an inch long. These have been carefully studied by Lebert, and named by him Panhistophyton; for the reason that, in subjects in which the disease is strongly developed, the corpuscles swarm in every tissue and organ of the body, and even pass into the undeveloped eggs of the female moth. But are these corpuscles causes, or mere concomitants, of the disease? Some naturalists took one view and some another; and it was not until the French Government, alarmed by the continued ravages of the malady, and the inefficiency of the remedies which had been suggested, despatched M. Pasteur to study it, that the question received its final settlement; at a great sacrifice, not only of the time and peace of mind of that eminent philosopher, but, I regret to have to add, of his health.

But the sacrifice has not been in vain. It is now certain that this devastating, cholera-like, Pébrine is the effect of the growth and multiplication of the Panhistophyton in the silkworm. It is contagious and infectious because the corpuscles of the Panhistophyton pass away from the bodies of the diseased caterpillars, directly or indirectly, to the alimentary canal of healthy silkworms in their neighbourhood; it is hereditary, because the corpuscles enter into the eggs while they are being formed, and consequently are carried within them when they are laid; and for this reason, also, it presents the very singular peculiarity of being inherited only on the mother's side. There is not a single one of all the apparently capricious and unaccountable phenomena presented by the Pébrine, but has received its explanation from the fact that the disease is the result of the presence of the microscopic organism, Panhistophyton.

Such being the facts with respect to the Pébrine, what are the indications as to the method of preventing it? It is obvious that this depends upon the way in which the Panhistophyton is generated. If it may be generated by Abiogenesis, or by Xeno genesis, within the silkworm or its moth, the extirpation of the disease must depend upon the prevention of the occurrence of the conditions under which this generation takes place. But if, on the other hand, the Panhistophyton is an independent organism, which is no more generated by the silkworm than the mistletoe is generated by the oak, or the apple-tree, on which it grows, though it may need the silkworm for its developement, in the same way as the mistletoe needs the tree, then the indications are totally different. The sole thing to be done is to get rid of and keep away the germs of the Panhistophyton. As might be imagined, from the course of his previous investigations, M. Pasteur was led to believe that the latter was the right theory; and guided by that theory, he has devised a method of extirpating the disease, which has proved to be completely successful wherever it has been properly carried out.

There can be no reason, then, for doubting that, among insects, contagious and infectious diseases of great malignity are caused by minute organisms which are produced by pre-existing germs, or by Homogenesis; and there is no reason, that I know of, for believing that what happens in insects may not take place in the highest animals. Indeed, there is already strong evidence that some diseases of an extremely malignant and fatal character to which man is subject, are as much the work of minute organisms as is the Pébrine. I refer for this evidence to the very striking facts adduced by Prof. Lister in his various well-known publications on the antiseptic method of treatment. It seems to me impossible to rise from the perusal of those publications without a strong conviction that the lamentable mortality which so frequently dogs the footsteps of the most skilful operator, and those deadly consequences of wounds and injuries which seem to haunt the very walls of great hospitals, and are even now destroying more men than die of bullet or bayonet, are due to the importation of minute organisms into wounds, and their increase and multiplication; and that the surgeon who saves most lives will be he who best works out the practical consequences of the hypothesis of Redi.

I commenced this Address by asking you to follow me in an attempt to trace the path which has been followed by a scientific idea, in its long and slow progress from the position of a probable hypothesis to that of an established Law of Nature. Our survey has not taken us into very attractive regions; it has lain chiefly in a land flowing with the abominable, and peopled with mere grubs and mouldiness. And it may be imagined with what smiles and shrugs practical and serious contemporaries of Redi and of Spallanzani may have commented on the waste of their high abilities in toiling at the solution of problems which, though curious enough in themselves, could be of no conceivable utility to mankind.

Nevertheless, you will have observed that before we had travelled very far upon our road, there appeared, on the right hand and on the left, fields laden with a harvest of golden grain, immediately convertable into those things which the most sordidly practical of men will admit to have value,—namely money and life.

The direct loss to France caused by the Pébrine in seventeen years cannot be estimated at less than fifty millions sterling; and if we add to this what Redi's idea, in Pasteur's hands, has done for the wine-grower and for the vinegar-maker, and try to capitalize its value, we shall find that it will go a long way towards repairing the money losses caused by the frightful and calamitous war of this autumn.

And as to the equivalent of Redi's thought in life, how can we over-estimate the value of that knowledge of the nature of epidemic and epizootic diseases, and, consequently, of the means of checking or eradicating them, the dawn of which has assuredly commenced?

Looking back no further than ten years, it is possible to select three (1863, 1864 and 1869), in which the total number of deaths from scarlet fever alone amounted to 90,000. That is the return of killed, the maimed and disabled being left out of sight. Why, it is to be hoped that the list of killed in the present bloodiest of all wars will not amount to more than this! But the facts which I have placed before you must leave the least sanguine without a doubt that the nature and the causes of this scourge will one day be as well understood as those of the Pébrine are now; and that the long-suffered massacre of our innocents will come to an end.

And thus mankind will have one more admonition that the "people perish for lack of knowledge"; and that the alleviation of the miseries and the promotion of the welfare of men must be sought, by those who will not lose their pains, in that diligent, patient, loving study, of all the multitudinous aspects of Nature, the results of which constitute exact knowledge, or Science.

It is the justification and the glory of this great Meeting that it is gathered together for no other object than the advancement of the moiety of Science which deals with those phenomena of Nature which we call Physical. May its endeavours be crowned with a full measure of success!

GEOLOGY AND MINERALOGY.

The Student's Elements of Geology. By Sir Charles Lyell, Bart., F.R.S.—The Elements and Principles of Geology, by Sir Charles Lyell, have been probably the most successful works on that science ever published. The former has gone through six editions, and the latter is now in its tenth. A new edition of the Elements being required, Sir Charles was induced to curtail it to such dimensions as would make it a more suitable manual for students, without sacrificing any of its essential features. This he has accomplished in the present "Student's Elements," which is a perfect gem in its way. Compact in size, admirably arranged, its well filled pages beautifully illustrated, it brings up every department of geology to the latest point in regard to facts, while the discussions in regard to theoretical views are very strict, pithy and well-weighed. While the formations of Europe are, as is usual in British text-books, taken as types, those of other parts of the world are well worked in ; and a fair share of attention is given to the discoveries which have recently been made on this continent.

Sir Charles notices fully the recent remarkable discoveries of fossils in the Lower Cambrian of Britain, which extend a rich fauna back into the Longmynd Group, at one time supposed to be nearly barren of fossils. He proposes, in connection with this to establish firmly the once debateable Cambrian system, and to extend it as far upward as the Tremadoc. He thus arranges these rocks :—

Upper Cambrian :

Tremadoc Slates (Primordial of Barrande in part.)
Lingula Flags (Primordial of Barrande.)

Lower Cambrian :

Menevian Beds (Primordial of Barrande.)
Longmynd Group { *a.* Harlech grits. *b.* Llanberis slates.

He regards the Potsdam Sandstone as equivalent to the Upper Cambrian, and places the Huronian as the possible equivalent of the Lower Cambrian. He barely notices our richly fossiliferous Lower Potsdam or Acadian group, and does not include it in his table, though it would have enabled him to find an equivalent for his Menevian beds. He still regards *Histioderma* as a worm-burrow, not being, apparently, aware of Mr. Billings' more probable explanation of it as a cast of a sponge.

It would, however, be useless to follow in detail a work of this kind, which every student and amateur in geology should have in his hands as a book of reference, and which as nearly as is possible in that science whose goal to-day is its starting point to-morrow, brings up the subject to a level with the present state of knowledge, and compresses all its more important facts into the shortest possible space, while exhibiting them with the utmost clearness.

Geological Discoveries in Brazil.—The following letter to one of the Editors from Prof. Hartt, a Nova Scotian by birth and education, and now Professor in Cornell University, gives some interesting notes on his present explorations in Brazil. The letter is dated from near Mont Alegre, Rio des Amazonas:—

"I have been making some discoveries down here that I think will interest you. On the Rio Tapajos I found a large area occupied by Carboniferous (lower) strata, affording fossils in profusion. The rocks are sandstone, limestone and shale,—the two former full of fossils. The strata are horizontal. The fossils bear a very close resemblance, many of them, to Nova Scotian species. There is a Productus cora and a P. semireticulatus wonderfully like the forms found at Windsor. I have between one and two hundred species of these fossils, and most of them will admit of determination. Many of the brachiopods, &c., are perfectly free from the rock, and shew interiors, loops, &c. I have one species of Trilobite, probably *Phillipsia*. Of fishes I have teeth, scales, and spines. I am in doubt whether the deposits are Sub Carboniferous or Lower Coal Measures; I think the latter the most probable. I am going to give up my little steamer, which, through the kindness of the President of the Province I have had for two months, and divide up my party. I shall then return to the Tapajos to study out carefully these carboniferous deposits and Agassiz's drift. By the bye in this last there are, at Mont Alegre and Aveiros, trap beds."

BOTANY AND ZOOLOGY.

The Geographical Handbook of Ferns; by Katharine M. Lyell, London, 1870.—Mrs. Lyell has done good service to botanical students by compiling and publishing this excellent and most laboriously prepared handbook. The labor incident to such work can be appreciated only by those who have made similar attempts at compilation and geographical distribution. The globe is divided into eighteen sections or botanical areas, and the catalogues of all the species known to occur in each of these sections occupies the bulk of the volume; an indication of the distribution of species throughout the section is given in addition to the name,— thus *Nephrodium fragrans* occurs in three of these catalogues, first in one of the sections of Asia, "Northern, Central and Western Asia, China and Japan" where its habitat is said to be "high-arctic and sub-arctic regions, Caucasus "to Kamtschatka, Manchuria, and Amur;"—and then in two of the N. A. areas. The last forty pages of the book are occupied by a systematic catalogue of all the species, with the occurrence of each throughout these eighteen areas tabulated in parallel columns. North America is botanically deemed to go no further south than the northern Mexican boundary and is divided into three areas:—1st, British America east of the Rocky mountains, and Greenland, 2nd, the United States east of the Rocky mountains and Bermuda, and 3rd, the territory west of the Rocky Mountains from Alaska to the Mexican boundary. As the two first are not botanically separable by any geographical line perhaps that chosen by Mrs. Lyell is as good as any. Of the forty-four species given as occuring in the Canadian division, four have probably been inserted without sufficient authority; *Woodsia scopulina, Lomaria Spicant* and *Polypodium alpestre* are known only from the west side of the Rocky Mountains, and the occurrence of *Asplenium marinum* in New Brunswick still awaits verification. On the other hand nine undoubted natives have been omitted, some of them through an inadvertence as Mrs. Lyell informs me; they are,—

Cheilanthes gracilis ("base of the Rocky Mountains, Aug. 13, 1858," Bourgeau no. 3689 in Herb. Hook.*),
Pteris aquilina,
Woodwardia Virginica,
Scolopendrium vulgare,
Woodsia Oregana (Lake Winnepeg and westward),
Aspidium Lonchitis,
Nephrodium Noveboracense,
Botrychium matricariæfolium *A. Br* (including *B. lanceolatum* and=*B. rutaceum* in Syn. Fil. of Hooker, but not of Swartz), and
Ophioglossum vulgatum.

Of these forty-nine species at least twenty are common to both sides of the Rocky Mountains, all of which (with a doubt as to

* Prof. Eaton was kind enough to trace out the exact locality for me —"Windy mountain near Lacs des Arcs, N. lat. 51° 1′ 44, *vide* Dr. Hector's journal in the 'Blue Book' on Capt. Palliser's Expedition." This station is probably its northern limit. In the U.S. it occurs on both sides of the Rocky mountains and as far south as Arizona (Herb. Eaton) and New Mexico (Ch. Wright nos. 818, 2125). It is the *Ch. vestita* of Hook. Fl. Bor. Am. ii, p. 264 and Sp. Fil. ii, p. 98, the *Ch. lanuginosa* of Gray's Manual.

the two species which are marked) are also known to occur on the mountains themselves; these are,—

Woodsia Oregana,
Cystea fragilis,
Adiantum pedatum ?
Cryptogramme crispa,
Pellæa atropurpurea,
Pteris aquilina,
Asplenium viride,
——— Trichomanes ?
——— Filix-fœmina,
Aspidium Lonchitis,
Aspidium aculeatum,
Nephrodium Filix-mas,
——— fragrans,
——— spinulosum,
Polypodium vulgare,
——— Phegopteris,
——— Dryopteris,
Botrychium Lunaria,
——— ternatum, and
——— virginianum.

On the east side of the Rocky Mountains, but apparently not extending as far west as the mountains, are twenty-three species, as follows,—

Onoclea sensibilis,
——— Struthiopteris,
Woodsia glabella,
——— hyperborea,
Dicksonia punctilobula,
Cystea bulbifera,
Pellæa gracilis,
Woodwardia Virginica,
Asplenium ebeneum,
——— angustifolium,
——— thelypteroides,
Scolopendrium vulgare,
Scolopendrium rhizophyllum,
Nephrodium Thelypteris,
——— Noveboracense,
——— Goldieanum,
Polypodium hexagonopterum,
Osmunda regalis,
——— Claytoniana,
——— cinnamomea,
Botrychium simplex,
——— matricariæfolium, and
Ophioglossum vulgatum.

The remaining six species of this area are found on the Rocky mountains, all of them (except *Ch. gracilis* which is not known east of Illinois) also extending eastward to the Atlantic; they are,

Cheilanthes gracilis,
Cystea montana,
Woodsia Ilvensis,
Aspidium acrostichoides,
Nephrodium cristatum, and
——— marginale;

making forty-nine species indigenous to that portion of British America to the east of the Rocky mountains. From the mountains westward to the Pacific we have but eleven other species which may be noted here. They are,

—On the Rocky Mountains and westward,

Woodsia scopulina,
Polypodium alpestre.

—On the West Coast, but not extending as far east as the Rocky Mountains,

Woodsia obtusa,*
Cheilanthes gracillima,

* It is somewhat singular that this species which is common throughout Prof. Chapman's and Dr. Gray's limits, coming right up to our borders

Pellæa densa,
Lomaria Spicant,
Polypodium Scouleri,
——— intermedium, and
Gymnogramme triangularis,
Nephrodium rigidum, (A. argutum, *Kaulf.*),
Aspidium munitum,

thus giving British America a known fern-flora of sixty species of which twenty-eight occur on the Rocky mountains.

On another page is given a list of the ferns of Labrador which includes some species not hitherto published. Thanks to Mr. Becket (one of the staff of the Geological Survey of the Island) and to Dr. Bell (this journal vol. iv. 1869, p. 256) we have now a tolerably long list of the ferns of Newfoundland though doubtless eight or ten species more would reward any careful collector. It is as follows :—

Onoclea sensibilis,
Woodsia Ilvensis,
——— glabella (Becket — robust specimens like some of Macoun's from Lake Superior),
Cystea fragilis,
——— bulbifera,
Pellæa gracilis,
Pteris aquilina,
Asplenium viride (Becket),
——— thelypteroides (Bell),
——— Filix-fœmina,
Aspidium aculeatum (Bell—the var. Braunii),
Nephrodium fragrans (Bell),
——— Filix-mas (Kunze),
——— spinulosum (verum et dilatatum),
Polypodium Dryopteris,
——— Phegopteris,
——— vulgare,
Osmunda regalis,
——— Claytoniana,
——— cinnamomea,
Botrychium Lunaria (Lyell),
——— ternatum (Hooker),
——— virginianum (Hooker).

A list of the ferns of Greenland, an outlying province of North America but with a European flora even along its western shores, has an interest in this connection. It is copied from Prof. Lange's catalogue in Rink's "Grönland" the author's nomenclature being preserved.

Polypodium Dryopteris *L.*
——— Phegopteris *L.*
——— alpestre *Hoppe,*
Aspidium Lonchitis *Sw.*
——— fragrans *Willd.*
Lastræa Filix-mas *Presl,*
——— dilatata *Presl,*
Cystopteris fragilis *Bernh.*
Woodsia ilvensis *R. Br.*
——— hyperborea *R. Br.*
Botrychium Lunaria *Sw.*
——— rutaceum *Fries* (=B. matricariaefolium *A. Br.*)

Mrs. Lyell adds *Woodsia glabella* and *Asplenium viride* without

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in the State of New York, should be unknown on the east side of the Rocky mountains in British America and unknown on the west side in the United States. Its Br. Am. station is on the authority of Kew specimens collected in 1861 on Galton mountains by Dr. Lyall of the Oregon Boundary Survey.

giving her authority and probably in error. Not one of these twelve species is peculiar to America; none of them are likely to have come from America unless *Aspidium fragrans*, a non-European plant wide-spread in north Asia.

Turning to Mrs. Lyell's second area, the United States east of the Rocky Mountains and north of Mexico, we find that the admitted species number seventy-eight, of which these four have probably been inserted in error :—

Cystea montana (the Rocky Mountains habitat of which is north of N. lat. 49°),
Pellæa densa ("Washington" Territory being on the west side),
Cheilanthes gracillima, and
Woodsia scopulina (neither of which occur on the east side of the mountains).

A good many species should be added which may be conveniently divided into various groups :—

A. Species which occur on the Rocky Mountains, but not as far north as lat. 49°—

Cheilanthes Fendleri,
Asplenium Septentrionale,
Nothochlæna Fendleri,
——— dealbata :—

[These four species added to the twenty-eight above noted, gives thirty-two species as the fern flora of the Rocky Mountains.]

B. Species which occur on both sides of the mountains (California, Arizona or New Mexico, and Texas)—

Pellæa Wrightiana,
——— mucronata,
Nothoclæna sulphurea (Mr. Baker's species is probably too comprehensive).

C. Species which have to be removed from the third area into this—

Cheilanthes Wrightii,
——— Lindheimeri,
Pellæa aspera,
——— pulchella,
——— cordata,
Aspidium juglandifolium,
Nothochlæna sinuata,
——— ferruginea,
Gymnogramme pedata,
Aneimia Mexicana.

This division must be held to include the trans-Mississippi States east and north of the Rio Grande, some of which (as Texas, Missouri, etc.) Mrs. Lyell erroneously quotes as belonging to her third area.

D. Two Eastern species are omitted, probably in error—Woodsia glabella (New York and northward); Woodsia hyperborea (Vermont, H. Mann, and northward).

These additions bring up the number of the known species inhabiting this area, to ninety-four; to which may be added

Woodsia Peruviana, should Chas. Wright's no. 2120 prove to be that species, and a new Asplenium recently found by Prof. Bradley in Tennessee.

Mrs. Lyell's third division, embracing all North America to the west of the Rocky Mountains and north of Mexico, is well separated into a botanical area, but, considering its extent and variety of climate, its fern flora is small though in many respects peculiar. Mrs. Lyell enumerates sixty species which number must, I fear, be considerably reduced, inasmuch as a great part of the range of mountains known as Sierra Madre is in (old) Mexico, not in New Mexico, and while such States as that last named and Colorada are common to both second and third areas, others, such as Texas, Kansas, Missouri, and Nebraska, are wholly in the second. The omissions should probably be as follows:—

A. The eleven species above enumerated as belonging to the second area not being known to occur on the west side of New Mexico.

B. Eight species not known on the west coast further north than Mexico proper:—

Adiantum Capilus-veneris (which, however, occurs on the east side from Alabama southward),
Cheilanthes Seemanni
——— microphylla (there is a Kew tradition that this species occurs in Texas, but it needs confirmation),
Cheilanthes viscosa,
Polypodium Madrense,
Gymnogramme tartarea,
——— podophylla,
Acrostichum conforme.

A few species should be added, some of which I enumerate:—

Cheilanthes argentea (said to have been collected by a Russian botanist in Alaska),
—— Newberrii *Eaton* (San Diego, Dr. Newberry and Prof. Wood),
Pellæa ——— (Sierras, 1869, Prof. Bolander — probably a new species),
Nephrodium fragrans (N. W. America, Seemann),
——— dilatatum, (same locality and collector).

The scanty fern flora of the west coast may be seen from the following list copied from "A Catalogue of the Plants of San Francisco," by H. N. Bolander, 1870, which is said to include all the "species found about a hundred miles north and south of "San Francisco, and as far east as Mount Diablo":—

Polypodium Scouleri,
——— Californicum,
Adiantum pedatum,
——— Chilense,

Petris aquilina,
Pellæa mucronata,
——— densa,
——— andromedæfolia,
Gymnogramme triangularis,
Woodwardia radicans,
Cystopteris fragilis,
Aspidium munitum,
——— Californicum,
Nephrodium rigidum,
——— Filix-mas,

or only fifteen species in all. Within the same distances of Montreal we could muster nearly three times as many.

Mrs. Lyell has followed the "Synopsis Filicum" of Hooker and Baker in nomenclature and species limitation, and, in the foregoing remarks, I have more or less closely followed her example.

Notice of Fucus Serratus found in Pictou Harbour. By Rev. A. F. Kemp, M.A.—On the 29th June, 1869, I had an opportunity of examining the shores of the harbour of Pictou, Nova Scotia, and was fortunate enough in finding very fine specimens of *Fucus serratus* Linn. This plant is very common on the rocky sea-shores of Europe, and specially so in the northern parts of the British Islands. Harvey, in his Preface to the Nereis Boreali-Americana, says that *Fucus serratus* has not yet (1851) been detected in America. In the supplement to that work (1858), he says: "I have received a small fragment of this "common European plant, stated to have been found at Newbury-"port, Mass, U.S. It is hardly probable that it is either con-"fined to one locality, or even rare, wherever it occurs; yet none "of my other correspondents have sent it, nor do I know "the circumstances under which Captain Pike obtained it. I "hope this notice may lead some one on the coast to investigate "the subject; for European botanists are yet uncertain whether "*F. serratus* be really *bona fide* native of the American coast, or "merely a stray waif accidentally cast ashore." I have myself examined several points on the eastern coast of America where, if anywhere, this plant might be expected to grow, but have never seen a fragment of it. At Portland, and along the coast of Maine, northward, the shore is highly favourable for the growth of the larger fuci. At Peak's Island I found a peculiar analogue of *F. serratus*, occupying very much its place, and having nearly the same form and habit, excepting the serratures of the margins. It was very abundant on the outer shores of the islands in Casco Bay, but seems very much to be confined to that locality. I did not find it on the northern shores of the State around Eastport. Harvey thinks the plant is *Fucus anceps*. It is as prolific and abundant as *F. serratus* is in Europe. I have also examined several localities on the northern shores of Nova Scotia and in the harbour of Halifax, and have not seen a fragment of *F. serratus,* nor have I ever found it in the collections of amateurs. It was on the western shore of the harbour of Pictou, north of the town, that I first met with this plamt. It was cast ashore along with other sea-weeds. I however found it nowhere *growing* there. *F. nodosus* and *F. vesiculosus* were abundant *in situ*, but not this one. I searched carefully for it at low water, and only found at last a few fronds of it growing on a flat stone about a foot and a half in length and six inches in breadth, and lying loose on other stones, on the shore about a mile to the south of the town. From the quantity that lay on the shores, it was obvious that it grew abundantly in the harbour, but in deep water. This is not its usual habit. Along with allied species it generally occupies the space between tide marks. From these circumstanees I have been led to think that *F. serratus* is not indigenous to this continent, and has been introduced from Europe. Probably it has been brought in the ballast of British ships, which used at a former time to be discharged in to the deeper parts of the harbour. This will also account for its deep-sea habitat. The fronds which I found *growing* were, as I have noted, on a flat stone that might easily have been washed ashore by the force of the waves, floated, as it would be to some extent, by the luxuriant vegetation which covered it. I have every reason to believe that this is the first authenticated instance of the existence of this plant on the eastern coast of America; and is probably the first instance in modern times of a naturalised European alga.

Labrador Plants.—The Rev. S. R. Butler, who has recently returned from a residence extending over several years in Labrador, has been good enough to give me a list of all the plants collected by him when there, from which I have compiled the following catalogue. Mr. Butler explains his localities thus:—
" The two places I have most thoroughly examined are Caribou
" Island and Forteau Bay. When a plant is marked 'Caribou,'
" it is meant that I found it only at that place; when 'Forteau'
" is mentioned, the plant may occur all round Forteau Bay,
" while 'Amour' means that I have found it only in 'L'ance
" Amour,' and that it is not likely to occur elsewhere in the Bay;

"and when no locality is specified, the species may be expected to "occur at many places, if not all along the coast." Amour Point is in the Strait of Belle Isle in long. 56° 50', and is thus in Labrador proper, while Caribou, three-fourths of a degree to the westward, is in the Dominion. Mr. Butler adds that he collected neither pines, willows nor glumaceous plants, and that his more obscure species were named for him by Prof. Eaton, of New Haven. This gentleman has kindly furnished me with a list of the collections of Miss Macfarlane in and around the same localities, which contained several species not mentioned by Mr. Butler; these I have inserted in their proper places, with the collector's name attached:

Ranunculus acris *Linn.* — level grassy places, Forteau.

Anemone parviflora *Michx*— hill-sides, Forteau.

Thalictrum dioicum *Linn.*—hill-sides and along brooks, Caribou and Forteau.

——— Cornuti *Linn.*—(Miss Macfarlane No. 1).

Coptis trifolia *Salisb.*—in swamps along the coast.

Nuphar advena *Aiton*—in ponds, Caribou.

Arabis alpina *Linn.*—brook-sides, Forteau.

Draba incana *Linn.*—Caribou.

Cochlearia tridactylites *Linn.*—sea-shore, Caribou.

——— ——— ——— hill-tops, Forteau.

Viola blanda *Willd.*—moist places, common along the coast.

——— Muhlenbergii *Torrey*—hill-sides, common.

Drosera rotundifolia *Linn.*—in swamps.

Parnassia parviflora *Cand.*—hill-sides, Amour.

Silene acaulis *Linn.*—hill-tops Amour, also Old Fort Island.

Arenaria Grœnlandica *Spreng.*—hill-sides, Baie des Rochers.

——— peploides *Linn.*—in sand near the sea-shore, Caribou and Forteau.

——— verna *Linn.* — hill-sides, Amour.

——— lateriflora *Linn.* — level grassy places.

Stellaria longipes *Goldie*—near the sea-shore.

——— Edwardsii *R. Br.*—(Miss Macfarlane No. 9. Torrey & Gray very properly reduce this to a variety of the last species).

——— borealis *Bigelow*—hill-sides, Caribou.

——— crassifolia *Ehrh.*—marshy flats.

Cerastium alpinum *Linn.* }
——— arvense *Linn.* }
—abundant about Forteau.

Astragalus alpinus *Linn.* }
Hedysarum boreale *Nuttall* }
—hill-sides, Amour.

Lathyrus maritimus *Bigelow*—Caribou and Amour.

——— palustris *Linn.*—Caribou.

Oxytropis campestris *Cand.*—hill-side near Forteau light-house.

Sanguisorba Canadensis *Linn.*—abundant on hill-sides.

Alchemilla vulgaris *Linn.*—abundant on hill-sides, Amour.

Dryas octopetala *Linn.*—hill-tops, Amour.

Geum rivale *Linn.*—brook-sides.

Potentilla Norvegica *Linn.*—along the sea-shore.

——— Anserina *Linn.*—flats near shore

——— palustris *Scopoli*—marshy places, Caribou.

——— tridentata *Aiton*—abundant everywhere.

——— maculata *Pourret* — hills, Amour.

Fragaria Virginiana *Ehrh.*—sparingly on hill-sides.
Rubus Chamæmorus *Linn.*—abundant everywhere.
——— articus *Linn.* — in level grassy places.
——— triflorus *Richn*—on hill-sides.
——— strigosus *Michx*—in inland gulches.
——— castoreus *Fries?*—Forteau.
Pyrus Americana *Cand.*—in gulches and on hills.
Amelanchier Canadensis *Torrey et Gray* var. oligocarpa *Gray* —in swamps.
Epilobium augustifolium *Linn.*—on hill-sides, Caribou.
——— alpinum *Linn.*—wet places, Forteau.
——— palustre *Linn.* — marshy places, common.
——— latifolium *Linn.*—sea-shore, Amour.
Ribes lacustre *Poiret* }
——— prostratum *L'Her.* }
—ravines, common in the interior.
Sedum Rhodiola *Cand.*—on rocks and hill-sides.
Saxifraga aizoides *Linn.*—on rocks, Forteau.
——— oppositifolia *Linn.* — on rocks, Amour.
——— cæspitosa *Linn.*—in level sandy places, Forteau.
Mitella nuda *Linn.* — hill-sides, Forteau.
Cornus Canadensis *Linn.*— common everywhere.
Heracleum lanatum *Michx* }
Archangelica atropurpurea *Hoffm.?* }
—hill-sides and ravines.
Ligusticum Scoticum *Linn.*—Caribou.
Lonicera cærulea *Linn.* }
Linnæa borealis *Gronov.* }
on hill-sides.
Viburnum pauciflorum *Pylaie*—in ravines.
Galium trifidum, var. pusillum *A. Gray*—(Miss Macfarlane No. 25).
Senecio pseudo-Arnica *Lessing*—on hill-sides.
——— aureus *Linn.* var. Balsamitæ *Gray*—in swamps.
Aster Radula *Aiton*—on the sea-shore.
Vaccinum cæspitosum *Michx*— on hill-sides.
——— uliginosum *Linn.* — in swamps.
——— Vitis-Idæa *Linn.*—on hills.
——— Oxycoccus *Linn.* — in swamps.
——— Pennsylvanicum *Lam.* var. angustifolium *Gray.*—on hill-sides.
Chiogenes hispidula *Torrey et Gray* —(Miss MacF. No. 35).
Cassandra calyculata *Don* — in marshy places.
Andromeda polifolia *Linn.* — in swamps.
Kalmia glauca *Aiton*—hill-sides and swamps.
Rhodora Canadensis *Linn.*—hill-sides, Caribou.
Ledum latifolium *Aiton*—common on hills.
Rhododendron Lapponicum *Wahl.* —on a hill-top near Amour.
Loiseleuria procumbens *Desv.*—on hills, Caribou.
Pyrola rotundifolia *Linn.* — in swamps, Amour.
Moneses uniflora *Gray*—in damp shady places.
Armeria Labradorica *Boissier*—on a hill-top, Amour.
Primula farinosa *Linn.*—along shore and on hill-sides.
——— stricta *Hornem.*—Fox Island near Caribou (P. Mistassinica *Michx.*)
Trientalis Americana *Pursh*—common on hills.
Plantago pauciflora *Pursh*—(Miss Macfarlane No. 42).
Pinguicula vulgaris *Linn.*—in moist places.
Euphrasia officinalis *Linn.*—on hill-sides, Caribou.
Rhinanthus Crista-galli *Linn.*—common on hill-sides and on flats.
Mertensia maritima *Don*—in sand on the sea-shore.
Diapensia Lapponica *Linn.*—common on hill-tops at Caribou.
Gentiana acuta *Michx*— on flats, Caribou.

——— propinqua *Richn* }
Halenia deflexa *Griseb.* }
—on hill-sides, Amour.
Pleurogyne rotata *Griseb.*—on flats at Caribou and shores of Esquimaux river.
Menyanthes trifoliata *Linn.*
Diapensia Lapponica *Linn.*—common on hill-tops, Caribou.
Polygonum viviparum *Linn.*—common.
Empetrum nigrum *Linn.*—everywhere common.
Myrica Gale *Linn.*—(Miss Macfarlane No. 56).
Betula nana *Linn.* }
——— glandulosa *Michx* }
—on hill-sides everywhere.
——— pumila *Linn.*—(Miss Macfarlane No. 57).
Larix Americana *Michx* — in swamps and ravines.
Juniperus communis *Linn.*—on hill-tops.
Sparganium simplex *Hudson*—(the vars. genuinum and angustifolium of *Gray*)—in ponds, Caribou.
Habenaria obtusata *Richn*—on hill-sides, Caribou.
——— dilatata *Gray* }
——— hyperborea *R. Br.* }
—in swamps and on hill-sides.
Listera cordata *R. Br.*—in ravines, Caribou.
Iris versicolor *Linn.*—common on flats and hill-sides.
Smilacina bifolia *Ker* }
——— trifolia *Desf.* }
—in marshy places.
——— stellata *Desf.*—on the sea-shore.
Clintonia borealis *Rafin.*—on hill-sides.
Streptopus roseus *Michx* — in ravines.
——— amplexifolius *Cand.*—(Miss Macfarlane No. 62).
Eriophorum capitatum *Host*—on hill-tops.
——— russeolum *Fries*—in swamps and on high hills.
Luzula parvifolia *Desv.*—on hills.
Poa pratensis *Linn.*—on the sea-shore.
Hierochloa borealis *Roem. et Schultes* }
Elymus mollis *Trinius* }
—on the sea-shore.
Lycopodium annotinum *Linn.*—ravines and hill-sides.
Polypodium Dryopteris *Linn.*—on rocks.
——— Phegopteris *Linn.* — in ravines.
Pellæa gracilis *Hook.* } rocks,
Cystea fragilis *Smith* } Amour.
——— montana (*Lam.*)—Amour.
Aspidium spinulosum *Swartz* — ravines and hills, common.
Athyrium Filix-fœmina *Roth*—on hill-sides.
Botrychium Lunaria *Swartz*—hill-sides, Amour.

The Student's Flora of the British Islands. By J. D. Hooker, C.B., etc. London: MacMillan & Co.—Yet another flora of Britain! is one's involuntary exclamation on opening this book—making not a fifth wheel but something like a tenth wheel to the proverbial coach. Nor is this feeling modified after a careful perusal of the book; the work is, of course, well done—remarkably well done, as is everything that Dr Hooker does—but why should one of the first botanists of the day waste such good work on a thread-bare subject? Had Dr. Hooker given us a condensed flora of north Europe, or, better still, taking in Ledebour's ground, of the northern portion of the eastern hemisphere, not merely British students, but students the world over would have thanked him; as it is, one cannot help feeling that a great deal of good work has been thrown away. Dr.

Hooker may well afford to leave the naming and describing of some twenty varieties of Ranunculus aquatilis and the thirty varieties of Rubus fruticosus to less busy pens. There are in this book some remarkably good features well worked out. Dr. Hooker gives the affinities of each family, oftentimes a note of its properties (p. 259, "a few are purgative or emetic or intensely bitter or very poisonous"), always its distribution throughout the world and the numbers of genera and species comprised in it. He gives the same details under each genus and the geographical distribution of each species. As regards our personal hobby, the ferns, his notes on such of the species as are also American are remarkably correct, much more so than in any foreign flora we have seen. I note only the following corrections: *Trichomanes radicans* occurs in Alabama which is not "trop. Am."; *Asplenium marinum* is still given as "Brit. N. America"; and *Scolopendrium vulgare* is said to occur in "N. W. America," while it is known only from Western Canada and New York. Dr. Hooker in orthodox in his mode of quoting authors; hence he writes the name of a well-known Linnean plant as "Selaginella selaginoides *Gray*," thus depriving Link of what little credit may be due to him, but giving compensation elsewhere by writing "Cystopteris montana *Link*," which species is certainly Bernhardi's in view of what he wrote in Schrader's neus Journal for 1806, part 2nd, p. 26; moreover this old blunderer's impossible genus (*loc. cit.*, table ii., fig. 9) having been accepted, he may as well get the benefit of any doubt touching one of the species. Dr. H. introduces a new name to fern honors, the *Acrostichum septentrionale* of Linneaus being referred to its proper genus Asplenium as A. septentrionale *Hull*, an author unknown to us. It would add greatly to the value of such manuals if the reference were given in addition to the name of the author of the species; Asplenium germanicum *Weis* Plantæ Crypt. p. 299, or Scolopendrium *Smith* in Turin Mem., v., p. 421, do not occupy much space, and are necessary to the proper understanding of the names quoted. Dr. Hooker writes "Nephrodium cristatum *Rich.*" probably for Richard, and referring to Michaux's Flora, of which work he was author. If this be correct some other author's name must be found to attach to this well-known Linnean plant, inasmuch as Prof. Eaton has shewn that Michaux's cristatum is spinulosum, as might have been surmised from the omission of the latter species from that work, though it is much more general than cristatum, and is one of the commonest of ferns in this country. The reference, " A. cristatum *Sw.*" under Nephrodium, Filix-mas, is probably a slip of the pen. The " var. uliginosum (Rabenhorst, no. 19) is correctly referred to this species, and is the same as our *Aspidium Boottii* of Tuckerman in Hovey's Mag. of Hort. and Bot. vol. ix. (1843), p. 145, which Dr. Hooker, however, quotes as a variety of his " sub sp. dilatatum " under " *N. spinulosum* Desv."—wherein, I think, he errs. The last-named species is divided into three sub-species : (1) " spinulosum proper " ; (2) dilatatum having four varieties — glandulosum, nanum, Boottii and dumetorum, and also, as I suppose dilatatum proper, ; and (3) remotum. Of dilatatum it is said that it " extends into W. Asia and E.N. America,)" but if I be correct in referring Seemann's no. 1760 and some of Dr. Lyall's British Columbia specimens to this variety, its range in North America is much more extensive. The usually noted differences between it and spinulosum, as color and shape of scales, color of the frond, and whether glandulose or otherwise, are all inconsistent ; the outline of the frond I judge to be the only consistent character. The publishers have done their part well ; the letter-press is remarkably clear and distinct, and the type well chosen, after the style first set by Dr. Gray. The paper, though good, is too soft to bear ink, and the fifty pages of advertisements are rather too heavy an imposition.

SAPONACEOUS PLANTS.—Many plants in different countries furnish useful substitutes for soap to the natives, where there are no conveniences or materials for manufacturing the ordinary soap of commerce. Prominent among these are the soapworts, tropical plants belonging to the genus Sapindus. The Hindoos use the pulp of the fruit of *Sapindus detergens* for washing linen. Several of the species are used for the same purpose instead of soap, owing to the presence of the vegetable principle called saponine. The root and bark also of some species are said to be saponaceous. The capsule of *Sapindus emarginatus* has a detergent quality when bruised, forming suds if agitated in hot water. The natives of India use this as a soap for washing the hair, silk, &c. The berries of *Sapindus laurifolius*, another Indian species, are also saponaceous. The name of the genus is merely altered from *Sapo-indicus*, Indian soap, the aril which surrounds the seed of *S. Saponaria* being used as soap in South America.

According to Browne, the seed-vessels are very acrid; they lather freely in water, and will cleanse more linen than thirty times their weight of soap, but in time they corrode or burn the linen. This assertion, however, requires confirmation. Humboldt tells us that proceeding along the river Carenicuar, in the Gulf of Cariaco, he saw the native Indian women washing their linen with the fruit of this tree, there called the *Para para*. Saponaceous berries are also used in Java, for washing. The fresh bark of the root *Monnina polystachia* called "Yalhoi," pounded and moulded into balls, is used by the Peruvians in place of soap. Saponine exists in many other seeds and roots—in the legumes of *Acacia concinna*, in which a considerable trade is carried on in some parts of India, and in the root of *Vaccaria vulgaris*, *Agrostemma Githago* and *Anagallis arvensis*. It also occurs in various species of Dianthus and Lychnis, and in the bark of *Silene inflata*. *Gypsopyila struthium* is used by the Spaniards for scouring instead of soap. The bruised leaves of *Saponaria officinalis*, a native of England, forms a lather which much resembles that of soap, and is similarly efficacious in removing grease spots. The bark of *Quillaia saponaria* of Central America answers the same purpose, and is used as a detergent by wool dyers. It has been even imported largely into France, Belgium, &c., and sold in the shops as a cheap substitute for soap. The fruit of the *Bromelia Pinguin* has also been found useful as a soap substitute. A vegetable soap was prepared some years ago in Jamaica from the leaves of the American aloe (*Agave Americana*), which was found as detergent as Castile soap for washing linen, and had the superior quality of mixing and forming a lather with salt water as well as fresh. Dr. Robinson, the naturalist, thus describes the process he adopted in 1767, and for which he was awarded a grant by the House of Assembly of Jamaica:—"The lower leaves of the Curaca or Coratoe (*Agave karatu*) were pressed between heavy rollers to express the juice, which, after being strained through a hair cloth, was merely inspissated by the action of the sun, or a slow fire, and cast into balls or cakes. The only precaution deemed necessary was to prevent the mixture of any unctuous materials, which destroyed the efficacy of the soap. Another vegetable soap, which has been found excellent for washing silk, &c. may be thus obtained:—To one part of the Ackee, add one and a-half parts of the before-named *Agave karatu*, macerated in one part of boiling water for twenty four hours, and with the extract from this decoction mix four per cent, of rosin." In Peru, the leaves of the *Maguey agave* are used instead of soap; the clothes are wetted, and then beaten with a leaf which has been crushed; a thick white froth is produced, and after rinsing the clothes are quite clean. The pulpy matter contained in the hard kernel of a tree called locally 'Del Joboncillo' is also used there for the same purpose. On being mixed with water it produces a white froth. In Brazil, soap is made from the ashes of the bassena or broom plant (*Sida lanceolata*), which abounds with alkali. There are also some barks and pods of native plants used for soaps in China. The soap-plant of California, *Phalangium pomeridianum*, is stated by Mr. Edwin Bryant to be exceedingly useful. The bulbous root, which is the saponaceons portion, resembles the onion, but possesses the quality of cleansing linen equal to any olive soap manufactured. From a paper read before the Boston Society of Natural History, it appears that this soap-plant grows all over California. The leaves make their appearance about the middle of November, or about six weeks after the rainy season has fairly set in; the plants never grow more than a foot high, and the leaves and stalk drop entirely off in May, though the bulbs remain in the ground all the summer without decaying. It is used to wash with, in all parts of the country, and, by those who know its virtues, it is preferred to the best of soap. The method of using it is merely to strip off the husk, dip the clothes into the water, and rub the bulb on them. It makes a thick lather, and smells not unlike brown soap. At St. Nicholas, one of the Cape Verde Islands, they make a soap from the oil of the *Jatropha curcas* seeds, and the ashes of the papaw tree leaf. The oil and ashes are mixed in an iron pot heated over a fire, and stirred until properly blended. When cool it is rolled up into balls about the size of a six pound shot, looking much like our mottled soap, and producing a very good lather.—*P. L. S. in the Journal of Applied Science.*

THE VULTURES AND HUMMING BIRDS OF TROPICAL AMERICA. —At the recent meeting of the American Association for the Advancement of Science, held at Troy, N.Y., in August, 1870, Prof. James Orton read a paper upon the "Condor and the Humming Birds of the Equatorial Region." The following abstract of the Professor's paper is taken from the October (1870) number of the *American Naturalist*:—

"He remarked that probably no bird is so unfortunate in the hands of the curious and scientific as the Condor. Fifty years have elapsed since the first specimen reached Europe, yet to-day the exaggerated stories of its size and strength are repeated in many of our text books, and the very latest ornithological work leaves us in doubt as to its relation to the other vultures. No one credits the assertion of the old geographer, Marco Paulo, that the Condor can lift an elephant from the ground high enough to kill it by the fall; nor the story of the traveller, so late as 1830, who declared that a Condor of moderate size, just killed, was lying before him, a single quill feather of which was twenty paces long. Yet the statement continues to be published that the ordinary expanse of a full grown Condor, is from fifteen to twenty feet, whereas it is very doubtful if it ever exceeds or even equals twelve feet. I have a full grown male from the most celebrated locality in the Andes, and the stretch of its wings is nine feet. Humboldt never found one to measure over nine feet; and the largest specimen which Darwin saw, was eight and one half feet from tip to tip. An old male in the Zoological Gardens of London, measures eleven feet. It is not yet settled that this greatest of unclean birds is generically distinct from the other great vultures. My own observation of the structure and habits of the Condor, incline me to think it should stand alone. Associated with the great Condor is a smaller vulture, having brown or ash-colored plumage instead of black and white, a beak wholly black instead of black at the base and white at the tip, and no caruncle. In inhabits the high altitudes, and is rather common. This was formerly thought to be a distinct species; but lately ornithologists have with one accord pronounced it the young of the Sarcoramphus gryphus—a conclusion which the speaker did not seem wholly to endorse.

As to the royal Condor, Professor Orton offered the following observations, either new or corroborative: Its usual habitation is between the altitudes of ten thousand and sixteen thousand feet. The largest seem to make their home around the volcano of Cayambi, which stands exactly on the Equator. In the rainy season they frequently descend to the coast, where they may be seen roosting on trees; on the mountains they rarely perch, but stand on the rocks. They are most commonly seen around vertical cliffs, perhaps because their nests are there, and also because cattle are likely to fall there. Flocks are never seen except around a large carcass. It is often seen singly, soaring at a great height in vast circles. Its flight is slow. It never flaps its wings in the air, but its head is always in motion as if in search of food below. Its mouth is kept open and its tail spread. To rise from the ground it must needs run for some distance; then it flaps its wings three times and soars away. A narrow pen is therefore sufficient to imprison it. In walking the wings trail on the ground and the head takes a crouching position. Though a carrion bird it breathes the purest air, spends much of its time soaring three miles above the sea. Humboldt saw one fly over Chimborazo. I have seen them sailing at one thousand feet above the crater of Pichincha. Its gormandizing power has hardly been overstated. I have known a single Condor, not of the largest size, to make away in one week with a calf, a sheep, and a dog. It prefers carrion, but will sometimes attack live sheep, deer, dogs, etc. The eyes and tongue of a carcass are the favorite parts and first devoured; next the intestines. I never heard an authenticated case of its carrying off children, nor of it attacking adults, except in defence of its eggs. In captivity it will eat everything except pork and fried or boiled meat. When full fed it is exceedingly stupid, and can be caught by the hand; but at other times it is a match for the stoutest man. It passes the greater part of the day sleeping, searching for prey in the morning and evening. It is seldom shot (though it is not invulnerable as once thought), but is generally caught in traps. The only noise it makes, is a hiss like that of a goose—the usual tracheal muscle being absent. It lays two white eggs on an inaccessible ledge. It makes no nest proper, but places a few sticks around the eggs. By no amount of bribery could I tempt an Indian to search for Condor's eggs, and Mr. Smith, who had hunted nearly twelve years in the Quito Valley, was never able to get sight of one. Incubation occupies about seven weeks, ending in April or May (in Patagonia much earlier, or about February.) The young are scarcely covered with dirty white down, and are not able to fly until nearly two years old. D'Orbigny says they take the wing in about a month and a half after being hatched, a manifest error, for they are then as downy as goslings. It is five months moulting, and while at that stage when its wings are useless, it is fed by its companion. As may be inferred the moulting time is not uniform. Though it has neither the smelling powers of the dog (as proved by Darwin), nor the bright eyes of the eagle, somehow it distinguishes a carcass afar off. He described in full the appearance of the Condor, remarking that the female is smaller than the male, an unusual circumstance in this order, the feminine eagles and hawks being larger than their mates.

Professor Orton next spoke of the Humming Bird, of the habits and economy of which our knowledge is very meagre. The relationship between the genera is not clear, and one species is no more typical than another. The only well marked divisions we can discover, are those adopted by Gould and Gray, the Phæthornithinæ and Polytminæ. The former are dull colored and frequent the dense forests. They are more numerous on the Amazon than the other group; and I know of no specimen from the Quito Valley, or from an altitude above ten thousand feet. Their nest are long, covered with lichens, lined with silk and hung over water courses. The latter comprises the vast majority of the Humming Birds, or nearly nine-tenths. They delight in sunshine, and the males generally are remarkable for their brilliant plumage. Their head-quarters seem to be near New Granada; some species are confined to particular volcanoes, or an area of a few miles square. Of the four hundred and thirty known species of Humming Birds, thirty-five are found in and around the valley of Quito, thirty-two on the Pacific slope, and seventeen on the Oriental side of the Andes, making a total of eighty-four, or about one-fifth of the family within the Republic of Ecuador. If the wanton destruction of Humming Birds for mere decorative purposes, continues for the next decade, as it has during the last, several genera may become utterly extinct. This is evident when we consider that many a genus is represented by a single species, which species has a very circumscribed habitat, and multiplies slowly, producing but two eggs in a year. He noticed one fact in regard to the nests of Humming Birds, which he could not explain. Our northern hummer glues lichens all over the outside; so do a number of species in Brazil, Guiana, etc. But in the valley of Quito moss invariably is used, though lichens abound. A similar variation is seen in the nests of the chimney swallow—our species building of twigs glued together with saliva, while its Quito representative builds of mud and moss. The time of incubation at Quito is twelve days, and there is but one brood in a year."

MISCELLANEOUS.

On the Comparative Steadiness of the Ross and the Jackson Microscope-Stands.—In most of the older Microscopes the *Body* was a fixture, and the focal adjustment was obtained by giving motion to the Stage. This plan, however, was very soon abandoned when the improvement of the Microscope, in its mechanical as well as its Optical arrangements, was seriously taken in hand by men of real constructive ability; and the *Stage* being made a fixture, two different modes were adopted for supporting and giving motion to the Body, of one or the other of which nearly all the different patterns devised by our now numerous makers may be regarded as modifications. The one in which the Body is attached at its base only to a transverse Arm, borne on the summit of a racked stem, I have elsewhere termed the *Ross model;* not because Mr. Ross could in any sense be considered its inventor, but merely because he was among the first to employ it, and his original patterns are now in general use, with extremely little modification. The other, in which the Body, having the rack attached to it, is supported for a great part of its length on a solid Limb, to the lower part of which the Stage is fixed, may with more propriety be distinguished as the *Jackson* * *model;* since it was originally devised by Mr. Jackson, and was thenceforth almost uniformly adopted by the Firm which may be considered as the representative of his ideas.

It has always appeared to me that the Jackson model is so obviously preferable *mechanically*, that if it had been introduced before the Ross model had come into use, it would have been the one more generally adopted; and having lately had an opportunity of comparing the performance of two instruments, one constructed on the Ross and the other on the Jackson model, under peculiarly trying circumstances, and having found my previous opinion most fully confirmed, I have thought it well to bring my experience in this matter before those whom it most especially concerns, namely, Microscope-makers and practical

* In the last edition of my 'Microscope' I inadvertently designated this as the *Lister* model, having supposed it to have been devised by Mr. J. J. Lister.

Microscopists. In order that the bearing of that experience may be rightly understood, it will be desirable in the first instance to examine the conditions on which *tremor* of the Microscopic image depends.

When the building in which the Microscopist is at work is thrown into vibration as a whole, as by the passage of a heavily-laden cart in the street outside,—or the floor of the room in which he is seated is made to vibrate by the tread of a person crossing it,—the Microscope and the observer move together; and if the frame of the Microscope were *perfectly rigid*, there would be no tremor of the image. For this tremor is the result, not of the vibration of the Microscope as a whole, but either (1) of the difference between the vibration of the Body as a whole and that of the object on the Stage; or (2) of the difference between the vibration of the two extremities of the Body, the ocular and the objective.

Now it scarcely seems to me possible to conceive a method of construction which should be more favourable to this *differential* vibration, especially at the ocular end of the Body, than that which is adopted in the Ross model. The long tubular body, fixed only at its base, is peculiarly subject to it; and although the oblique stays with which it is sometimes furnished diminish the vibrations of the tube, they by no means prevent it. The transverse arm and the stem which bears it, each have a vibration of their own; and it is obvious that the nearer to the fixed point of the whole system—which, in this arrangement, is the part of the racked Stem embraced by the tube that carries the Stage—flexure takes place, the greater will be the vibration of the Eye-piece, which is at the greatest distance from that fixed point. The only mode in which this vibration can be kept in check, is the giving great solidity to the Stem, the Arm, and the Body, especially the two former; and this, while objectionable on account of the cumbrousness which it imparts to the Microscope-stand, is by no means effectual for its purpose; as every Microscopist knows to his cost, when using very high powers under any condition but that of the most perfect stillness of the support.

On the other hand, in the Jackson model, the support of the Body along a great part of its length reduces to a minimum the vibration of the tube, and the consequent differential vibration of the eye-piece; and even in those modifications of it in which the tube has but a short bearing, as the support is given to it in the middle of its length, instead of at its lower extremity; the vibration equally affects its ocular and its objective extremities. The form of the Limb makes the Body much less liable to vibration as a whole, than when supported on the transverse Arm and vertical Stem of the Ross model; and as there is no fixed point from which vibration can commence, increasing in extent with the distance from that point, the Body and Stage are much more likely to move together, such motion imparting no tremor to the image.

In the "Porcupine" Expedition for the Exploration of the Deep Sea, in which I took part last summer, microscopic inquiry had to be carried on under conditions very different from those which obtain on shore. When our ship was lying-to under sail, even if the swell was sufficient to produce considerable pitching and rolling, the motion, being imparted equally to the Microscope as a whole and to the Observer, did not produce any tremor of the image; and the only difficulty lay in the maintenance of the observer's own position, which was most effectually secured by firmly grasping the leg of the table (which was fixed to the floor of the cabin) between his knees. When the ship was going under "easy steam," with either a fair wind or a light contrary breeze, there was enough *general* vibration to produce a considerable *differential* vibration in any Microscope liable to it, and thus to occasion a decided tremor in the image even when only moderate powers were employed. But when we were steaming with full power against a head-sea, the general vibration became so great as to be the severest test of the mechanical arrangements of our Microscopes. Now, it happened that whilst my own instrument—a portable Binocular Microscope weighing *less than seven pounds*, which is my usual travelling companion—is constructed on the Jackson model, Professor Wyville Thomson was provided with an instrument of about the same scale, but heavier by some pounds, made upon the Ross model; and we thus had an opportunity of fairly testing the two plans of construction under circumstances peculiarly critical. The difference in their performance was even more remarkable than I had anticipated. I found that I could use a 1-4th-inch objective on my own Microscope, with an even greater freedom from tremor in the image than I could use a 2–3rds–inch objective on Professor Wyville Thomson's. In fact the image "danced" very perceptibly in the latter, even when the 1½-inch objective was in use.

Now I purposely abstain (for obvious reasons) from naming the Makers of these two instruments. But I think it well to say this much, in order to meet the possible objection, that the difference lay rather in the *workmanship* of the two instruments than in their *plan of construction*,—that the advantage, if any, lay on the side of the Ross model. And my own very decided conviction is, that the adoption of the principles of the Jackson model would be decidedly advantageous, alike for *first*-class Microscopes, in which the *steadiness of the image* when the highest powers are being employed ought to be a primary consideration,—for those *second*-class instruments, which are intended, at a less cost, to do as much of the work of the first-class as they can be made to perform, *portability* being here of essential importance,—and for those *third*-class instruments in which everything has to be reduced to its simplest form, so as to permit the greatest reduction in their cost. — *Dr. W. B. Carpenter, in Transactions of the Royal Microscopic Society.*

— Mr. J. Gwyn Jeffreys, who had just returned from the south of Europe, after having accomplished his part of this year's deep-sea exploring expedition in H.M.S. *Porcupine*, stated that in this cruise he had dredged across the Bay of Biscay, and along the coasts of Spain and Portugal to Gibraltar. The weather had not been favourable; but the depth reached was 1,095 fathoms. A large collection of Mollusca, Echinoderms, Corals, Sponges, and Hydrozoa, had been made. Half a-dozen specimens of a beautiful new *Pentacrinus* (*P. wyville-thomsoni*) had been taken in 795 fathoms depth, between Vigo and Lisbon. Both Northern and Mediterranean species of shells were met with.

— Congress has granted $30,000 for the erection of a Government Winter Garden, either at New York or Washington, somewhat similar to that at Kew, but on a smaller scale. This will partake partly of the nature of an economic garden, in which useful plants can be raised and then disseminated far and wide throughout the States.

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A FEW HOURS AT CAPE-TOWN, SOUTH AFRICA.

By Lieut.-Major George E. Bulger, F.L.S., F.R.G.S., C.M.L.S., etc.

It was on the 3rd December, 1864, at the beginning of the South African Summer, that, with two companions, I left Cape Town by the 7.14 a.m. train for Salt River, where we had hopes of obtaining a few curlews, as well as some of the various kinds of *Tringæ* and *Charadriadæ*, which, with other wild fowl, frequent the banks of the stream, and the adjacent shores and inlets of Table Bay, in considerable numbers. Our expedition was decidedly more ornithological than sporting, for success with the curlews could only be regarded as a possible contingency, while we looked upon good specimens of the smaller birds as almost certain trophies.

Ten minutes travelling brought us to Salt River Station, where, quitting the railway, we struck down towards the beach, on foot, and speedily arrived at one of the branches of the stream, six or seven yards across, by about the same number of inches in depth, which intersected the sands, and cut us off from the part we wished to explore. The water was beautifully clear but brackish and quite cold, as we soon learnt by walking through it, no other means of crossing having presented itself. After this, as it was low tide, we kept along the shore of the Bay, where the sand was hard and firm, and where we could enjoy the cool, fresh and delicious breeze that came sweeping in steadily from seaward, the heavy surf-rollers crashing and breaking a short distance to our left, while the spent waves curled up to our very feet, and the spray drifted across us like showers of fine rain.

For some distance we found nothing more extraordinary than the crushed and broken fragments of sea-shells, shreds of coarse *algœ*, and some six or seven specimens of a pretty little *Coccinella* with yellow spots; and then came another branch of the Salt River slightly deeper and a good deal broader than the last: however, we forded it without difficulty, and, leaving the beach, took the river-bank as a guide to further progress. Thereabouts the land on either side of the stream was very flat, though it rose gradually on the left hand, in low, sandy undulations, and at last, swelled up to a ridge along the sea-shore fourteen or fifteen feet, in some places, above the water level.

The Zout, or Salt River rises near Riebeck's Castle, a mountain in the District of Malmesburg, 3109 feet high, and, after a course of about forty miles, falls into Table Bay a short distance below where we crossed it. At the time of our visit, the water was very low, and much of the flat sandy bed was uncovered, affording great attraction to the sandpipers and small plovers that were feeding merrily upon its surface. Of these we recognized *Charadrius tricollaris, Kittlitzi et marginatus*, the turnstone (*Cinclus interpres*), the red shank (*Totanus calidris*), the green sandpiper (*Totanus ochropus*), the greenshank (*Totanus glottis*), the pigmy curlew (*Tringa Subarquata*), the sanderling (*Calidris arenaria*), and the little stint (*Tringa minuta*), the last three in largish flocks, the others far less abundant, and the turnstones keeping, as L.—remarked, apart from the rest in a little band of six or seven. No curlews were in sight, nor any other birds besides those I have mentioned, excepting a few swifts, and two or three swallows, which were careering through the pure air with their usual grace and rapidity: the former appeared to be all representatives of *Cypselus apus*, and the latter of *Hirundo rustica*.

There was an alluvial deposit of mud on either bank of the river, and this, on the side next the sea, where we were, was covered with wild chamomile, (*Matricaria hirta*), whose white-rayed blossoms perfumed the air with their fragrance. There were also quantities of samphire (*Crithmum maritimum*), quite crimson in some places, apparently where it had been covered at high water by the Salt Stream. Outside of this border of alluvial mudw as the sand, adorned with several species of *Mesembryanthemum*, and other plants, amongst which, the most striking and beautiful was a small, graceful shrub with pale-coloured, finely cut foliage, and a profusion of round, scarlet orange berries, which had an agreeably astringent taste. I had never met with this elegant little bush before, and neither of my companions appeared to recognize it, though L.—said he believed the fruit was known to the Dutch Colonists as "skildpatbesjes" or tortoise-berries, a name applied, however, by Pappe* to the drupes of a very different plant, the *Mundtia spinosa* of Kunth. I have since been informed, through the kindness of a friend, that the graceful little stranger was the *Chymococca empetroides* of De Candolle. It appeared to grow in considerable abundance, and was conspicuously gay from the brilliant colour and beauty of its clusters of bright berries.

Almost immediately after crossing the river, a flock of sanderlings sprang from the ground before us, and flew along towards the sea, while one solitary curlew (*Numenius arquatus*),† arose uttering his peculiar alarm note, got up from the opposite bank and soon disappeared: no others were visible, and as far as we could see, the river margin was only tenanted by the smaller birds. For some distance we walked on without meeting with any more curlews, but, at last, half a dozen came flying up the river at a tolerable height above us, entirely, as I thought, out of range; however, L.—, who was a short distance to my left, was of a different opinion, as he fired at the nearest bird, and brought it down satisfactorily. The river-sands and mud-banks were alive with little, busy, graceful creatures, now running over the moist edges of the stream, now taking wing and wheeling with the speed and wonderful unity of action, so to speak, which characterizes the aerial movements of the gregarious plovers and sandpipers, while the music of their plaintive, whistling notes rose and fell upon the breeze, as they swept past us, hither and thither, over their desolate feeding-grounds; but no more curlews were to be seen, and we soon diverged from our course to the sea shore, where we seated ourselves upon a log, and preceded to refresh the inner man with sandwiches and other portable kinds of food.

* *Floræ capensis medicæ prodromus.*

† Layard says (*Birds of South Africa*, p. 322) "Schlegel separates our South African species from the European bird on account of its size, and calls it *Numenius major*."

While we were thus employed, the younger of my two companions who had separated from us about two hours before, returned from an unsuccessful chase after an oyster catcher (*Hæmatopus Moquini*) which, though severely wounded, had escaped him by swimming out to sea.

Between three and four o'clock we began to retrace our steps along the river-bank, and, very soon several large flocks of curlew passed before us, having been driven inland by the advancing tide, but they were all out of range, and it was too late in the afternoon to follow them to the upper sands, where they appeared to be congregating. We procured, however, specimens of *Totanus glottis*, *Tringa subarquata* and *Charadrius Kittlitzi*, and, in a field near the road, L.—added a beautiful hobby (*Hypotriorchis subbuteo*), to the collection. This charming little falcon is rare in South Africa, and my companion told me very few specimens had been obtained. Swifts and Swallows were abundant, and amongst them in addition to *Cypselus apus* and *Hirundo rustica*, already mentioned, we recognized *Cypselus melba et caffer*, as also *Cotyle palustris*, and *Hirundo rufifrons et capensis*, we only saw one pelican, (*Pelecanus onocrotalus !*), although, at times, L.— assured me they are common enough in this locality, and that, occasionally, the rarer and more beautiful *Pelecanus rufescens* is also to be obtained. I observed no other birds, excepting a solitary jackal-vogel, the *Buteo jackal* of Shaw.

Butterflies were apparently rare, and not being of special interest to me at the time, I did not examine those I saw, excepting one very lovely kind, which L.— said was *Zeritis thysbe:* its predominant colour was orange, and I did not observe the blueish gloss said to characterize the species.*

Plants of course were abundant, and some of them very peculiar, but we had no leisure to pay much attention to them. A lovely golden-yellow *Mesembryanthemum* † was very plentiful, as well as other species of the same genus, but only one of them was known to me, the ordinary Hottentot fig (*Mesembryanthemum edule.*) *Mundtia spinosa*, and the foul-smelling *Melianthus major*, which

* I find that Trimen says (*Rhopalocera Africæ australis p.* 226) that *Zeritis thysbe* proper does not occur near Cape-town, but that it is there represented by a different variety of the same species (*Papilio palmus of Cramer*) destitute of the blue gloss referred to.

† Probably *Mesembryanthemum reptans* of Harvey and Sonder's *Flora capensis*, but I cannot be sure.

the Dutch call "Truytje roer my niet," (Gertrude don't touch me) the wild water-melon or "bitter appel," of the colonists *Citrullus amarus*, and the brilliant *Leonotis Leonurus*, were common. The scarlet blossoms of the last-mentioned, as usual, being very conspicuous amidst the greenery around them.

ON SPORE-CASES IN COALS.

(*From the American Journal of Science and Arts for April*, 1871.)

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

When in London, last spring, Prof. Huxley was kind enough to show me some remarkably beautiful slices of coal mounted by his assistant, Mr. Newton, and showing with great distinctness multitudes of spore-cases and spores, some of them very well preserved. He further stated to me his belief that such material had been largely or mainly instrumental in the production of Coal. At the time I declined to accept this conclusion, on the ground that the specimens probably represented layers of coal exceptionally rich in spore-cases; and that even in these specimens a large quantity of matter was present which long experience in the examination of coals enabled me to recognize as cortical or epidermal matter, which I had previously shown by my examination of the coals of Nova Scotia to be the principal ingredient in ordinary coal. I promised, however, on my return to Canada, to look over my series of preparations of coal, with a view to the occurrence of spore-cases, and also to make trial of the somewhat improved method of preparation employed by Mr. Newton. On my return I gave the results of my examination to Prof. Huxley in a letter which he has quoted in the brilliant exposition of his observations and conclusions in the "Contemporary Review" for November,* and which will probably give a tone to the representations of popular writers on this subject for some time. While, however, admitting the great interest and importance of Prof. Huxley's observations, and prepared to contribute some additional illustrations of the occurrence of spore-cases in coal, I think it well to direct attention anew to the actual composition of the substance,

* In the quotation the word "cubical" has been substituted for "cortical."

as proved by its mode of occurrence, and illustrated by my own extensive series of observations on the coals of Nova Scotia and Cape Breton, including the series of eighty-one seams exposed at the South Joggins, the whole of which I have examined *in situ* and under the microscope.

The occurrence of bodies supposed to be spore-cases in coal, is, as Prof. Huxley states, no new discovery; but in reality these may be said to be the first organisms recognized by any microscopic observer of coal—that is, if all the clear spots and annular bodies seen in slices of coal are really spore-cases. They were noticed by Morris as early as 1836, and they had been observed and described long before by Fleming in Scotland. Goeppert mentioned and figured them in his "Treatise on Coal" in 1848. Balfour described them in 1859 as occurring in Scottish coals, and Quekett figured them in his account of the Torbane Hill mineral in the same year. In 1845 the latter microscopist showed me in London slices exhibiting round bodies of this kind, very similar to those now described by Huxley; but at that time I regarded them as concretionary, though Prof. Quekett was disposed to consider them organic. Mr. Carruthers has summed up most of these facts in his account of his genus Flemingites in the Geological Magazine for October, 1865. The subject has also attracted the attention of microscopists in connection with the Tasmanite, or "White Coal" of Tasmania, which consists in great part of spore-cases of Ferns.

I suppose that the oldest spore-cases known are those described by Hooker from the Ludlow formation of the Upper Silurian; but these, if really spore-cases, are different in structure from those ordinarily found in the coal-formation, more especially in the great thickness of their walls, and I am not aware that they have anywhere been found in considerable quantities.

The oldest bed of spore-cases known to me, is that at Kettle Point, Lake Huron. It is a bed of brown bituminous shale, burning with much flame, and under a lens is seen to be studded with flattened disc-like bodies scarcely more than a hundredth of an inch in diameter, which under the microscope are seen to be spore-cases, slightly papillate externally, and with a point of attachment on one side and a slit more or less elongated and gaping on the other, figs. 1, 2, 3. I have proposed for these bodies the name *Sporangites Huronensis*. When slices of the rock are made, its substance is seen to be filled with these bodies, which, viewed as transparent objects, appear yellow like amber, and show little structure, except that the walls can, in some cases, be distinguished from the internal cavity, and the latter may be seen to inclose patches of flocculent or granular matter. In the shale containing them there are also vast numbers of rounded translucent granules which may be the escaped spores.

The bed at Kettle Point is stated in the report of the Geological Survey to be 12 to 14 feet in thickness; but to what degree either in its thickness or horizontal extent it retains the characters above described, I do not know. It belongs to the Upper Devonian, being supposed to be a representative of the Gennessee slates of New York. It contains stems of *Calamites inornatus* and of a *Lepidodendron*, obscurely preserved, but apparently of the type of *L. Veltheimianum*, and possibly the same with *L. primævum* of Rogers. The spore-cases are not improbably those of this plant, or of the species *L. Gaspianum*, which belongs to the same horizon, though not found at this locality. The occurrence of this bed is a remarkable evidence of the abundance of Lycopodiaceous trees, whose spores must have drifted in immense quantities in the winds, to form such a bed. It is to be observed, however, that this is not a bed of coal, but a bituminous shale of brown color, and with pale streak, no doubt accumulated in water, and even marine, since it contains *Spirophyton** and shells of *Lingula*. In this it agrees with the Australian Tasmanite, which though composed in great part of spore-cases of Ferns, is, as I am informed by Mr. Selwyn, an aqueous deposit, containing marine shells.

There is, however, one bed of true coal known in the Devonian of Eastern America, that of Tar Point, Gaspé, and it is curious to observe that this is not composed of spore-cases, but of successive thin layers of rhizomata and stems of *Psilophyton*, with occasional fragments of *Lepidodendron* and *Cyclostigma*. Rounded disks which may be spore-cases, occur in it, but very rarely. In the bituminous shales associated with this coal, the microscope shows amber-colored flakes of irregular form, but these are easily ascertained to be portions of the epidermis of Psilophyton, or of the chitinous crusts of crustaceans which abound in these beds.

Ascending to the Lower Carboniferous (sub-carboniferous), there are great quantities of rounded spore-cases of the size of

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* The well known *Cauda-galli* fucoid.

mustard seeds (*Sporangites glabra* of my papers) in the rocks of Horton Bluff and Lower Horton, Nova Scotia. They are sometimes globular, and filled with pyrites of a granular texture which perhaps represents the original cellular structure or the microspores. In other cases they are flattened and constitute thin carbonaceous layers. They are almost without doubt the spore-cases of *Lepidodendron corrugatum*, which abounds in the same beds, and constitutes in one place a forest of erect stumps. I described them in a paper on the Lower Carboniferous of Nova Scotia in the Proceedings of the Geological Society of London for 1858, though not then aware of their true nature, which was, however, recognized by Dr. Hooker in some specimens which I had sent to London.

In my paper on the conditions of the accumulation of Coal, (Proceedings of Geological Society of London, May, 1866), I proposed the name *Sporangites* for these bodies, in consequence of the difficulty of referring them certainly to any generic forms. Carruthers had in Oct. 1865, described a cone containing rounded spore-cases of not dissimilar type, under the name *Flemingites*. In the paper above referred to, I stated that out of eighty one coals of the South Joggins Section examined by me, I recognized these bodies and other fruits or Sporangia, in only sixteen; and of these only four had the rounded Lycopodiaceous spore-cases similar to those of Flemingites. These are the following:—

(1.) Coal group 12, of Division IV, has a bed of coal one foot thick, of which some layers are almost wholly composed of *Sporangites papillata*.

(2.) Coal group 13, Div. IV, has in some layers great quantities of *Sporangites glabra*, especially in the shaly parts of the coal.

(3.) In Coal group 14, Div. IV, a shaly parting contains great numbers of similar Sporangites.

(4.) In Coal group 15 *a*, Div. IV, the shaly roof abounds in sporangites, but I did not observe them in the coal itself.

In addition to these cases, all of which curiously enough occur in one part of the section, and among the smaller coals, I have noted the occurence of clear amber spots in several of the compact coals, bnt I did not regard these as certainly organic, suspecting them to be rather concretionary or segregative structures.

The great coal beds of Pictou are, in so far as my observation has extended, remarkably free from indications of spore-cases, and consist principally of cortical and ligneous tissues with layers of finely comminuted vegetable matter. A layer of cannel, however, from a bed near New Glasgow has numerous flattened amber-colored discs, which may be of this character. In those of Cape Breton, the yellow spore-case-like spots are much more abundant; but these coals I have less extensively examined than those of the mainland of Nova Scotia. Of American coals the richest in spore-cases that I have seen, is a specimen from Ohio, which contains many large spore-cases, and vast numbers of more minute globular bodies apparently macrospores. It quite equals in this respect some of the English coals referred to by Huxley, (fig.4). I have also a specimen of Anthracite from Pennsylvania, full of spore-cases, some of them retaining their round form and filled with granular matter which may represent the spores.

It is not improbable that sporangites or bodies resembling them, may be found in most coals; but the facts above stated indicate that their occurrence is accidental rather than essential to coal accumulation, and that they are more likely to have been abundant in shales and cannel coals, deposited in ponds or in shallow waters in the vicinity of Lycopodiaceous forests, than in the swampy or peaty deposits which constitute the ordinary coals. It is to be observed, however, that the conspicuous appearance which these bodies and also the strips and fragments of epidermal tissue, which resemble them in texture, present in slices of coal, may incline an observer not having large experience in the examination of coals, to overrate their importance, and this I think has been done by most microscopists, especially those who have confined their attention to slices prepared by the lapidary. One must also bear in mind the danger arising from mistaking concretionary accumulations of bituminous matter for sporangia. In sections of the bituminous shales accompanying the Devonian coal above mentioned, there are many rounded yellow spots, which on examination prove to be the spaces in the epidermis of Psilophyton through which the vessels passing to the leaves were emitted. To these considerations I would add the following condensed from my paper above referred to, in which the whole question of the origin of coal is fully discussed.*

(1.) The mineral charcoal or "mother coal" is obviously woody tissue and fibres of bark; the structure of the varieties of which

* See also Acadian Geology, 2d edit., pp. 138, 461, 493.

and the plants to which it probably belongs, I have discussed in the paper above mentioned.

(2.) The coarser layers of coal show under the microscope a confused mass of fragments of vegetable matter belonging to various descriptions of plants, and including, but not usually largely, sporangites.

(3.) The more brilliant layers of the coal are seen, when separated by thin laminæ of clay, to have on their surfaces the markings of Sigillariæ and other trees, of which they evidently represent flattened specimens, or rather the bark of such specimens. Under the microscope, when their structures are preserved, these layers show cortical tissues more abundantly than any others.

(4.) Some thin layers of coal consist mainly of flattened layers of leaves of *Cordaites* or *Pychnophyllum.*

(5.) The Stigmaria underclays and the stumps of Sigillaria in the coal roofs equally testify to the accumulation of coal by the growth of successive forests, more especially of Sigillariæ. There is on the other hand no necessary connection of sporangite beds with Stigmarian soils. Such beds are more likely to be accumulated in water, and consequently to constitute bituminous shales and cannels.

(6.) Lepidodendron and its allies, to which the spore-cases in question appear to belong, are evidently much less important to coal accumulation than Sigillaria, which cannot be affirmed to have produced spore-cases similar to those in question, even though the observation of Goldenberg as to their fruit can be relied on; the accuracy of which, however, I am inclined to doubt.

On the whole then, while giving due credit to Prof. Huxley and those who have preceded him in this matter, for directing attention to this curious and no doubt important constituent of mineral fuel, and admitting that I may possibly have given too little attention to it, I must maintain that Sporangite beds are exceptional among coals, and that, cortical and woody matters are the most abundant ingredients in all the ordinary kinds; and to this I cannot think that the coals of England constitute an exception.

It is to be observed, in conclusion, that the spore-cases of plants, in their indestructibility and richly carbonaceous character, only partake of qualities common to most suberous and epidermal matters, as I have explained in the publications already referred to. Such epidermal and cortical substances are extremely rich in carbon and hydrogen; in this resembling bituminous coal. They are also very little liable to decay, and they resist more than other vegetable matters aqueous infiltration; properties which have caused them to remain unchanged and to resist the penetration of mineral substances more than other vegetable tissues. These qualities are well seen in the bark of our American white birch. It is no wonder that materials of this kind should constitute considerable portions of such vegetable accumulations as the beds of coal, and that when present in large proportion they should afford richly bituminous beds. All this agrees with the fact, apparent on examination of the common coal, that the greater number of its purest layers consist of the flattened bark of Sigillariæ and similar trees, just as any single flattened trunk imbedded in shale becomes a layer of pure coal. It also agrees with the fact that other layers of coal, and also the cannels and earthy bitumens appear, under the microscope, to consist of finely comminuted particles, principally of epidermal tissues, not only from the fruits and spore-cases of plants, but also from their leaves and stems. The same considerations impress us, just as much as the abundance of spore-cases, with the immense amount of the vegetable matter which has perished during the accumulation of coal, in comparison with that which has been preserved.

I am indebted to Dr. T. Sterry Hunt, for the following very valuable information, which at once places in a clear and precise light the chemical relations of epidermal tissue and spores with coal. Dr. Hunt says—" The outer bark of the Cork tree and the cuticle of many if not all other plants consists of a highly carbonaceous matter, to which the name of *suberin* has been given. The spores of Lycopodium also approach to this substance in composition, as will be seen by the following, one of two analyses by Duconi,* along with which I give the theoretical composition of pure cellulose or woody fibre, according to Payen and Mitscherlich, and an analysis of the suberin of Cork from *Quercus suber*, from which the ash and 2·5 per cent of cellulose have been deducted.†

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*Liebig and Kopp, Jahresbuch, 1847-48.

† Gmelin, Handbook, xv. 145.

	Cellulose	Cork	Lycopodium
Carbon,	44·44	65·73	64·80
Hydrogen,	6·17	8·33	8·73
Nitrogen,	——	1-50	6·18
Oxygen,	49·39	24·44	20·29
	100·00	100·00	100·00

This difference is not less striking when we reduce the above centesimal analyses to correspond with the formula of cellulose, $C_{24}H_{20}O_{20}$ and represent Cork and Lycopodium as containing 24 equivalents of carbon. For comparison I give the composition of specimens of Peat, Brown Coal, Lignite and Bituminous Coal.*

Cellulose,	$C_{24}\ H_{20}\ O_{20}$
Cork,	$C_{25}\ H_{81\frac{2}{10}}\ O_{6\frac{7}{10}}$
Lycopodium,	$C_{24}\ H_{19\frac{4}{10}}\ NO_{5\frac{6}{10}}$
Peat, (Vaux),	$C_{24}\ H_{14\frac{4}{10}}\ O_{10}$
Brown Coal, (Schrother),	$C_{24}\ H_{14\frac{3}{10}}\ O_{10\frac{6}{10}}$
Lignite, (Vaux),	$C_{24}\ H_{11\frac{3}{10}}\ O_{6\frac{4}{10}}$
Bituminous Coal, (Regnault),	$C_{24}\ H_{10}\ O_{3\frac{3}{10}}$

It will be seen from this comparison that, in ultimate composition, Cork and Lycopodium are nearer to Lignite than to woody fibre; and may be converted into coal with far less loss of carbon and hydrogen than the latter. They in fact approach closer in composition to resins and fats than to wood, and moreover like those substances repel water, with which they are not easily moistened, and thus are able to resist those atmospheric influences which effect the decay of woody tissue."

I would add to this only one further consideration. The Nitrogen present in the Lycopodium spores no doubt belongs to the protoplasm contained in them, a substance which would soon perish or decay; and substracting this, the cell-walls of the spores and the walls of the spore-cases would be most suitable material for the production of bituminous coal. But this suitableness they share with the epidermal tissue of the scales of Strobites, and of the stems and leaves of Ferns and Lycopods; and above all with the thick corky envelope of the stems of Sigillariæ and similar trees, which as I have elsewhere shown,† from its condition

* Canadian Naturalist, vi. 253.

† Vegetable structures in Coal, Journ. Geol. Soc. xv, 626. Conditions of Accumulation of Coal. Ib. xxii, 95; Acadian Geology, 197, 464.

in the prostrate and erect trunks contained in the beds associated with coal, must have been highly carbonaceous and extremely enduring and impermeable to water. In short, if instead of "spore-cases," we read "epidermal tissues in general, including spore-cases," all that Huxley has affirmed will be strictly and literally true, and in accordance with the chemical composition, microscopical characters and mode of occurrence of coal. It will also be in accordance with the following statement, which I may be pardoned for quoting from my paper on the Structures in Coal, published in 1859.

"A single trunk of Sigillaria in an erect forest, presents an epitome of a coal-seam. Its roots represent the Stigmaria under clay; its bark the compact coal; its woody axis, the mineral charcoal; its fallen leaves (and fruits), with remains of herbaceous plants growing in its shade, mixed with a little earthy matter, the layers of coarse coal. The condition of the durable outer bark of erect trees concurs with the chemical theory of coal, in showing the suitableness of this kind of tissue for the production of the purer compact coals. It is also probable that the comparative impermeability of the bark to mineral infiltration, is of no importance in this respect, enabling this material to remain unaffected by causes which have filled those layers consisting of herbaceous materials and decayed wood with pyrites and other mineral substances."

Fig. 1.

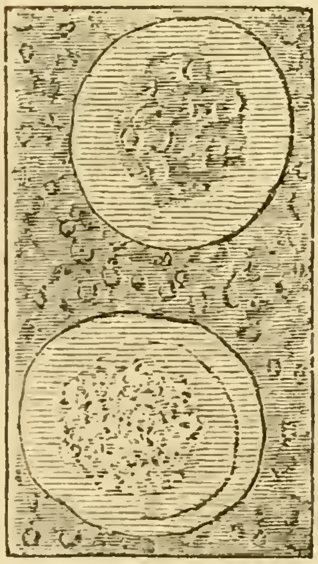


Fig. 2.

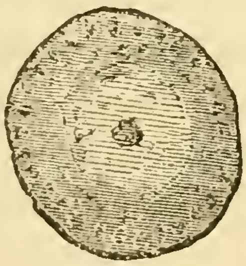


Fig. 3.

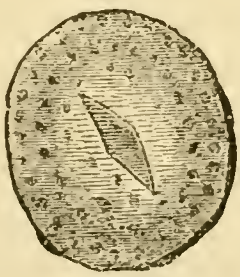


Fig. 4.

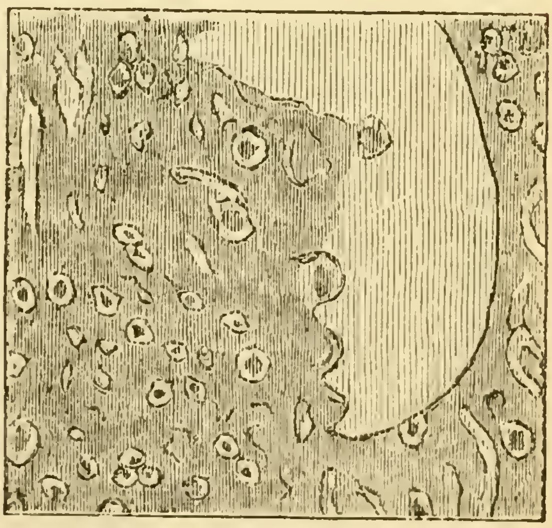


Fig. 1.—Part of a slice of shale from Kettle Point, shewing two spore-cases and remains of spores; 70 diameters.

Fig. 2 and 3.—Spore-cases from the same as opaque objects x 70.

Fig. 4.—Part of a slice of Ohio coal, showing at one side a large spore-case and numerous spores x 70.

BIVALVE CRUSTACEANS FROM THE GULF OF ST. LAWRENCE, DESCRIBED BY G. S. BRADY, Esq., C.M.Z.S.

Introduction.

In the great class of Crustacea or soft shell-fish, there is a group of microscopic creatures, found both in fresh and salt waters, which have the peculiarity of being covered with a bivalved shell, which is not unlike that of some bivalve mollusks. These are the *Ostracoda* of zoologists. Some of the species may be found in abundance in our fresh water pools, where they move about with great rapidity, and are very voracious devourers of any animal substance that may come within their reach. If a quantity of them be taken up in a bottle with some of the water in which they live, and examined with a magnifying glass, they will be seen to extend little tufted antennœ or feelers from the end of the shell, and little jointed feet from the front, with which they scramble along in a curious lop-sided way, but with much swiftness. If a bit of meat be placed in the water, they crowd around it with great eagerness, and it is amazing to witness the rapidity with which it will disappear under their attacks. These fresh-water species belong to the genus *Cypris*, and several species occur in different parts of this country; but the marine species are much more numerous, and may be found in all depths and in all latitudes. They are also an ancient tribe; many species being found in our old limestone rocks, and they seem at all periods and in all places to have been among the most efficient scavengers of the waters.

The species noticed in the following lists and descriptions are all from the Gulf of St. Lawrence. They were obtained from specimens of marine sand and mud in the collection of Dr. Dawson, and obtained by him partly in his own dredging expeditions, and partly from dredgings and soundings by Capt. Orlebar, R.N., Mr. Whiteaves, F.G.S., of Montreal, and the officers of the Geological Survey. The whole of these collections were placed in the hands of Mr. G. M. Dawson, for the purpose of selecting the minute microscopic shells of the order Foraminifera. In picking out these, any other organic bodies were also selected, and among the rest the crusts of the Ostracoda. These being somewhat numerous and varied, were sent to Mr. Brady, of Sunderland, who is the best living authority on these curious creatures, and who kindly undertook their determination. The results have just been published by him in the "Annals of Natural History," and are reprinted below as an interesting contribution to a little known department of Canadian Natural History.

We may add that the original specimens mounted by Mr. Brady, will soon be in this city, and will be available for purposes of comparison by any naturalist who may care to study these little creatures.—Ed.

Feb., 1871.

RECENT OSTRACODA FROM THE GULF OF ST. LAWRENCE.

By George Stewardson Brady, C.M.Z.S.

The specimens which form the subject of the present notice have been kindly placed in my hands by Dr. Dawson, of Montreal, for examination and description. They were selected by Mr. G. M. Dawson from dredgings and soundings made in various parts of the Gulf of St. Lawrence, in depths varying mostly from 10 to 50 fathoms, but in one case reaching 250 fathoms. The following is the list of species :—

Argillœcia, sp.
Cythere leioderma, *Norman.*
——— lutea, *Muller.*
——— pellucida, *Baird.*
——— emarginata, *Sars*, sp.
——— concinna, *Jones.*
——— tuberculata, *Sars.*
——— canadensis, nov. sp.
——— villosa, *Sars.*
——— dunelmensis, *Norman*, sp.
——— Dawsoni, nov. sp.
——— abyssicola, *Sars.* sp.
——— (?) Whiteii, *Baird*, sp.
——— costata, *Brady.*
Cytheridea papillosa, *Bosquet.*
Cytheridea punctillata, *Brady.*
——— Sorbyana, *Jones.*
——— ? elongata, *Brady.*
Eucythere Argus, *Sars*, sp.
Loxoconcha, sp.
Xestoleberis depressa, *Sars.*
Cytherura undata, *Sars* (var.)
——— pumila, *C., B. & R.* (MS.)
——— ? concentrica, *C., B. & R.* (MS)
Cytheropteron nodosum, *Brady.*
Bythocythere turgida, *Sars.*
Cytherideis foveolata, nov. sp.
? Philomedes interpuncta, *Baird*, sp.
Bradycinetus, sp.

The determination of these species has been a most perplexing task, owing to their variation in most cases from the types as known to us on this side of the Atlantic. It is probable, indeed that many which I have here identified with well-known species would by other carcinologists be thought worthy of distinct specific rank; but, considering the small number of specimens at my disposal for examination, I have thought it better to err, if err I must, by allowing too much latitude to variation, rather than by unnecessary species-splitting. The variation, though in most cases such as to be almost incommunicable by drawings or written description, is nevertheless sufficient to be puzzling, consisting in very slight modifications of the shell in almost all directions—in outline, proportions, and degree of surface-ornament. Such remarks as I have thought it necessary to make on these points will be found under the names of the different species.

It would be unwise to generalize hastily from the small number of dredgings here described; yet we cannot help noticing that the general facies of this fauna much more nearly approaches to that of the Shetland seas or of the Scottish glacial clays than it does to that of England, while it has scarcely any thing in common with that of the Mediterranean. The species which give it an emphatically boreal character are *Cythere leioderma* (perhaps the most abundant species in these dredgings, and hitherto found only in the Shetland seas), *C. emarginata, C. costata* and *Cytheridea Sorbyana*, all of which may be said to range, on our side óf the Atlantic, north of the 60th degree of north latitude. And several other members of the list become with us very scarce south of 54°: these are *Cythere concinna, C. lutea, C. tuberculata, C. dunelmensis, Cytheridea papillosa*, and *C. punctillata*. Except the three species here described as new, these two lists include all the characteristic species of Dr. Dawson's dredgings, the rest being represented in each case only by one or two specimens, often imperfect.

Argillœcia, sp.

One specimen, possibly referable to *A. cylindrica*, Sars.

Cythere leioderma, Norman.

(Norman, Shetland Dredging Report, p. 291.)

Carapace, as seen from the side, subquadrate, slightly higher in front than behind; greatest height situated at the anterior third, and equal to about half the length; anterior extremity obtuse, obliquely rounded; posterior subtruncate, sinuated in the middle: superior margin scarcely arched, obsoletely angular about the eye-tubercles; inferior nearly straight, with a slight median sinuation. Seen from above, the outline is broadly ovate (almost elliptical), only slightly narrower in front than behind; greatest width equal to the height, and situated near the middle: extremities broadly and evenly rounded. Hinge-margins somewhat depressed; hinge-processes strongly developed. Surface of the shell smooth and polished, beset with more or less numerous circular punctures, each bearing a short rigid hair. Colour yellowish white. Length $\frac{1}{25}$ inch.

This is the most abundant species in the dredgings here described, and occurs in greater or less quantity in almost all the localities. In Britain it is known only from the single (?) specimen described by Mr. Norman, which was taken in "very deep water" in Unst Haaf. Mr. Norman's description applies accurately to the American specimens, except in the matter of the "distant punctured papillæ." The ornamentation, it is true, does appear papillose in some lights; but this is, I think, an optical illusion: when carefully examined, the seemingly elevated circles resolve themselves into concave pits, each with a little central bristle. I have seen a single fossil valve of this species from the Scottish glacial clay.

Cythere tuberculata, Sars.

These specimens are much less rounded in outline and more rugged in general appearance than is usual with European specimens; there is also a tendency, more or less pronounced, to the formation of one or more longitudinal ridges near the ventral border. But the distinctions do not seem sufficient to warrant the separation of the form as a new species.

Cythere Canadensis, nov. sp., figs. 4–6.

Carapace elongate, compressed; seen from the side, quadrate; greatest height situate at the anterior third, and scarcely equal to half the length; anterior extremity very obliquely rounded, and bordered at the lower angle with several small teeth; posterior subtruncate, slightly emarginate in the middle; superior margin gently sloping, nearly straight, sinuated behind the anterior hinge; inferior margin also straight, excepting a slight median sinuation. Seen from above, somewhat lozenge-shaped, somewhat tapered toward the front, more rounded behind widest near the middle: width equal to about two-fifths of the length; extremities obtuse, subtruncate. Shell-surface uneven, irregularly pitted, marked with more or less prominent, flexuous longitudinal ribs, and bearing usually a rounded central tubercle; bordered in front, a little within the anterior margin, by a wide, elevated, and rounded ridge; posterior margin having a similar but less conspicuous border. Length $\frac{1}{35}$ inch.

This species approaches very closely to *C. abyssicola* Sars, and *C. Stimpsoni*, Brady. From the former it differs chiefly in having a less pronounced marginal belt, a more rugged surface, and a less angular outline when viewed from above; from the latter in the absence of any sharply cut longitudinal crests, and by its more rounded contour and elevated anterior margin. There is, however, considerable diversity amongst the specimens here grouped under the specific name *Canadensis*, and it is possible that a more extended series might have shown that they belong to two or more species. The chief difference resides in the surface-ornament, some exhibiting several short, rough and abruptly elevated ridges, others being only moderately pitted, while some (from one of which our drawings are taken) are intermediate in character, being rather delicately ridged, chiefly on the posterior half, and vaguely pitted and ridged in front.

Cythere Dawsoni, nov. sp. (Figs. 8–10.)

Carapace, seen from the side, quadrangular, highest in front; greatest height equal to half the length; anterior extremity obliquely rounded, bordered with strong, blunt teeth; posterior narrower, rectangularly truncate, slightly rounded: superior margin nearly straight, gently sloping backwards, irregularly emarginate; inferior almost straight. Seen from above, subhexagonal; sides nearly parallel, suddenly tapering towards the extremities, which are obtusely mucronate; outline throughout very rugged. Surface marked by irregularly scattered rounded tubercles, and by two irregular longitudinal rows of transversely elongated tubercular eminences. Length $\frac{1}{35}$ inch.

This is apparently a very distinct species; but the single specimen contained in these dredgings was unfortunately lost while the drawings here given were in course of completion; so that I am unable to describe it as accurately as might be wished.

Cytheridea elongata, Brady.

The specimen so named is very doubtfully referred to this species; and the same remark may apply to

Xestoleberis depressa, Sars,

of which only a poor specimen occurs, and may perhaps belong to some other member of the genus.

Cytherura undata, Sars, var.

A specimen which I suppose to belong to *C. undata* differs enough to make it worth while to figure it. The difference is chiefly in surface-sculpture, but slightly also in outline.

Cytherura pumila, C., B. & R., and *Cytherura concentrica*, C., B. & R.

These species have already been figured and described (in MS.) by the author in conjunction with Messrs. Crosskey and Robertson, from fossil post-tertiary specimens; and I have not thought it right here to forestall those descriptions, the publication of which I hope may not be long delayed.

Cytherideis foveolata, nov. sp. (Figs. 1–3.

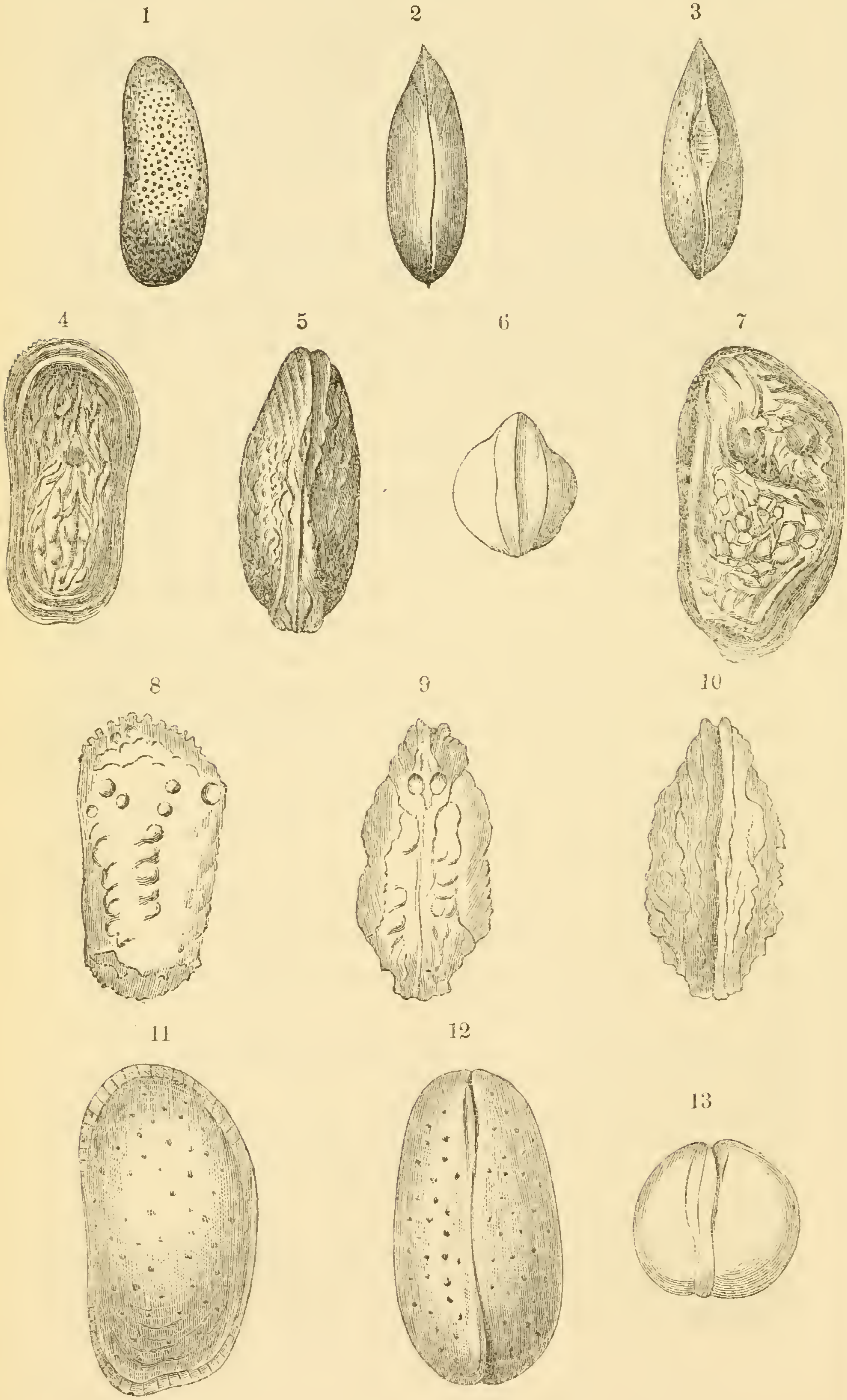
Carapace elongate, compressed; seen from the side, siliquose, slightly depressed in front; greatest height situate about the middle, and equal to rather more than one-third of the length; extremities rounded, the anterior much the narrower; superior margin almost straight, inferior slightly sinuated in the middle. Seen from above, elongate ovate, widest near the middle, tapering gradually toward the front, more abruptly behind; extremities acuminate; width equal to one-third of the length. Shell surface smooth, minutely and somewhat densely punctate, semitransparent, horny. Length $\frac{1}{35}$ inch.

Nearly allied to *C. subulata*, Brady, but more robust and more densely punctate.

EXPLANATION OF PLATE OF RECENT OSTRACODA FROM THE GULF OF ST. LAWRENCE.

Fig. 1. *Cytherideis foveolata*, carapace, seen from the left side. } x 40.
Fig. 2. The same, seen from above.
Fig. 3. The same, seen from below.
Fig. 4. *Cythere canadensis*, carapace, seen from the left side. } x 50.
Fig. 5. The same, seen from above.
Fig. 6. The same, seen from the front.
Fig. 7. *Cytherura undata*, var., carapace, seen from the left side. x 84.
Fig. 8. *Cythere Dawsoni*, carapace, seen from the left side. } x 50.
Fig. 9. The same, seen from above.
Fig. 10. The same, seen from below.
Fig. 11. *Cythere leioderma*, carapace, seen from the left side. } x 40.
Fig. 12. The same, seen from above.
Fig. 13. The same, seen from behind.

RECENT OSTRACODA FROM THE GULF OF ST. LAWRENCE.



EXTRACT FROM NOTES ON FOSSIL OSTRACODA FROM THE POST-TERTIARY DEPOSITS OF CANADA AND NEW ENGLAND.

By George Stewardson Brady, C.M.Z.S., and H. W. Crosskey F.G.S.

(*From the Geological Magazine for Feb.*, 1871.)

We are indebted for the material from which the following notes have been compiled to Principal Dawson of Montreal, and to the Secretary of the Portland Society of Natural History, to whom our best thanks are due for the opportunity thus afforded us of comparing the fossils of the North American Clay Beds with those of our own country. By carefully washing the clays kindly forwarded to us, we have obtained many specimens in excellent condition for examination.

Of the thirty-three species here noticed, twenty-three are well known to us as occurring in the Scottish Glacial Clays, twenty-five are living inhabitants of the British Seas, while six (*Cythere cuspidata, C. MacChesneyi, C. Logani, Cytherura granulosa, C. cristata, Cytheropteron complanatum*) are new to science, being here for the first time described.

We know too little of the recent American Ostracoda to institute any very precise comparison between them and the fossil fauna represented by the following list of species; but when compared with British collections, we find the contents of the Canadian fossiliferous clays to resemble very closely those of some similar formations in Scotland, and less closely those of dredgings obtained in the seas around the Hebrides and Shetland.

The character of the Mollusca with which the Ostracoda are associated justifies the same observation. About two-thirds of the Mollusca collected from the Scotch glacial clays are also found in the corresponding beds of Canada; and the difference between the glacial fossil fauna of Canada and that now existing in the Gulf of St. Lawrence is far less marked than the difference between the glacial fauna of the Clyde beds and that now existing in the Firth. The fossil fauna of Canada is slightly more arctic than that of the Gulf, but does not contrast with it so broadly as the fauna of the Scotch glacial clays with the Mollusca still living in the neighbouring waters. The resemblance between the fossil glacial Ostracoda of America and the Ostracoda of Scotch glacial clays, being closer than the resemblance between the glacial and the living Ostracoda of Scotland, renders the determination of their relationship to living American Ostracoda of considerable geological importance. It may be useful to geologists to enumerate the Ostracoda found in the various clays we have examined, and indicate at the same time the general character of the groups of Mollusca with which they are associated.

PORTLAND.—Out of 31 species of Mollusca catalogued, 18 occur fossil in Scotch glacial clays, including such characteristic forms as *Pecten Groenlandicus*; *Pecten Islandicus*; *Leda pygmœa*; *Tellina calcarea* (*proxima*); *Natica affinis* (*clausa*); *Buccinum Groelandicum.* The associated Ostracoda are:

Cythere emarginata (Sars).
" concinna (Jones).
" Dawsoni (Brady).
" limicola (Norman).
" dunelmensis (Norman).
Cytheridea papillosa (Bosquet).
" Sorbyana (Jones).
Loxoconcha granulata (Sars)
Xestoleberis depressa (Sars).
Cytherura nigrescens (Baird).
Cytherura Sarsii (Brady).
" cristata, nov. sp.
" striata (Sars).
" granulosa, nov. sp.
" undata, var.
Cytheropteron latissimum (Norman)
" nodosum (Brady).
Sclerochilus contortus (Norman).
Paradoxostoma variabile (Baird).

Saco (*Maine*).—On the banks of the Saco river, about ten miles from its mouth, 15 species of Mollusca are catalogued, of which only five occur in the Scotch clays, viz.: *Leda pygmœa*; *Leda arctica*; *Nucula inflata*; *Menestho albula*; *Natica affinis* —*M. albula*, however, being rather doubtful and very young. The great abundance of *Leda arctica* constitutes a remarkable analogy between this bed and the clay at Errol near Dundee, and at Moss in Christianiafjörd. The associated Ostracoda are:

Cythere leioderma (Norman).
" lutea (Müller).
" MacChesneyi, nov. sp.
" emarginata (Sars).
" limicola (Norman).
" cuspidata, nov. sp.
" dunelmensis (Norman).
Cytheridea papillosa (Bosquet).
" cornea (Brady and Robertson).
" Sorbyana (Jones).
" Williamsoniana? (Bosquet).
Cytheropteron latissimum Norman.
" complanatum, nov. sp.

Lewiston, 110 feet above the sea. Only two species of Mollusca can we find yet determined from near this place, viz.: *Mya arenaria* and *Leda truncata*, both also Scotch fossils. The associated Ostracoda are:

Cythere emarginata Sars.
Cytheridea Sorbyana Jones.
Cytheropteron inflatum B., C., and R., MS.
Sclerochilus contortus Norman.

Montreal.—Upon examining catalogues given by Dr. Dawson in the Canadian Naturalist, it appears that out of 20 species of *Lamellibranchiata*, 15 occur fossil in Scotland, and 17 out of 27 species of *Gasteropoda*. The beds contain nearly all the most characteristic Scotch glacial fossils. The associated Ostracoda are:

Cythere MacChesneyi, nov. sp.
" Dawsoni Brady.
" globulifera Brady.
" Logani, nov. sp.
Cytheridea papillosa Bosquet.
" punctillata (Brady).
Cytheridea Sorbyana (Jones).
Cytherura Robertsoni Brady.
Cytheropteron complanatum, nov. sp.
" inflatum B., C. and R., MS.
" angulatum B., C., and R. MS.
Eucythere argus.

There is no doubt both that many more species of Ostracoda will be discovered upon examination of larger quantities of material than we have yet obtained, and that the number of Mollusca will be increased by every fresh exposure of the clays; but these lists have been given, merely tentatively to indicate general relationships, which, when further developed, may prove of geological value in classifying the various deposits of the Glacial epoch.

One of the writers of this paper (Mr. Brady) has described 29 species of recent Ostracoda from the Gulf of St. Lawrence, dredged in depths varying from 10 to 50 fathoms, but in one case 250 fathoms (Annals and Mag. Nat. Hist., Dec., 1870). Of these 29 species, 13 are found in our list of fossils from the American glacial clays, viz.:

Cythere leioderma.
" lutea.
" emarginata.
" concinna.
" dunelmensis.
" Dawsoni.
Cytheridea papillosa.
" punctillata.
Eucythere argus.
Xestoleberis depressa.
Cytherura undata.
Cytheropteron nodosum.

Although, as Mr. Brady remarks, it is unwise to generalize hastily, yet we cannot help noticing that the general facies of the recent Ostracoda from the Gulf of St. Lawrence much more nearly approaches to that of the Shetland seas or of the Scottish glacial clays, than it does to that of England, while it has scarcely anything in common with that of the Mediterranean,—a fact which has an important connexion with the suggestions we have made in this paper.

NOTES ON GRANITIC ROCKS.

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

First and Second Parts.

Read before the American Association for the Advancement of Science at Troy, August 20, 1870.

§ 1. The name of granite is employed to designate a supposed eruptive or exotic unstratified composite rock, granular, crystalline in texture, and consisting essentially of orthoclase-feldspar and quartz, with an admixture of mica, and frequently of a triclinic feldspar, either oligoclase or albite. This is the definition of granite given by most writers on lithology, and applies to a great portion of what are commonly called granitic rocks; there are, however, crystalline granite-like agregates in which the mica is replaced by a dark colored hornblende or amphibole, and to such a compound rock many authors have given the name of syenite, while to those in which mica and hornblende co-exist, the name of syenitic granite is applied. It is observed that in certain of these hornblendic granites the quartz becomes less in amount than in ordinary granites, and finally disappears altogether, giving rise to a rock composed of orthoclase and hornblende only. To this

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* From the *American Journal of Science* for February and March, 1871.

binary aggregate von Cotta and Zirkel would restrict the term syenite, which was already defined by d'Omalius d'Halloy to be a crystalline aggregate of hornblende and feldspar, by which orthoclase-feldspar may be understood, since he describes varieties of syenite, as passing into diorite ; a name by most modern lithologists restricted to a compound of albite or some more basic triclinic feldspar with hornblende. It is apparently by failing to appreciate the distinction between orthoclase and triclinic feldspars, in this connection, that Haughton has lately described under the name of syenite rocks composed of crystalline labradorite and hornblende.

§ 2. Naumann, regarding orthoclase and quartz as the essential constituents of granite, designates those aggregates which contain mica as mica-granites, and thus distinguishes them from hornblende-granites, in which the mica is replaced by hornblende. These definitions seem the more desirable as the name of granite is popularly applied both to the hornblendic and the micaceous aggregates of orthoclase and quartz. There are not wanting examples of well-defined rocks of this kind in which both mica and hornblende are almost or altogether wanting. Such rocks have been designated binary granites, a term which it will be well to retain. Chloritic and talcose granites, into the composition of which chlorite and talc enter, need only be mentioned in this connection. The name of syenite, so often given to hornblendic granites, will, in accordance with the views already expressed, be restricted to rocks destitute of quartz. While the disappearance of this mineral from hornblendic granites is held to give rise to a true syenite, the same process with micaceous granites affords a quartzless rock consisting of orthoclase and mica, for which we have no name. Great masses of an eruptive rock, granite-like in structure, and consisting of crystalline orthoclase or sanidin, without any quartz, occur in the province of Quebec. This rock contains in some cases a small admixture of black mica, and in others an equally small proportion of black hornblende. The latter variety might be described as syenite, but for the former we have no distinctive name, and I have described both of these by the name of granitoid trachytes, a term which I adopted the more willingly on account of the peculiar composition of the feldspar; and also because compact and finely granular rocks in the same region, having a similar chemical composition, present all the characters of typical trachytes, and apparently graduate into the granitoid rocks just noticed.* In all attempts to define and classify compound rocks, it should be borne in mind that they are not definite lithological species, but admixtures of two or more mineralogical species, and can only be arbitrarily defined and limited.

§ 3. Having thus defined the mineral composition of granitic rocks, we proceed to notice their structure. Gneiss has the same mineral elements as granite, but is distinguished by the more or less stratified and parallel arrangement of its constituents, and lithologists are aware that in certain varieties of gneiss, this structure is scarcely evident, except on a large scale, so that the distinction between gneiss and granite rests rather on geognostical than on lithological grounds. To the lithologist, in fact, the granitoid gneisses are simply more or less stratiform granites, while it belongs to the geologist to consider whether this structure has resulted from a sedimentary deposition, or from the flowing of a semi-fluid heterogeneous mass giving rise to a stratiform arrangement.

§ 4. The rocks having the mineralogical composition of granites present a gradual passage from the coarse structure of ordinary micaceous hornblendic and binary granites to finely granular and even impalpable mixtures of the constituent minerals, constituting the rocks known as felsite, eurite and petrosilex. These rocks are often porphyritic from the presence of crystals of orthoclase, and sometimes of crystals or grains of quartz imbedded in the finely granular or impalpable paste. These felsites and felsite-porphyries are, in very many cases at least, stratified or indigenous rocks, and they are sometimes found associated with granular aggregates of different degrees of coarseness, which show a transition from true felsites into granitic gneisses. The resemblances in ultimate composition between felsites, granites and granitic gneisses are so close that it cannot be doubted that their differences are only structural.

§ 5. Felsites and felsite-porphyries are well known in eastern Massachusetts, at Lynn, Saugus, Marblehead and Newburyport, and may be traced from Machias and Eastport in Maine, along the southern coast of New Brunswick to the head of the Bay of Fundy, with great uniformity of type, though in every place subject

* Amer. Journal of Science, II, xxxviii, 95. See also Zirkel, *Petrographie*, ii, 179.

to considerable variations, from a compact jasper-like rock to more or less coarsely granular varieties, all of which are often porphyritic from feldspar crystals, and sometimes include grains or crystals of quartz. The colors of these rocks are generally some shade of red, varying from flesh-red to purple; pale yellow, gray, greenish and even black varieties are however occasionally met with. These rocks are throughout this region distinctly stratified, and are closely associated with dioritic, chloritic and epidotic strata. They apparently belong, like these, to the great Huronian system.

§ 6. Many of the so-called granites of New England are true gneisses, as for example, those quarried in Augusta, Hallowell, Brunswick, and many other places in Maine, which are indigenous rocks interstratified with the micaceous and hornblendic schists of the great White Mountain series. To this class also, judging from lithological characters, belong the so-called granites of Concord and Fitzwilliam, New Hampshire. These indigenous rocks are tenderer, less coherent, and generally finer grained than the eruptive granites, of which we have examples in the micaceous granite of Biddeford, Maine, and the hornblendic granites of Marblehead and Stoneham, Mass., and Newport, Rhode Island, in all of which localities the contact of the eruptive mass with the enclosing rock is plainly seen, as is also the case farther eastward, on the St. Croix and St. John's Rivers, in New Brunswick, and in the Cobequid Hills and elsewhere in Nova Scotia. The hornblendic granites of Gloucester, Salem and Quincy, Massachusetts, seem also, from their lithological characters, to belong to the class of exotic or true eruptive granites.* The farther discussion of the nature and origin of these gneisses and granites is reserved for another occasion, and we now proceed to notice the history of granitic veins.

§ 7. The eruptive granitic masses just noticed, not only include fragments of the adjacent rocks, especially near the line of contact, but very often send off dykes or veins into the surrounding strata. The relation of these with the parent mass is however generally obvious, and it may be seen that they do not differ from it except in being often finer grained. These injected or intruded veins are not to be confounded with a third class of granitic aggregates, which I have elsewhere described as granitic veinstones, or, to

* T. S. Hunt on the Geology of Eastern New England, Amer. Journal of Science for July 1870, p. 88; also Notes on the Geology of the vicinity of Boston, Proc. Boston Nat. Hist. Soc., Oct. 19, 1870.

express their supposed mode of formation, endogenous granites. They are to the gneisses and mica-schists, in which they are generally enclosed, what calcite veins are to stratified limestones, and although long known, and objects of interest from their mineral contents, have generally been confounded with intrusive granites.

§ 8. Scheerer, in his famous essay on granitic rocks, which appeared in the Bulletin of the Geological Society of France in 1847, (vol. iv, p. 468), conceives the congealing granitic rocks to have been impregnated with "a juice" which was nothing else than a highly heated aqueous solution of certain mineral matters. This, under great pressure, oozed out, penetrating even the stratified rocks in contact with the granite, filling cavities and fissures in the latter, and depositing therein crystals of quartz and of hornblende, the arrangement of which shows them to have been of successive growth. Neither Scheerer nor Virlet d'Aout, who supported his views, however (*ibid.*, iv. p. 493) extended them to feldspathic veins, though Daubrée, at an earlier date, had described certain granitic veins in Scandinavia as having been formed by secretion rather than by igneous injection as maintained by Durocher.

§ 9. Elie de Beaumont, starting from the hypothesis of a cooling liquid globe, imagined "a bath of molten matter on the surface of which the first granites crystallized." From the ruins of these were formed the first sedimentary deposits, but directly beneath were other granitic masses, which became fixed immediately afterward. "Some parts of these masses, coagulated from the commencement of the cooling process, but not completely solidified, were then erupted through the sedimentary deposits" just mentioned. "In these jets of pasty matter" were contained many of the rarer elements of the granitic magma, which were thus concentrated in the outermost portions of the granitic crust, and in the ramifications formed by these portions in the masses through which they were forced by the eruptive agents. Those portions of the granitic masses and their ramifications in which these rarer elements are concentrated, are distinguished from the rest of the masses alike by their exterior position and their peculiar structure. They are often coarse-grained, and include the pegmatites, tourmaline-granites, and veins carrying cassiterite and columbite, often abounding in quartz. These mineral products are to be regarded as emanations from the granite, and are described as a *granitic aura*, constituting what Humboldt has called the penumbra of the granite. (*Bull. Soc. Geol. de France*, (2) iv, 1249. See particularly pages 1295, 1321 and 1323).

§ 10. While Fournet, Durocher and Rivière conceived the granitic magma to have been purely anhydrous, and in a state of simple igneous fusion, Elie de Beaumont maintained with Poulett-Scrope and Scheerer that water had in all cases intervened, and that a few hundredths of water might, at a low red heat, have given rise to the condition of imperfect liquidity which he imagined for the material of the injected granites. The coarsely crystalline granitic veins were, according to him, veins of injection, and he speaks of them as examples in which "the phenomena essential to the formation of granite had been manifested with the greatest intensity." The granitic emanations, which are supposed to have furnished the material of these veins, appear to be regarded by him as the result of a process of eliquation from the congealing granitic mass. De Beaumont is careful to distinguish between them and those emanations which are dissolved in mineral waters, or are exhaled as volcanic vapors (page 1324). To the agency of such waters he ascribes the formation of concretionary veins, which are generally characterized by their symmetrically banded structure. He further adds that granites, as to their mode of formation, offer a character intermediate between ordinary veins and volcanic and basic rocks. This is conceivable as regards granitic veins, since these, according to him, although formed by injection, and not by concretion, result from a process of emanation from the parent granitic mass, which may be described as a kind of segregation.

I have thus endeavored to give, for the most part in his own words, the views on the origin of granites enunciated by the great French geologist in his classic essay on Volcanic and Metalliferous Emanations, published in 1847. They belong to the history of our subject, and are remarkable as a clear and complete expression of those modified plutonic views which are probably held by a great number of enlightened geologists at the present time. My reason for dissenting from them, and the theories which I offer in their stead will be shown in the sequel.

§ 11. Elie de Beaumont, while regarding the formation of granitic veins as a process in which water intervened to give fluidity to the magma, was careful to distinguish the process from that of the production of concretionary veins from aqueous solution, and supposed the fissures to have been filled by the injection of a jet of pasty matter derived from a consolidating granitic mass. Daubrée and Scheerer, in describing the granitic veins of Scandinavia, conceive the material filling them to have been derived from the enclosing crystalline strata instead of an unstratified granitic nucleus, but do not, so far as I am aware, compare their formation to that of concretionary veins. Their publications on this subject, it should be said, are both anterior to the essay of de Beaumont.

§ 12. The notion that all granitic veins are the result of some process of injection, and not to be confounded with concretionary veins, seems indeed to have been general up to the present time. Even von Cotta, while strongly maintaining the aqueous and concretionary origin of metalliferous veins in general, when describing those consisting of quartz, mica, feldspar, tourmaline, garnet, and apatite, with cassiterite, wolfram, etc., which occur at Zinnwald and at Johann georgenstadt, is at a loss whether to regard these veins, from their granitic character, as igneous-fluid injections or as concretionary lodes. In support of the latter view he refers to their more or less regular and symmetrically banded structure, and while recalling the fact that mica and feldspar may both be formed in the humid way, considers the nature of these veins to be very problematical, and the question of their origin a difficult one.—(*Ore Deposits.*, Prime's translation, 1870, pages 110—124).

§ 13. I have for several years taught that granitic veins of the kind just referred to are concretionary and of aqueous origin. In 1863 I described certain veins in the crystalline schists of the Appalachian region of Canada, "where flesh-red orthoclase occurs so intermingled with chlorite and white quartz as to show the contemporaneous formation of the three species. The orthoclase generally predominates, often reposing upon or surrounded by chlorite; at other times it is imbedded in quartz, which covers the latter. Drusy cavities are also lined with small crystals of the feldspar, and have been subsequently filled with cleavable bitter-spar, sometimes associated with specular iron, rutile and sulphuretted copper ores." A study of these veins shows a transition from those "containing quartz and bitter-spar with a little chlorite or talc, through others in which feldspar gradually predominates, until we arrive at veins made up of orthoclase and quartz, sometimes including mica, and having the character of a coarse granite; the occasional presence of sulphurets of copper and specular iron characterizing all of them alike. It is probable that these, and indeed a great proportion of quartzo-feldspathic veins are of aqueous origin, and have been deposited from solutions in fissures of the strata, precisely like metalliferous lodes. This remark applies especially to those granitic veins which include minerals containing the rarer elements. Among these are boron, phosphorus, fluorine, lithium, rubidium, glucinum, zirconium, cæsium, tin and columbium; which characterize the mineral species apatite, tourmaline, lepidolite, spodumene, beryl, zircon, allanite, cassiterite, columbite, and many others."—(*Geology of Canada*, p. 476, also p. 644.)

In this connection I referred to the occurrence of orthoclase with quartz, calcite, zeolites, epidote and native copper in certain mineral veins of Lake Superior, so well described by Prof. J. D. Whitney. (American Journal of Science II, xxviii, 16). The associations, according to him, show the contemporaneous crystallization of the copper, natrolite, calcite and feldspar, which last was found by analysis to be a pure potash-orthoclase.

§ 14. In 1864, this view was still farther insisted upon in the Amer. Journal of Science (II, xxxvii, 252), where, in speaking of mineral veinstones "which doubtless have been deposited from aqueous solution," it is added, "while their peculiar arrangement, with the predominance of quartz and non-silicated species, generally serves to distinguish the contents of these veins from those of injected plutonic rocks, there are not wanting cases in which the predominance of feldspar and mica gives rise to aggregates which have a certain resemblance to dykes of intrusive granite. From these, however, true veins are generally distinguished by the presence of minerals containing boron, fluorine, phosphorus, cæsium, rubidium, lithium, glucinum, zirconium, tin, columbium, etc.; elements which are rare, or found only in minute quantities in the great mass of sediments, but are here accumulated by deposition from waters, which have removed these elements from the sedimentary rocks and deposited them subsequently in fissures."

In the Report of the Geological Survey of Canada for 1865 (p. 192), I have, in describing the veins of the Laurentian rocks, insisted still farther on the distinction just drawn between granitic dykes and granitic veinstones, which latter I have proposed to call endogenous rocks, to indicate the mode of their formation, and to distinguish them from intrusive or exotic rocks, and sedimentary or indigenous rocks.

§ 15. The peculiar banded arrangement, which is so characteristic in concretionary veins not granitic in composition, is probably not less marked in granitic veinstones, and often appears in these in a remarkable manner, showing that they have been formed by successive depositions of mineral matter, and generally in open fissures. This structure, and various peculiarities to be observed in granitic veinstones, will be best illustrated by descriptions of various localities, most of which I have personally examined. It is proposed to notice first, the veins of the gneiss and mica-schist series of New England, and secondly those of the Laurentian rocks of New York and Canada. In the latter class will be noticed the more or less calcareous veinstones into which the Laurentian granitic veins are found to graduate.

§ 16. It is in the series of micaceous schists with interstratified gneisses (§ 6) which I have elsewhere provisionally designated the Terranovan series,* that I have seen concretionary granitic veins in the greatest abundance and on the grandest scale. This stratified system, which is well seen in the White Mountains, appears to extend southward to Long Island Sound and north-eastward beyond the limits of Maine. It is in this state that I have particularly studied the granitic veinstones of this system, whose history may be illustrated by a few examples from notes taken on the spot. In Brunswick the strata near the town are fine-grained, friable, dark colored, micaceous and hornblendic, passing into mica-schist on the one hand, and into well-marked gneiss on the other, and dipping to the S. E. at angles of from 15° to 40°. Very similar beds are found in the adjoining towns of Topsham, and in both places they include numerous endogenous granitic veins. The course of these is generally N. W., or at right angles to the strike, though occasionally for short distances with the strike, and intercalated between the beds; the veins vary in breadth from a few inches to sixty feet, and even more. They generally consist in great part of orthoclase and quartz, with some mica and tourmaline, and offer in the associations and grouping of these minerals many peculiarities, which are met with not only in different veins but in different parts of the same vein. In

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* Amer. Journal of Science for July, 1870, page 83, and Can. Naturalist, V. p. 198.—The rocks of this White Mountain series are in the present state of our knowledge supposed to be newer than the Huronian system noticed in § 5, to which, with Macfarlane and Credner, I refer the crystalline schists with associated serpentines and diorites of the Green Mountains.

some cases, colorless vitreous quartz predominates greatly, and encloses crystals of milk-white orthoclase, often modified, and from one to several inches in diameter. At other times pure vitreous quartz forms one or both walls, or the center of the vein, or else is arranged in bands parallel with the sides of the vein, and sometimes a foot or more in thickness, alternating with similar bands consisting wholly or in great part of orthoclase, or of an admixture of this mineral with quartz, having the peculiar structure of what is called graphic granite, or else presenting a finely granitoid mixture of the two minerals, with little or no mica, and with small crystals of deep red garnet. Prisms of black tourmaline are also met with in these veins, and more rarely beryl and even chryso beryl. In the rock-cutting on the Lewiston railroad, just below Topsham bridge over the Androscoggin, there is a fine exhibition of these veins, which present alternate coarser and finer grained layers, traversed by long spear-shaped crystals of dark mica passing from one layer to another.

§ 17. A remarkable example of a vein of considerable dimensions is seen in the feldspar-quarry in Topsham, which occurs in a dark fine-grained friable micaceous schist. At the time of my visit, in 1869, the limits of the vein were not seen, though large quantities of white orthoclase and of vitreous quartz had already been extracted. These were each nearly pure, and in alternate bands, the quartz presenting drusy cavities lined with remarkable tabular crystals. One band was made up in great part of large crystals of mica, and portions of the vein consisted of a granular saccharoidal feldspar. The famous locality of red, green and blue tourmalines, with beryl, lepidolite, amblygonite, cassiterite, etc., at Mount Mica in Paris, is a huge granitic vein, which, with many others, is included in a dark colored very micaceous gneiss.

§ 18. In Westbrook numerous small veins of this kind, holding coarsely lamellar orthoclase with black tourmaline and red garnet, intersect strata of fine-grained whitish granitoid gneiss. In Windham the dark colored staurolite-bearing mica-schist of this series is traversed by a granitic vein holding crystals of beryl. In Lewiston a large vein of coarse graphic granite, holding black tourmaline, and showing fine-grained bands, cuts a great mass of bluish gneissoid limestone, which forms an escarpment near the railroad, about half a mile below the town. This limestone, which dips eastward about 15°, is interlaminated with thin quartzite beds, which are seen on weathered surfaces to be much contorted.

The bluish crystalline limestone is mixed with grains of greenish pyroxene, and includes nodular granitic masses of white crystalline orthoclase with quartz, enclosing large plates of graphite, crystals of hornblende, and more rarely of apatite. These associations of minerals are met with in the granitic veins of the Laurentian limestones, to be noticed elsewhere. The limestone of Lewiston, however, appears to be included in the great mica-schist series of the region; where similar beds, though less in extent, are met with in various places, sometimes associated with pyroxene, garnet, idocrase and sphene. A thin band of impure pyroxenic limestone, like that of Lewiston, occurs with the mica-schists on the Maine Central Railroad, near Danville Junction, and beds of a purer crystalline limestone were formerly quarried in the south-east part of Brunswick, where they are interstratified with thin-bedded dark hornblendic and micaceous gneiss, dipping S. E. at a high angle.

§ 19. At Danville Junction strata of hornblendic and micaceous gneiss, passing into mica-schists, dip S. E. at moderate angles, and include huge veins of endogenous granite. Two of these appear in the hill just south of the railroad station, apparently running with the strike of the beds. They are seen to rest upon the mica-schist, and in one of them a mass of this rock, three feet in width, is enclosed like a tongue in the granite, which has a transverse breadth of about seventy-five feet. Notwithstanding the apparent intercalation of these granitic masses the proof of their foreign origin is evident in a transverse fracture and slight vertical dislocation of the mica-schist, around the broken edges of which the granite is seen to wrap. The endogenous character of this granite is well shown by its banded structure; belts of white quartz some inches wide alternate with others of coarsely cleavable orthoclase, while other portions hold black tourmalines and garnets of considerable size.

The evidence of disturbance of the strata in connection with these endogenous granites is seen on a large scale at the falls of the Sunday River in Ketchum. There, mica-schists and gneisses, similar to those already noticed, enclose great masses of endogenous granite, which are seen to be transverse to the strata. On one side of such a mass more than sixty feet wide, the schistose strata are twisted from their regular N. E. strike to the N. W., and so enclosed in the granite as to appear as if interstratified with it for short distances. The banded structure of the transverse granite veins is here very marked. Some portions present cleavage-planes of orthoclase six inches in diameter; other parts, which are less coarse, abound in mica. Similar banded granite veins abound in the adjoining towns of Newry and North Bethel, and sometimes present layers of quartz six inches or more in thickness, besides large crystals of mica, and more rarely apatite. These veins are often irregular in shape and bulging at intervals, and they sometimes run partially across the beds, which seem to have been distended and disturbed, a fact which was also observed in the thin-bedded schists in contact with some of the veins in Brunswick, and is apparently due to the expansive force of crystallization, as noticed in § 27.

§ 20. The locality already described at Danville offers an instructive example of a phenomenon often met with in the region now under consideration, where granitic masses, resisting the actions which have degraded the soft enclosing schists, stand out in relief on the surface, and seem to constitute the rock of the country. A careful search will however show that they are simply veins or endogenous masses of very limited dimensions, rising from out of the mica-schists, which are often concealed by the soil. This is well seen about the lower falls of the Presumpscott near Portland, where the mica-schists with some fine-grained gneisses, dipping S. E. at angles of from 30° to 40°, enclose large numbers of granitic veins, which, though sometimes but a few inches in breadth, often measure twenty or even fifty feet, and are usually very coarse-grained, with white mica, black tourmaline, and more rarely beryl. They are sometimes transverse to the stratification, but more often parallel, and, rising above the soil, are very conspicuous.

§ 21. We have already noticed the exotic granites of Biddeford, which are intruded among fine-grained bluish or grayish silicious strata. These latter are traversed by numerous veins of endogenous granite, which are very unlike in aspect to the intrusive rock. One of these veins near Saco Pool, has a diameter of about an inch and a half, and presents on either wall a layer of yellowish crystalline feldspar about one-fourth of an inch in thickness, which includes long plates of dark brown mica. These penetrate the central portion of the vein, which is a broadly crystalline bluish orthoclase, enclosing small portions of quartz after the manner of a graphic granite. The yellowish and less coarsely crystalline feldspar with its accompanying mica, had evidently lined the walls of the vein while the centre yet remained open, and had moreover entirely filled a small lateral branch. The same conditions are seen in the filling of other veins in this vicinity, which are often much larger, and present upon their walls bands of an inch or two of the yellowish feldspar with mica.

The successive filling of a granitic vein is still more clearly shown in a specimen from Sherbrooke, Nova Scotia, which I owe to the kindness of Prof. H. Y. Hind. The vein, which is seen to be transverse to the adherent fine-grained mica-schist, has a breadth of nearly four inches, about two-thirds of which is symmetrical, and is included between two layers, perpendicular to the walls, consisting of a fine-grained mixture of white feldspar and quartz, each about one-fourth of an inch thick, and marked by subordinate zones, more or less quartzose. Within these two bands is a coarser aggregate, consisting of two feldspars, with some quartz and muscovite, plates of which, and crystals of pink orthoclase penetrate an irregular layer of smoky quartz varying from one-eighth to one-half an inch in diameter. This fills the center of the symmetrical portion of the vein, on one side of which is the mica-schist, while the other is bounded by a band of more than half an inch of fine-grained granite with yellowish-green mica, presenting large crystals of feldspar near the outer margin; where it is succeeded by a layer of pure smoky vitreous quartz of about the same thickness, whose outer surface, against the wall, shows irregular bosses or nodular masses, the depressions between which are occupied by a finely granular micaceous aggregate unlike any other part of the vein in texture. This description may be read in connection with the remarks in § 27.

Dana has described and figured a similar granitic vein, banded with quartz, observed by him at Valparaiso in Chili, (Manual of Geology, 1862, p. 713). * and has moreover maintained that such granitic veins, like ordinary metalliferous lodes, are clearly concretionary in their origin, and have been filled by slow and successive deposits from aqueous solutions. His testimony to the views which I have advocated in this paper had been overlooked by me, or it would have been noticed in § 12.

§ 22. The numerous granitic veins so well known to mineralogists in the mica-schists and gneisses of New Hampshire, Massachusetts and Connecticut, including among other familiar localities, Grafton, Acworth, Royalston, Norwich, Goshen, Ches-

* From U. S. Exploring Expedition, Report on the Geology, 1849, p. 570.

terfield, Middleton and Haddam, seem from descriptions, and from their mineral constituents to be similar to those of Maine, already mentioned. With the exception of Royalston however these localities are as yet only known to me from specimens and descriptions. It is noteworthy that at this last the finely-crystallized beryls are directly imbedded in vitreous quartz, and the same is the case with the blue and green tourmalines of Goshen. A remarkable example of a vein of this character occurs in Buckfield, Maine, described to me by Prof. Brush, where large isolated crystals of white orthoclase, nearly colorless muscovite and brown tourmaline occur in a vein of vitreous quartz. At Paris and at Hebron, Maine, tourmalines are found penetrating crystals of quartz. The flattened tourmalines and garnets found in muscovite at several localities in New England, are well known to collectors, and a curious example of enclosure has been observed by Prof. Brush at Hebron, where crystals of muscovite are encased in lepidolite.

§ 23. The following list includes the principal mineral species found in these granitic veins in New England: apatite, amblygonite, triphylline, autunite, yttrocerite, orthoclase, albite, oligoclase, spodumene, iolite, muscovite, biotite, lepidolite, cookeite, chlorite, chlorophyllite, garnet, epidote, tourmaline, beryl, zircon, quartz, chrysoberyl, automolite, cassiterite, rutile, brookite, uraninite, columbite, pyrochlore, scheelite, and bismutite. As I am not aware that chlorite has hitherto been mentioned as a constituent of these veins, it may be said that it occurs in one at Albany, Maine. To the above should probably be added the rare species nepheline, cancrinite and sodalite, which have long been known in boulders of a granite-like rock in Maine. According to information given me by Prof. Brush, green elæolite with white orthoclase and black biotite occurs in a granitic vein twenty feet in breadth, lately observed in the northwest part of Litchfield, Maine.

§ 24. We have seen that these endogenous veins are found alike in the gneisses, mica-schists, limestones and quartzose strata of this region. They are also met with in the eruptive granites, small fissures in which are sometimes filled with coarsely crystalline orthoclase, smoky quartz, various micas and zircon. Examples of this are seen in the granites of Hampstead, New Brunswick, and Mt. Uniacke, Nova Scotia. The fine green feldspar of Cape Ann, Mass., and the micas, cryophyllite and lepidomelane with zircon, described by Prof. Cooke, from the same region, occur in veins in the hornblendic granites of that locality. Small veins cutting a somewhat similar rock at Marblehead, contain crystallized green epidote with white quartz and red orthoclase.

§ 25. The veins which we have described are frequently of very limited extent, and seem to occupy short and irregular fissures, while in other cases the mineral aggregates which characterize them occur in nests or geodes. This is seen near Fall Brook in the Nerepis valley in New Brunswick, where the red micaceous granite is in one part very friable, and presents irregular geode-like cavities, sometimes several inches in diameter, which are partially filled by radiating prisms of black tourmaline, accompanied with quartz and albite crystals, and more rarely small octahedrons of purple fluorine. The enclosing granite is composed of deep red orthoclase, with small portions of a white triclinic feldspar, smoky quartz and black mica. The conditions seen at this place recall the description of the famous locality of feldspars, etc., at Fariolo near Baveno in Northern Italy. The rock, described as a granite, resembles, in a specimen before me, some of the intrusive granites of New Brunswick, and contains a pink and a white feldspar, with a little black mica. It includes veins of graphic granite, and also spheroidal masses, which differ in texture from the mass of the rock, and present geodes of considerable size, lined with fine large red and white crystals of orthoclase, accompanied by albite, epidote, quartz, fluorine and a greenish mica (or chlorite) all of which, according to Fournet, are so mingled and interlocked as to show that they are of contemporaneous origin. To these are to be added, as occurring in the geodes, prehnite, calcite, hyalite, and specular iron. The orthoclase crystals often have adhering to their opposite faces crystalline plates of albite, which are larger than the planes to which they are attached. The crystals of orthoclase moreover frequently present hollowed-out or hopper-shaped faces, which Fournet happily describes as resulting from the forming of the frame-work or skeleton of the crystals, when the material was not sufficient for their completion. A process analogous to this is often seen in crystallization, whether from fusion, solution or vaporous condensation, giving rise in some cases to external depressions, and in others to internal cavities in the resulting crystals. Fournet ascribes the formation of the geodes in the granite of Fariolo to a process of shrinking and a subsequent segregation filling the resulting cavities, in which he is forced to recognize the intervention of water, though by no means admitting the aqueous origin of veins, since he holds even those of quartz to have been formed by igneous injection. (*Géologie Lyonnaise*, *278.

§ 26. When we consider the cause which has produced the fissures in the mica-schists and gneisses of New England, which hold the granitic veins already described, it is to be remarked that their comparative abundance, their shortness and their irregularity destinguish them from the fissures which are filled with eruptive rocks. Examples of the latter may be seen near Danville, Maine, where dykes of fine-grained dolerite are posterior to the endogenous granitic veins here occuring in the mica-schist. These dykes may be supposed to be dependent upon movements in the earth's crust opening deep fissures which connected with some softened rock far below. Through such openings were extravasated the exotic rocks, whether granites or dolerites,—more or less homogeneous mixtures, often widely different in composition from the encasing rocks. The endogenous veins, on the contrary, are distinguished not only by their more or less heterogeneous and often banded structure, but by the fact that their principal constituents are the mineral species most common in the adjacent strata.

§ 27. Volger has attributed the formation of the openings containing concretionary veins to the force of crystallization, which is shown to be very great in the congelation of water and the crystallizing of salts in cavities and fissures. Such a process once commenced in an opening in a rock would, he conceived, be sufficient to make still wider the fissure, which might be fed by fresh solutions passing by capillarity through the pores of the rock. If this process were to become concentrated around several points, the intermediate space might be so opened that free crystallization could go on, resulting in the production of geodes in veins thus formed.

Fournet, on the other hand, suggests that contraction in the cooling of erupted granites gave origin to the fissures and geodes now filled or partially filled with crystalline minerals at Fariolo, and we may readily suppose that a process of contraction attendant upon the crystalline aggregation of the materials of sedimentary strata, would give rise to rifts or fissures therein. The lesions thus produced in the solid rocks become more or less completely repaired, if we may so speak, by an effusion of mineral matter from the walls, and thus are generated geodes, irregular masses and many veins. That the process imagined by Volger may in some cases intervene, and may act subsequently to the one just imagined, is highly probable, though we are disposed to assign it but a secondary place in the production of vein-fisures. It offers however the most plausible explanation of the distortion of the thin-bedded strata already noticed in connection with some of the concretionary granitic veins of Maine, which seem, by a process of growth, to have bent outward the adjacent beds. The vertical transverse veins are, in many cases at least, unsymmetrical, as if they had grown from one side, while the distortion of the beds, sometimes attended by irregular concretions in the banded veinstone, appears at the opposite wall. The notion that the vein-fissures opened as crystallization advanced, has been defended by Grüner.

§ 28. It is not here the place to discuss how far the greater and deeper fissures of the earth are dependent upon the contraction of sediments, as just explained, or upon the wider spread movements of the earth's crust, though even of these it may be said that they are more or less directly the results of a process of contraction. It should however be noted that while some fissures of this kind are filled with dykes of erupted rocks (§ 26), others hold concretionary veins, which are to be distinguished from the class of veins just described, inasmuch as the openings in which they were deposited evidently communicated with the surface of the earth. Examples of these are seen in the lead and zinc-bearing veins with calcite amd barytine, which traverse vertically the carboniferous limestone in England, and enclose in their central portions material of liassic age, abounding in the remains of a marine and a fresh-water fauna, which show these veins to have been deposited in fissures communicating with the surface-waters of the liassic period. For a description of these veins by Mr. Charles Moore, see the Report of the British Association, for 1869, and Amer. Jour. of Science II, l, 365. Similar evidence is afforded by the existence of rounded pebbles imbedded in veins, as observed in Bohemia, and also in Cornwall, where numerous pebbles both of slate and quartz were found at a depth of six hundred feet in a lode, cemented by tinstone and sulphuret of copper. (Lyell, Student's Elements of Geology, p. 593. Not less instructive in this connection are the observations of Mr. J. A. Phillips, on the silicious veinstones now in process of formation in open fissures in Nevada (L. E. and D. Phil. Mag. (4), xxxvi, 321, 422, Amer. Jour. of Science II, xlvii, 138). We cannot doubt that the ancient, like these modern veins, have been channels for the discharge of subterranean mineral waters, and it would seem that while the deposition of the incrusting materials on the walls of the fissure is in part due to cooling, and in part perhaps to the infiltration, in some cases, of precipitants from lateral sources, it is chiefly to be ascribed to the reduction of solvent power consequent upon the diminution of pressure as the waters rise nearer to the surface. This conclusion, deducible from the researches of Sorby on the relation of pressure to solubility, I have pointed out in the Geological Magazine for February, 1868, p. 57. See also Amer. Jour. of Science, II, l, 27.

§ 29. There is evidently a distinction to be drawn between veins which have been open channels, and the segregated masses and geodes formed in cavities which appear to have been everywhere limited by the enclosing rock. In the former case, a free circulation of the mineral solution would prevail, while in the latter there could be no renewal of it except by percolation or diffusion through the rock. A comparison between the contents of geodes and fissure-veins, whether in granite rocks or in fossiliferous limestones, will however show that these differences do not sensibly affect the mineral constitution of the deposits.

§ 30. The range of conditions under which the same mineral species may be formed is apparently very great. Sorby, from his investigations of the fluid-cavities of crystals, concludes that the quartz which occurs with cassiterite, mica and feldspar in the granitic veins of Cornwall, must have crystallized at temperatures from 200° to 340° Centigrade, and under great pressure, conditions which we can hardly suppose to have presided over the production of the crystallized quartz found in the unaltered tertiaries of the Paris basin, or the auriferous conglomerates of California. In like manner beryl, though a common mineral of the tin-bearing granite veins, like those studied by Sorby, occurs at the famous emerald mine of Muso in New Grenada, in veins in a black bituminous limestone, holding ammonites, and of neocomian age, its accompaniments being calcite, quartz and carbonate of lanthanum (parisite). Small crystals of emerald are disseminated through this argillaceous somewhat magnesian limestone, which contains moreover a small amount of glucina in a condition soluble in acids. (Lewy, *Ann. de Ch. et Phys.*, liii, 1—26, and Fournet, *Geol. Lyonnaise*. 455).

§ 31. To these we may add the production of various hydrated crystallized silicates, including apophyllite, harmotome and chabazite, during the historic period in the masonry of the old Roman baths at Plombières and Luxeuil, and by the action of waters at temperatures of from 46° to 70° Centigrade; the presence of apophyllite, natrolite and stilbite in the lacustrine tertiary limestones of Auvergne; apophyllite incrusting fossil wood, and chabazite crystals lining shells in a recent deposit in Iceland. The association of such hydrated silicates with orthoclase, as already noticed (§ 13) and as described by Scheerer, where natrolite and orthoclase envelope each other, showing their contemporaneous formation, with many other facts of a similar kind, lead to the conjecture that orthoclase, like beryl and quartz, and perhaps some other constituents of granitic veins, may have crystallized in many cases at temperatures much lower than those determined by Sorby, and thatthe conditions of their production include a considerable range of temperature; a conclusion which is however, probably true to some extent, of zeolites also.

It is proposed to continue the subject of granitic veins, and in a third part of this paper to give some facts in the history of the veinstones of Laurentian rocks.

NOTES ON THE BIRDS OF NEWFOUNDLAND.

By Henry Reeks, Esq., F.L.S., &c.

(*Continued from page* 304.)

Procellariidæ.

Fulmar Petrel, Procellaria glacialis, *Linn.*—Apparently common in its migrations, but I could not learn that it bred on the island.

Leach's Petrel, Thalassidroma Leachi (*Temm.*)—Tolerably common, and probably breeds on some of the islands in company with the following species.

Wilson's Stormy Petrel, T. Wilsoni, *Bon.*—Appeared to be more common than *T. Leachi*, and was said to breed on several islands along the coast of Newfoundland, especially at Port au Port; it is very probable, however, that some of these reported breeding places refer to the following species.

Stormy Petrel or *Mother Carey's Chicken*, T. pelagica (*Linn.*) —A common summer migrant, remaining probably until the appearance of the drift ice. Breeds on many of the islands round the coast.

Greater Shearwater, Puffinus major (*Faber.*)—I have never observed this species so far north as Cow Head, but it appeared tolerably common in the Gulf of St. Lawrence, on the west coast of Newfoundland.

Sooty Shearwater, P. fuliginosus, *Strick.*—Common on the banks of Newfoundland, but rather rare in the Straits of Labrador.

Manx Shearwater, P. anglorum, *Ray.*—Tolerably common, especially about the Gulf of St. Lawrence. The shearwaters are rarely, if ever, seen on the islands near the coast of Newfoundland. They are to be seen at all seasons in the Gulf of St. Lawrence, which has given rise to some curious ideas among the sailors, viz., that these birds *never breed*, or that during the breeding season the females retire to some *unknown* islands for that purpose. Their breeding stations are equally unknown to the settlers, but they are probably on some of the surf bound islands on the "banks"—once the favourite resort of the great auk.

LARIDÆ.

Pomarine Skua, Stercorarius pomarinus, *Temm.*—Common, especially in the fall of the year.

Arctic Skua, S. parasiticus (*Linn.*)—Most common in spring and fall. This and the preceding are called "dung birds" by the settlers, evidently from the manner in which they persecute the smaller species of *Laridæ*, and devour not only their disgorged food but also their fœces.

Buffon's Skua, S. cepphus (*Brünn.*)—Appeared to be a rather rare periodical migrant, but it is difficult to distinguish the three skuas on wing, even with the aid of a good glass; from specimens obtained this species seems to be the rarest.

Glaucous Gull, Larus glaucus *Brünn.*—Tolerably common in its periodical migrations, especially in the fall of the year, and during strong gales of north-westerly winds. It is called the "large ice gull."

White-winged Gull, L. leucopterus, *Faber.*—Like the preceding species a periodical migrant, and most common in the fall of the year.

Great Blackbacked Gull, L. marinus, *Linn.*—A common summer migrant, arriving towards the last of April and remaining until the drift-ice appears. It builds its nest of grass and rushes, on rocks and small islands, most commonly in fresh-water ponds and lakes, but very frequently in similar situations in bays, &c. Provincial name, "Saddler Gull."

Herring Gull,* L. argentatus, *Brunn.*—Abundant throughout the summer, and breeds in similar situations, and often in company with the preceding and following species. It is called the "blue gull" by the settlers.

Ring-billed Gull, L. Delawarensis, *Ord.*—Common throughout the summer. Provincial name "squeezy gull." All the above species of *Larus* are carnivorous, but more especially *L. glaucus* and *L. marinus.* No sooner does a dead or dying bird appear on the surface of the water (the raven generally secures such prizes when washed ashore,) than it is quickly espied by the gulls, which immediately commence squalling and in circling flights survey their victim. Should it prove to be a goose or duck, or even one of their own species, the "old saddler" (*L. marinus*) usually commences operations; this it does, if the bird is quite dead, by standing *on* the floating body and picking first the neck and then the breast, and in a wonderfully short time the gulls devour every part of a fine fat goose except the bones and feathers: I have often watched the process in, I fear, a rather dog-in-the-manger spirit—having first killed or crippled the goose for them.

Bonaparte's Gull, Chroicocephalus Philadelphia(*Ord.*)—I have every reason to believe this little gull occurs occasionally in the Straits of Labrador. During the fall (Aug. and Sept.) of 1866, and again in 1867, I saw gulls (on wing) which I could refer to no other species, and the settlers, to whom I showed specimens of the following species, said they were larger than the "tickler."—a small gull with which they evidently seemed familiar, and one

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* Professor Newton informs me "that the American form of this bird has been of late regarded as distinct under the name of *L. Smithsonianus.*"

which I think will prove to be this species.* As the species of some of the *Laridæ* in immature plumage are not easily determined, even by naturalists, there is room to doubt the testimony of fishermen, as well as my own, as to the identity of *C. Philadelphia* with the provincial name "tickler;" at the same time I think it would be negligent on my part not to mention the evidence in favor of its occurrence on the coast of Newfoundland. Because so celebrated an ornithologist as Audubon did not see it, there is no reason why another person may not.

Kittiwake Gull, Rissa tridactylus (*Linn,*) — Tolerably common, especially in its periodical migrations. I did not hear of any breeding station on the island.

Ivory Gull, Pagophila eburnea (*Gmelin.*)—A very rare periodical migrant on the N. W. coast of Newfoundland. Two were obtained at Parson's Pond in January 1867, and another in January 1868; they were brought to me for identification, being unknown to the settler who shot them, and who, strange to say, killed all the three specimens. They were shot during a gale from the S. E., so that they must have flown across the island, which is narrow at this part, and not more than fifty miles from water to water.

Sabine's Gull or *Fork-tailed Gull*, Xema Sabinii (*Sabine*).—A periodical visitor, but not common at Cow Head.

Caspian Tern, Sterna caspia, *Pallas.*—A tolerably common summer migrant, and breeds on many of the islands along the coast: I obtained eggs in the Bay of St. Paul. The settlers call it the "mackerel bird."

Wilson's Tern, S. Wilsoni, *Bonap.*—The most abundant species on that part of the coast which I visited. It arrives early in June, congregating and breeding on the coast islands as well as the mainland.

Arctic Tern, S. macrura, *Nauman.*—Rare at Cow Head; otherwise I confused it with the preceding species. Both are called "steerings" by the settler—a name which their cry suggests. Some few small islands round the coasts of Newfoundland have been named "Steering" Islands from the number of terns which breed on them, although the name suggest a nautical derivation.

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* There is certainly a possibility that the American Black headed Gull (*Chroicocephalus atricilla*) goes farther north than Massachusetts, and visits the coasts of Newfoundland; perhaps in company with C. *Philadelphia*.

Least Tern, S. frenata, *Gambel*.—Apparently very rare. I only examined one specimen, which was shot about the 10th of September, 1867. This bird was probably blown across to Newfoundland by N.W. gales, which often prevail at that season.

SULIDÆ.

Common Gannet, Sula bassana (*Linn.*)—A very common summer migrant and constant attendant on the large shoals of mackarel and herring, which are migratory in spring and fall, the seasons of which are indicated to the settlers by gannets and gulls.

PHALACROCORACIDÆ—THE CORMORANTS.

Common Cormorant, Graculus carbo (*Linn.*)—A summer migrant and very abundant at some breeding stations along the coast.

Double-crested Cormorant, G. dilophus (*Swain.*)—Equally abundant with the preceding; both species fly in the form of the letter V reversed, and breed in colonies: *G. dilophus* is said to breed *in trees* in Hawk's Bay, Newfoundland.

COLYMBIDÆ.

Loon or Great Northern Diver, Colymbus Torquatus, *Brunn.*—A very common summer migrant to Newfoundland, where it is called "Loo," *not Loon*. At this season nearly every lake and large pond is tenanted by its pair of loos; I say by *its* pair, because I believe the same pair, unless destroyed or continually disturbed, invariably return to the same site for many years. In 1867 a female loo hatched her two eggs on a rock in Parson's Pond, within gunshot of a house of one of the settlers. The house was not usually tenanted during summer, but some of the family were daily going to and from it. The same pair of birds (?) had for many years hatched their young on this rock, which sloped gradually into the water, and was nowhere at that season more than a foot out of water. When built on an island, or by the side of a lake, I have never known the nest more than three feet from the water, and very rarely so much: the birds are very awkward walkers, although wonderfully strong on wing, and breed on many of the lakes in the interior of Newfoundland; not only on the plains but on the high table-land, upwards of two thousand feet above the sea. Loos are often taken in the salmon-nets of the settlers: I got a very fine adult male taken in this way on July 10th, 1867.

The settlers easily "tole" these birds within gunshot by secreting themselves and waving a cap or red handkerchief. So fascinating is the red handkerchief that I have seen the same bird "toled" up within easy range, and shot at two or three times before it was killed; they are such expert divers, that they are far more easily toled than shot on the water. Young birds are sometimes so fat in the fall of the year, that I have seen the fat lining the inside of the skin average half an inch in thickness! The settlers affirm that there are two species of Loos; the great northern, which they call the "spotted loo," and another with the throat white, which is termed the "whitethroated loo," and which is distinguished from the young of *C. torquatus* in its first year's plumage by having the feathers on the back spotted with white instead of "margined with greyish white." Certain it is that plenty of such birds are seen every summer, *i. e.*, June and July; and, although the settlers say that they have found nests of the "whitethroated species (?), I am under the impression that they will prove to be non-breeding birds of *C. torquatus* in the *second* year's plumage—a state of which I have seen no description. The fact, however, of these birds being found at mid-summer white-throated and with the back spotted is worthy of note, because the great northern diver has scarcely commenced laying at that season.*

Redthroated Diver, C. Septentrionalis, *Linn.*—A common summer migrant, breeding generally in some of the smaller ponds in the marshes; placing its nest on a tussock of grass surrounded by water.

Podiceps——? A species of grebe was caught in the marshes near Cow Head by one of the settlers, and was considered a great curiosity by all who saw it. This occurred a year or two before I got there, and unfortunately no part of the bird was preserved; it was probably a straggler from the Labrador shore, as none have been taken since, neither could I learn of any previous capture.

ALCIDÆ.

Great Auk, Alca impennis, *Linn.*—With this species I arrive at the most interesting of Newfoundland birds—once abundant, but now, alas! I fear extinct, or nearly so. Almost the sole ob-

* Adult specimens of *C. Torquatus* had the bill *black* tipped with horn; while immature birds had the bill *horn coloured*, with ridge of upper mandible *black*.

ject of my visiting the island was to collect further information from those who were likely to have met with this bird,—which is called "Pinwing"* by the settlers, and *not* Penguin, as Audubon informs us,—in a living state, and also, if possible, to visit the islands on the east coast, more especially Funk and neighboring islands. The latter intention was, however unfortunately frustrated by the severe accident I met with so shortly after my arrival, and, although I met several old settlers who had seen the living bird fishing in the mouths of Bonne Bay, Bay of Islands and Bay of St. George, none could with certainty tell me when the last was either seen or captured. I was, however, informed by some of the settlers that "a living pinwing was caught by one Captain Stirling about twelve years ago," but whether destroyed or not I could not learn: Captain Stirling was drowned and his vessel wrecked some seven or eight years since. I have no doubt this tale is true in the main; the only questionable part being the *exact* date which, from my experience of these good-hearted people, is just as likely to have been fifteen or sixteen years ago as "about twelve." The fact recorded by Col. Drummond-Hay (Ibis,' 1861, p. 397) of a living specimen of *A. impennis* being seen on the banks of Newfoundland so recently as 1852, and also of another picked up dead the following year in Trinity Bay, goes far to substantiate the statement of the settlers, and, I think, to fix the time at about that date. The settlers generally believe that the pinwing is *not* extinct, but such testimony cannot be of the slightest value, as they have no reason *why* it should not be so; neither have I, although I fondly—some will perhaps say foolishly—cherish the same belief, except that vessels have no object in going within several miles of the surf-bound and dangerous islands on the southern and eastern coasts, which are the most likely to hold the great auk at the present day. As Mr. Gurney ('Zoologist,' S.S., p. 1640) appears under the impression that the mummy of the great auk forwarded to the

* Professor Newton tells me that more than ten years ago he formed the opinion (from the fact that the operation known as "*pinioning*" is called "*pin-winging*" in some parts of England) that the name "Penguin," or "Pingwin" as it is often also spelled, was but a corruption of the word Pin wing, and had been applied to certain sea-fowl which being unable to fly appeared to have been "pin-winged." Until quite lately informed by me, he did not know that the Newfoundland name of *Alca impennis* was so pronounced as to give support to his theory.

British Museum by Mr. J. M. Jones,* President of the Nova Scotia Institute of Natural Science, was "found by the Bishop of Newfoundland while on a missionary cruise at Funk Island," I will take the liberty of transcribing his lordship's letter to Mr. Jones as it appears in the "Transactions of the N. Scotia Institute of Nat. Science," the more so as I wish to make a few remarks thereon. The italics are mine:—

"St. John's, N. F., August 10th, 1864.

"My dear Sir,—I am much pleased that the mummy arrived in a good state of preservation. How long it has been *embalmed or entombed in the ice* I cannot of course tell, but I understand the different specimens were found several feet (at least four) below the surface, and *under ice which never melts*. They were all found on the Funk Islands, but on which side I am not able now to discover, as the person who dug them up is not at present, I believe, in St. John's. He was sent, or went there to gather the guano or bird manure on speculation, with strict injunctions to procure, if possible, the bones or skeletons of the extinct bird. In this he succeeded better than in his own business, and probably if he had known the value attached to these specimens by naturalists he might have turned them to better account than the guano. One specimen I sent to Mr. Newton, and you saw by his letter how highly it was prized. Another was sent to Agassiz, and the third I have been enabled through the kindness of our Governor to forward to you: and this is the most perfect of the three, or certainly more perfect than the one I sent to Mr. Newton; the other I did not see.

"I think it very likely more specimens might be found, as no persons are living on the island; and it is only lately that any attempt has been made to discover and preserve the skeleton.

"Your's faithfully,

"ED. NEWFOUNDLAND."

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* Of this specimen Professor Newton writes me that "it was originally intended to have been sent to me, but that having sailed for Spitsbergen just before the Bishop's letter to me reached England, I was unable to let him have an answer for many months. I wrote to him immediately on my return home, and shortly after was inexpressibly mortified to find that not having heard from me for so long, he imagined I did not care to have a second specimen, and so sent it to Mr. Jones, by whom it was given to the British Museum, where its skeleton—a very perfect one—is now to be seen."

The parts of sentences italicised in the above letter appear to me rather conflicting observations. In the first place his lordship appears to have been informed, either directly or indirectly, that the mummies were, or rather the one sent to Mr. Jones was, "embalmed or entombed *in the ice*," and also that they were found at least four feet "*under* ice which *never melts!*" If the specimens were really "embalmed or entombed in the ice," it is right to infer that they were not originally Funk Island birds—*i. e.*, were not there in a living state, but that they died in high northern regions and *there* became "entombed" in ice which eventually *drifted* on to Funk Island, because the drift ice *only* remains unmelted until late in summer; that which is formed during winter on the coasts, or on the islands along the coasts of Newfoundland, *soon melts* on the approach of summer. Again, on the other hand, it is new to me, and contrary to my experience, to find that ice, even from high northern latitudes, when drifted to and piled on an island by the winds, only a few feet above sea-level, and in the same latitude as the extreme south of England, should *never* melt! In all probability ice has drifted on to Funk Island for many hundreds, or perhaps thousands of years,—as long, at any rate, as the pinwings have used it for a breeding station, but at the same time I consider it *quite* as probable that the ice *melted annually* before the birds commenced breeding. It hardly seems reasonable that birds which make little or no nest should select an island and deposit their eggs on ice which "never melts," when plenty of adjacent islands were quite free from ice at that season. From the fact of the specimens being found under ice so late as June or July, the man who dug them up was probably impressed with the idea that the ice was a permanency on the island. For further particulars respecting the great auk on the coasts of Newfoundland I must refer my readers to two papers by Professor Newton,—one in the 'Proceedings of the Zoological Society' for 1863, and another in the 'Natural History Review' for October 1865,—the latter being a capital *résumé* of and commentary on previously published matter.

Razor-billed Auk, A. torda. *Linn.*—Common throughout the summer and fall; in fact, until driven south by the drift ice. It is called a "tinker" by the settlers.

Common Puffin, Mormon arcticus (*Linn.*)—Common in the summer, but most abundant in the fall. It is the only species of puffin I obtained, but the settlers say a larger puffin is also found there in the fall of the year, which is probably *M. glacialis*, Leach,

Black Guillemot, Uria grylle (*Linn.*)—A very common summer migrant, remaining until after assuming its winter plumage, and migrating only on the appearance of drift ice. Provincial name "pigeon."

Common Guillemot or *Murre*, U. lomvia, *Brunn.*—A very common periodical migrant, breeding plentifully on islands on the north coast of Newfoundland, and along the Labrador shore. I was unable to identify U. *ringvia* as more than a common form of *U. lomvia.*

Thick-billed Guillemot, U. arra (*Pallas*).—Equally common with the preceeding. Both species are called "murres" and "turres" by the settlers.

Little Auk, Mergulus alle (*Linn.*)—A very common periodical migrant arriving in October and remaining until driven farther south by ice. Povincial name "bull-bird."

In the above list two hundred and twelve species have been enumerated, nearly all of which I have identified as belonging to the avi-fauna of Newfoundland. That the subject is anything like exhausted I am far from thinking; although perhaps some years may elapse before this list is materially added to, yet there is much to be learned on the economy and migration of some species. Why many of the Charadridæ, Scolopacidæ, &c , which are supposed to breed in Alaska, or even in the Artic Circle, should be so abundant in Newfoundland and during the autumnal migrations, and yet rarely or never observed on the vernal migration, I am unable to explain. Nevertheless, it seems pretty evident and perhaps natural that a more direct route is taken at that season. Prof. Baird is of opinion (I presume from evidence adduced) that the vernal migration is by way of the Mississippi valley; thence by the great lakes in the Hudson's Bay territories. Be this as it may, it is wonderful that a station (say for argument Bahama Islands, or any of the West India Islands) used as winter quarters should be annually resorted to *viâ* Newfoundland and Bermuda, and that Alaska, or territories within the Artic Circle, should also annually be visited in summer by a route several hundred miles westward of that (the Newfoundland) invariably adopted in the fall of the year. I trust naturalists in Newfoundland and the British Provinces will *carefully* note those species which pass southward in the autumn, and *especially* those which reappear in the spring: I allude here, of course, only to those species which are known to breed far north, although the migration of species will be found one of the most interesting studies in the economy of animal life.

THE CORRELATION OF VITAL AND PHYSICAL FORCES.*

By Prof. Geo. F. Barker, M.D., of Yale College.

In the Syracusan Poecile, says Alexander von Humboldt in his beautiful little allegory of the Rhodian Genius, hung a painting, which, for full a century, had continued to attract the attention of every visitor. In the foreground of this picture a numerous company of youths and maidens of earthly and sensuous appearance gazed fixedly upon a haloed Genius who hovered in their midst. A butterfly rested upon his shoulder, and he held in his hand a flaming torch. His every lineament bespoke a celestial origin. The attempts to solve the enigma of this painting—whose origin even was unknown—though numerous, were all in vain, when one day a ship arriving from Rhodes, laden with works of art, brought another picture, at once recognized as its companion. As before, the Genius stood in the center, but the butterfly had disappeared, and the torch was reversed and extinguished. The youths and maidens were no longer sad and submissive, their mutual embraces announcing their entire emancipation from restraint. Still unable to solve the riddle, Dionysius sent the picture to the Pythagorean sage, Epicharmus. After gazing upon them long and earnestly, he said: Sixty years long have I pondered on the internal springs of nature, and on the differences inherent in matter; but it is only this day that the Rhodian Genius has taught me to see clearly that which before I had only conjectured. In inanimate nature everything seeks its like. Everything, as soon as formed, hastens to enter into new combinations, and nought save the disjoining art of man can present in a separate state ingredients which ye would vainly seek in the interior of the earth or in the moving oceans of air and water. Different, however, is the blending of the same substances in animal and vegetable bodies. Here vital force imperatively asserts its rights, and heedless of the affinity and antagonism of the atoms, unites substances which in inanimate

* Lecture delivered before the American Institute, New York in 1870.

nature ever flee from each other, and separates that which is incessantly striving to unite. Recognize, therefore, in the Rhodian Genius, in the expression of his youthful vigor, in the butterfly on his shoulder, in the commanding glance of his eye, the symbol of vital force as it animates every germ of organic creation. The earthly elements at his feet are striving to gratify their own desires and to mingle with one another. Imperiously the Genius threatens them with upraised and high-flaming torch, and compels them, regardless of their ancient rights, to obey his laws. Look now on the new work of art; turn from life to death. The butterfly has soared upward, the extinguished torch is reversed, and the head of the youth is drooping; the spirit has fled to other spheres, and the vital force is extinct. Now the youths and maidens join their hands in joyous accord. Earthly matter again resumes its rights. Released from all bonds, they impetuously follow their natural instincts, and the day of his death is to them a day of nuptials.[1]

The view here put by Humboldt into the mouth of Epicharmus may be taken as a fair representation of the current opinion of all ages concerning vital force. To-day, as truly as seventy-five years ago when Humboldt wrote, the mysterious and awful phenomena of life are commonly attributed to some controlling agent residing in the organism—to some independent presiding deity, holding it in absolute subjection. Such a notion it was which prompted Heraclitus to talk of a universal fire, Van Helmont to propose his Archæus, Hofmann his vital fluid, Hunter his *materia vitæ diffusa*, and Humboldt his vital force.[2] All these names assume the existence of a material or immaterial something, more or less separable from the material body, and more or less identical with the mind or soul, which is the cause of the phenomena of living beings. But as science moved irresistibly onward, and it became evident that the forces of inorganic nature were neither deities nor imponderable fluids separable from matter, but were simple affections of it, analogy demanded a like concession in behalf of vital force.[3] From the notion that the effects of heat were due to an imponderable fluid called caloric, discovery passed to the conviction that heat was but a motion of material particles, and hence inseparable from matter. To a like assumption concerning vitality it was now but a step. The more advanced thinkers in science of to-day, therefore, look upon the life of the living form as inseparable from its substance, and believe that the former is purely phenomenal, and only a manifestation of the latter. Denying the existence of a special vital force as such, they retain the term only to express the sum of the phenomena of living beings.

In calling your attention this evening to the Correlation of the Physical and the Vital Forces, I have a two-fold object in view. On the one hand, I would seek to interest you in a comparatively recent discovery of Science, and one which is destined to play a most important part in promoting man's welfare; and on the other I would inquire what part our own country has had in these discoveries.

In the first place, then, let us consider what the evidences are that vital and physical forces are correlated. Let us inquire how far inorganic and organic forces may be considered mutually convertible, and hence, in so far, mutually identical. This may best be done by considering, first, what is to be understood by correlation: and second, how far are the physical forces themselves correlated to each other.

At the outset of our discussion, we are met by an unfortunate ambiguity of language. The word Force, as commonly used, has three distinct meanings; in the first place, it is used to express the cause of motion, as when we speak of the force of gunpowder; it is also used to indicate motion itself, as when we refer to the force of a moving cannon-ball; and lastly it is employed to express the effect of motion, as when we speak of the blow which the moving body gives.[4] Because of this confusion, it has been found convenient to adopt Rankine's snggestion,[5] and to substitute the word 'energy' therefor. And precisely as all force upon the earth's surface—using the term force in its widest sense—may be divided into attraction and motion, so all energy is divided into potential and actual energy, synonymous with those terms. It is the chemical attraction of the atoms, or their potential energy, which makes gunpowder so powerful; it is the attraction or potential energy of gravitation which gives the power to a raised weight. If now, the impediments be removed, the power just now latent becomes active, attraction is converted into motion, potential into actual energy, and the desired effect is accomplished. The energy of gunpowder or of a raised weight is potential, is capable of acting; that of exploding gunpowder or of a falling weight is actual energy or motion. By applying a match to the gunpowder, by cutting the string which sustains the weight, we convert potential into actual energy. By potential energy, therefore, is meant attraction; and by actual energy, motion. It is in the latter sense that we shall use the word force in this lecture; and we shall speak of the forces of heat, light, electricity and mechanical motion, and of the attractions of gravitation, cohesion, chemism.

From what has now been said, it is obvious that when we speak of the forces of heat, light, electricity or motion, we mean simply the different modes of motion called by these names. And when we say that they are correlated to each other, we mean simply that the mode of motion called heat, light, electricity, is convertible into any of the others, at pleasure. Correlation therefore implies convertibility and mutual dependence and relationship.

Having now defined the use of the term force, and shown that forces are correlated which are convertible and mutually dependent, we go on to study the evidences of such correlation among the motions of inorganic nature usually called physical forces; and to ask what proof science can furnish us that mechanical motion, heat, light, and electricity are thus mutually convertible. As we have already hinted, the time was when these forces were believed to be various kinds of imponderable matter, and chemists and physicists talked of the union of iron with caloric as they talked of its union with sulphur, regarding the caloric as much a distinct and inconvertible entity as the iron and sulphur themselves. Gradually, however, the idea of the indestructibility of matter extended itself to force. And as it was believed that no material particle could ever be lost, so, it was argued, no portion of the force existing in nature can disappear. Hence arose the idea of the indestructibility of force. But, of course, it was quite impossible to stop here. If force cannot be lost, the question at once arises, what becomes of it when it passes beyond our recognition? This question led to experiment, and out of experiment came the great fact of force-correlation; a fact which distinguished authority has pronounced the most important discovery of the present century.[6] These experiments distinctly proved that when any one of these forces disappeared, another took its place; that when motion was arrested, for example, heat, light or electricity was developed. In short, that these forces were so intimately related or correlated—to use the word then proposed by Mr. Grove[7]—that when one of them vanished, it did so only to reappear in terms of another. But one step more was necessary to complete this magnificent theory. What can produce motion but motion itself? Into what can motion be converted, but motion? May not these forces, thus mutually convertible, be simply different modes of motion of the molecules of matter, precisely as mechanical motion is a motion of its mass? Thus was born the dynamic theory of force, first brought out in any completeness by Mr. Grove, in 1842, in a lecture on the "Progress of Physical Science," delivered at the London Institution. In that lecture he said: "Light, heat, electricity, magnetism, motion, are all convertible material affections. Assuming either as the cause, one of the others will be the effect. Thus heat may be said to produce electricity, electricity to produce heat; magnetism to produce electricity, electricity magnetism; and so of the rest." [8]

A few simple experiments will help us to fix in our minds the great fact of the convertibility of force. Starting with actual visible motion, correlation requires that when it disappears as motion it should reappear as heat, light, or electricity. If the moving body be elastic, like this rubber ball, then its motion is not destroyed when it strikes, but is only changed in direction. But if it be non-elastic, like this ball of lead, then it does not rebound; its motion is converted into heat. The motion of this sledge-hammer, for example, which, if received upon this anvil, would be simply changed in direction, if allowed to fall upon this bar of lead, is converted into heat; the evidence of which is that a piece of phosphorus placed upon the lead is at once inflamed. So too, if motion be arrested by the cushion of air in this cylinder, the heat evolved fires the tinder carried in the plunger. But it is not necessary that the arrest of motion should be sudden; it may be gradual, as in the case of friction. If this cylinder containing water or alcohol be caused to revolve rapidly between the two sides of this wooden rubber, the heat due to the arrested motion will raise the temperature of the liquid to the boiling point, and the cork will be expelled. But motion may also be converted into electricity. Indeed electricity is always the result of friction between heterogeneous particles.[9] When this piece of hard rubber, for example, is rubbed with the fur of a cat, it is at once electrified; and now if it be caused to communicate a portion of its charge to this glass plate, to which at the same time we add the mechanical motion of rotation, the strong sparks produced give evidence of the conversion.

So, too, taking heat as the initial force, motion, light, electricity may be produced. In every steam-engine the steam which leaves the cylinder is cooler than that which entered it, and cooler by exactly the amount of work done. The motion of the piston's mass is precisely that lost by the steam molecules which batter against it. The conversion of heat into electricity, too, is also easily effected. When the junction of two metals is heated, electricity is developed. If the two metals be bismuth and antimony, as represented in this diagram, the currents flow as indicated by the arrows; and by multiplying the number of pairs, the effect may be proportionately increased. Such an arrangement, called a thermo-electric battery, we have here; and by it the heat of a single gas-burner may be made to move, when converted, this little electric bell-engine. Moreover, heat and light have the very closest analogy; exalt the rapitity with which the molecules move and light appears, the difference being only one of intensity.

Again, if electricity be our starting point, we may accomplish its conversion into the other forces. Heat results whenever its passage is interrupted or resisted; a wire of the poorly conducting metal platinum becoming even red hot by the converted electricity. To produce light, of course, we need only to intensify this action; the brightest artificial light known, results from a direct conversion of electricity.

Enough has now been said to establish our point. What is to be particularly observed of these pieces of apparatus is that they are machines especially designed for the conversion of some one force into another. And we expect of them only that conversion. We pass on to consider for a moment the quantitative relations of this mutual convertibility. We notice, in the first place, that in all cases save one, the conversion is not perfect, a part of the force used not being utilized, on the one hand, and on the other, other forces making their appearance simultaneously. While, for example, the conversion of motion into heat is quite complete, the inverse conversion is not at all so. And on the other hand, when motion is converted into electricity, a part of it appears as heat· This simultaneous production of many forces is well illustrated by our little bell-engine, which converts the electricity of the thermo-battery into magnetism, and this into motion, a part of which expends itself as sound. For these reasons the question "How much?" is one not easily answered in all cases. The best known of these relations is that between motion and heat, which was first established by Mr. Joule in 1849, after seven years of patient investigation.[10] The apparatus which he used is shown in the diagram. It consists of a cylindrical box of metal, through the cover of which passes a shaft, carrying upon its lower end a set of paddles, immersed in water within the box, and upon its upper portion a drum on which are wound two cords, which, passing in opposite directions, and over pulleys, and are attached to known weights. The temperature of the water within the box being carefully noted, the weights are then allowed to fall a certain number of times, of course in their fall turning the paddles against the friction of the liquid. At the close of the experiment the water is found to be warmer than before. And by measuring the amount of this rise in temperature, knowing the distance through which the weights have fallen, it is easy to calculate the quantity of heat which corresponds to a given amount of motion. In this way, and as a mean of a large number of experiments, Mr. Joule found that the amount of mass-motion in a body weighing one pound, which had fallen from a height of 772 feet, was exactly equal to the molecular motion which must be added to a pound of water, in order to heat it one degree Fahrenheit. If we call the actual energy of a body weighing one pound which has fallen one foot, a foot-pound, then we may speak of the mechanical equivalent of heat as being 772 foot-pounds.

The significance and value of this numerical constant will appear more clearly if we apply it to the solution of one or two simple problems. During the recent war two immense iron guns were cast in Pittsburgh, whose weight was nearly 112,000 pounds each, and which had a caliber of 20 inches.[11] Upon this diagram is a calculation of the effective blow which the solid shot of such a gun, assuming its weight to be 1,000 pounds and its velocity 1,100 feet per second, would give; it is 902,797 tons.[12] Now, if it were possible to convert the whole of this enormous mechanical power into heat, to how much would it correspond? This question may be answered by the aid of the mechanical equivalent of heat; here is the calculation, from which we see that when 17 gallons of ice-cold water are heated to the boiling point, as much energy is communicated as is contained in the death-dealing missile at its highest velocity.[13] Again, if we take the impact of a larger cannon ball, our earth, which is whirling through space with a velocity of 19 miles a second, we find it to be 98,416,136,000,000,000,000,000,000,000,000 tons.[14] Were this energy all converted into heat, it would equal that produced by the combustion of 14 earths of solid coal.[15]

The conversion of heat into motion, however, as already stated, is not as perfect. The best steam-engines economize only one-twentieth of the heat of the fuel.[16] Hence if a steam ship require 600 tons of coal to carry her across the Atlantic, 570 tons will be expended in heating the waters of the ocean, the heat of the remaining 30 tons only being converted into work.

One other quantitative determination of force has also been made. Prof. Julius Thomsen, of Copenhagen, has fixed experimentally the mechanical equivalent of light.[17] He finds that the energy of the light of a spermaceti candle burning 126½ grains per hour, is equal in mechanical value to 13·1 foot pounds per minute. The same conclusion has been reached by Mr. Farmer, of Boston, from different data.[18]

If we pass from the actual physical energies or motions to consider for a moment the potential energies or attractions, we find, also, an intimate correlation. Since all energy not active in motion is potential in attraction, it follows that in the attractions we have energy stored up for subsequent use. The sun is thus storing up energy: every minute it raises 2,000,000,000, tons of water to the mean height of the clouds, 3½ miles; and the actual energy set free when this water falls is equal to 2,757,000,000,000 horse powers.[19] So when the oxygen and the zinc of the ore are separated in the furnace, the actual energy of heat becomes the potential energy of chemical attraction, which again becomes actual in the form of electricity when the zinc is dissolved in an acid. We see, then, that not only may any form of force or actual energy be stored up as any form of attraction or potential energy, but that the latter, from whatsoever source derived, may appear as heat, light, electricity, or mechanical motion.

Having now established the fact of correlation for the physical forces, we have next to inquire what are the evidences of the correlation of the vital forces with them. But in the first place it must be remarked that life is not a simple term like heat or electricity; it is a complex term, and includes all those phenomena which a living body exhibits. In this discussion, therefore, we shall use the term vital force to express only the actual energy of the body, however manifested. As to the attractions or the potential energy of the organism, nothing is more fully settled in science than the fact that these are precisely the same within the body as without it. Every particle of matter within the body obeys implicitly the laws of the chemical and physical attractions. No overpowering or supernatural agency comes in to complicate their action, which is modified only by the action of the others. Vitality, therefore, is the sum of the energies of a living body, both potential and actual.

Moreover, the important fact must be fully recognized that in living beings we have to do with no new elementary forms of matter. Precisely the same atoms which build up the inorganic fabric, compose the organic. In the early days of chemistry, indeed, it was supposed that the complicated molecules which life produced were beyond the reach of simple chemical law. But as more and more complex molecules have been, one after another, produced, chemistry has become re-assured, and now doubts not her ability to produce them all. A few years hence, and she will doubtless give us quinine and protagon, as she now gives us coumarin and neurine, substances the synthesis of which was but yesterday an impossibility.[20]

In studying the phenomena of living beings, it is important also to bear in mind the different and at the same time the coordinate purposes subserved by the two great kingdoms of nature. The food of the plant is matter whose energy is all expended; it is a fallen weight. But the plant-organism receives it, exposes it to the sun's ray, and, in a way yet mysterious to us, converts the actual energy of the sunlight into potential energy within it. The fallen weight is thus raised, and energy is stored up in substances which now are alone competent to become the food of the animal. This food is not such because any new atoms have been added to it; it is food because it contains within it potential energy, which at any time, may become actual as force. This food the animal now appropriates; he brings it in contact with oxygen, and the potential energy becomes actual; he cuts the string, the weight falls, and what was just now only attraction, has become actual force; this force he uses for his own purposes, and hands back the oxidized matter, the fallen weight, to the plant to be again de-oxidized, to be again raised. The plant then is to be regarded as a machine for converting sunlight into potential energy: the animal, a machine for setting the potential energy free as actual, and economizing it. The force which the plant stores up is undeniably physical; must not the force which the animal sets free by its conversion, he intimately correlated to it?

But approaching our question still more closely, let us, in illustration of the vital forces of the animal economy, choose three forms of its manifestation in which to seek for the evidences of correlation; these shall be heat evolved within the body; muscular energy or motion; and lastly, nervous energy, or that form of force which, on the one hand, stimulates a muscle to contract, and on the other, appears in forms called mental.

The heat which is produced by the living body is obviously of the same nature as heat from any other source; it is recognized by the same tests, and may be applied for the same purposes. As to its origin, it is evident that since potential energy exists in the food which enters the body, and is there converted into force, a portion of it may become the actual energy of heat. And since, too, the heat produced in the body is precisely such as would be set free by the combustion of this food outside of it, it is fair to assume that it thus originates. To this may be added the chemical argument that while food capable of yielding heat by combustion is taken into the body, its constituents are completely or almost completely, oxidized before leaving it; and since oxidation always evolves heat, the heat of the body must have its origin in the oxidation of the food. Moreover, careful measurements have demonstrated that the amount of heat given off by the body of a man weighing 180 pounds is about 2,500,000 units. Accurate calculations have shown, on the other hand, that 288·4 grams of carbon and 12·56 grams of hydrogen are available in the daily food for the production of heat. If burned out of the body, these quantities of carbon and hydrogen would yield 2,765,134 heat units. Burned within it, as we have just seen, 2,500,000 units appear as heat; the rest in other forms of energy.[21] We conceive, however, that no long argument is necessary to prove that animal heat results from a conversion of energy within the body; or that the vital force heat, is as truly correlated to the other forces as when it has a purely physical origin.

The belief that the muscular force exerted by an animal is created by him is by no means confined to the very earliest ages of history. Traces of it appear to the careful observer even now, although, as Dr. Frankland says, science has proved that "an animal can no more generate an amount of force capable of moving a grain of sand than a stone can fall upward or a locomotive drive a train without fuel."[22] In studying the characters of muscular action we notice, first, that, as in the case of heat, the force which it develops is in no wise different from motion in inorganic nature. In the early part of the lecture, motion produced by the contraction of muscle, was used to show the conversion of mass-force into molecular fore. No one in this room believes, I presume, that the result would have been at all different, had the motion been supplied by a steam-engine or a water-wheel. Again, food, as we have seen, is of value for the potential energy it contains, which may become actual in the body. Liebig, in 1842, asserted that for the production of muscular force, the food must first be converted into muscular tissue,[23] a view until recently accepted by physiologists.[24] It has been conclusively shown, however, within a few years that muscular force cannot come from the oxidation of its own substance, since the products of this metamorphosis are not increased in amount by muscular exertion.[25] Indeed, reasoning from the whole amount of such products excreted, the oxidation of the amount of muscle which they represent would furnish scarcely one-fifth of the mechanical force of the body. But while the products of tissue-oxidation do not increase with the increase of muscular exertion, the amount of carbonic gas exhaled by the lungs is increased in the exact ratio of the work done.[26] No doubt can be entertained, therefore, that the actual energy of the muscle is simply the converted potential energy of the carbon of the food. A muscle, therefore, like a steam-engine, is a machine for converting the potential energy of carbon into motion. But unlike a steam-engine, the muscle accomplishes this conversion directly, the energy not passing through the intermediate stage of heat. For this reason, the muscle is the most economical producer of mechanical force known. While no machine whatever can transform all of the energy into motion (the most economical steam-engines utilizing only one-twentieth of the heat) the muscle is able to convert one-fifth of the energy of the food into work.[2] The other four-fifths must, therefore, appear as heat. Whenever a muscle contracts, then, four times as much energy appears as heat as is converted into motion. Direct experiments by Heidenhain have confirmed this, by showing that an important rise of temperature attends muscular contraction;[28] a fact, however, apparent to any one who has ever taken active exercise. The work done by the animal body is of two sorts, internal and external. The former includes the action of the heart, of the respiratory muscles, and of those assisting the digestive process. The latter refers to the useful work the body may perform. Careful estimates place the entire work of the body at about 800[7] foot-tons daily; of which 450 foot-tons is internal, 350 foot-tons external work. And since the internal work ultimately appears as heat within the body, the actual loss of heat by the production of motion is the equivalent of the 350 foot-tons which represents external work. This by a simple calculation will be found to be 250,000 heat units, almost the precise amount by which the heat yielded by the food when burned without the body, exceeds that actually evolved by the organism. Moreover, while the total heat given off by the body is 2,500,000 units, the amount of energy evolved as work is equal to about 600,000 heat units; hence the amount of work done by a muscle is, as above stated, one-fifth of the actual energy derivable from the food. One point further. The law of correlation requires that the heat set free when a muscle in contracting does work, shall be less than when it effects nothing; this fact, too, has been experimentally established by Heidenhain.[29] So, again, when muscular contraction does not result in motion, as when one tries to raise a weight too heavy for him, the energy which would have appeared as work, takes the form of heat: a result deducible by the law of correlation from the steam-engine.

The last of the so-called vital forces which we are to examine, is that produced by the nerves and nervous centers. In the nerve which stimulates a muscle to contract, this force is undeniably motion, since it is propagated along this nerve from one extremity to the other. In common language, too, this idea finds currency in the comparison of this force to electricity; the gray or cellular matter being the battery, the white or fibrous matter the conductors. That this force is not electricity, however, Du Bois-Reymond has demonstrated by showing that its velocity is only 97 feet in a second, a speed equalled by the greyhound and the race-horse.[30] In his opinion, the propagation of a nervous impulse is a sort of molecular polarization, like magnetism. But that this agent is a force as analogous to electricity as is magnetism, is shown not only by the fact that the transmission of electricity along a nerve will cause the contraction of the muscle to which it leads, but also by the more important fact that the contraction of a muscle is excited by diminishing its normal electrical current; [31] a result which could take place only with a stimulus closely allied to electricity. Nerve-force, therefore, must be a transmuted potential energy.

What, now, shall we say of that highest manifestation of animal life, thought-power? Has the upper region called intelligence and reason, any relations to physical force? This realm has not escaped the searching investigation of modern science; and although in it investigations are vastly more difficult than in any of the regions thus far considered, yet some results of great value have been obtained, which may help us to a solution of our problem. It is to be observed at the outset that every external manifestation of thought-force is a muscular one, as a word spoken or written, a gesture, or an expresssion of the face; and hence this force must be intimately correlated with nerve-force. These manifestations, reaching the mind through the avenues of sense, awaken accordant trains of thought only when this muscular evidence is understood. A blank sheet of paper excites no emotion; even covered with Assyrian cuneiform characters, its alterations of black and white awaken no response in the ordinary brain. It is only when, by a frequent repetition of these impressions, the brain-cell has been educated, that these before meaningless characters awaken thought. Is thought, then, simply a cell-action which may or may not result in muscular expression, —an action which originates new combinations of truth only, precisely as a calculating machine evolves new combinations of figures? Whatever we define thought to be, this fact appears certain, that it is capable of external manifestation by conversion into the actual energy of motion, and only by this conversion. But here the question arises, Can it be manifested inwardly without such a transformation of energy? Or is the evolution of thought entirely independant of the matter of the brain? Experiments, ingenious and reliable, have answered this question. The importance of the results will, I trust, warrant me in examining the methods employed in these experiments somewhat in detail. Inasmuch as our methods for measuring minute amounts of electricity are very perfect, and the methods for the conversion of heat into electricity are equally delicate, it has been found that smaller differences of temperature may be recognized by converting the heat into electricity, than can be detected thermometrically. The apparatus first used by Melloni in 1832,[32] is very simple, consisting first, of a pair of metallic bars like those described in the early part of the lecture, for effecting the conversion of the heat; and second, of a delicate galvanometer, far measuring the electricity produced. In the experiments in question one of the bars used was made of bismuth, the other of an alloy of antimony and zinc.[33] Preliminary trials having shown that any change of temperature within the skull was soonest manifested externally in that depression which exists just above the occipital protuberance, a pair of these little bars was fastened to the head at this point; and to neutralize the results of a general rise of temperature over the whole body, a second pair, reversed in direction, was attached to the leg or arm, so that if a like increase of heat came to both, the electricity developed by one would be neutralized by the other, and no effect be produced upon the needle unless only one was affected. By long practice it was assertained that a state of mental torpor could be induced, lasting for hours, in which the needle remained stationary. But let a person knock at the door outside the room, or speak a single word, even though the experimenter remained absolutely passive, and the reception of the intelligence caused the needle to swing through 20 degrees.[31] In explanation of this production of heat, the analogy of the muscle at once suggests itself. No conversion of energy is complete; and as the heat of muscular action represents force which has escaped conversion into motion, so the heat evolved during the reception of an idea, is energy which has escaped conversion into thought, from precisely the same cause. Moreover, these experiments have shown that ideas which affect the emotions, produce most heat in their reception; "a few minutes' recitation to one's self of emotional poetry, producing more effect than several hours of deep thought." Hence it is evident that the mechanism for the production of deep thought, accomplishes this conversion of energy far more perfectly than that which produces simply emotion. But we may take a step further in this same direction. A muscle, precisely as the law of correlation requires, develops less heat when doing work than when it contracts without doing it. Suppose, now, that beside the simple reception of an idea by the brain, the thought is expressed outwardly by some muscular sign. The conversion now takes two directions, and in addition to the production of thought, a portion of the energy appears as nerve and muscle-power; less, therefore, should appear as heat, according to our law of correlation. Dr. Lombard's experiments have shown that the amount of heat developed by the recitation to one's self of emotional poetry, was in every case less when that recitation was oral; *i. e.*, had a muscular expression. These results are in accordance with the well-known fact that emotion often finds relief in physical demonstrations; thus diminishing the emotional energy by converting it into muscular. Nor do these facts rest upon physical evidence alone. Chemistry teaches that thought-force, like muscle-force, comes from the food; and demonstrates that the force evolved by the brain, like that produced by the muscle, comes not from the disintegration of its own tissue, but is the converted energy of burning carbon.[35] Can we longer doubt, then, that the brain, too, is a machine for the conversion of energy? Can we longer refuse to believe that even thought is, in some mysterious way, correlated to the other natural forces? and this, even in face of the fact that it has never yet been measured?[36]

I cannot close without saying a word concerning the part which our own country has had in the development of these great truths. Beginning with heat, we find that the material theory of caloric is indebted for its overthrow more to the distinguished Count Rumford than to any other one man. While superintending the boring of cannon at the Munich Arsenal, towards the close of the last century, he was struck by the large amount of heat developed, and instituted a careful series of experiments to ascertain its origin. These experiments led him to the conclusion that "anything which any insulated body or system of bodies can continue to furnish without limitation, cannot possibly be a material substance." But this man, to whom must be ascribed the discovery of the first great law of the correlation of energy, was an American. Born in Woburn, Mass, in 1753, he, under the name of Benjamin Thompson, taught school afterward at Concord, N. H., then called Rumford. Unjustly suspected of toryism during our Revolutionary war, he went abroad and distinguished himself in the service of several of the governments of Europe. He did not forget his native land, though she had treated him so unfairly; when the honor of nobility was tendered him, he chose as his title the name of the Yankee village where he had taught school, and was thenceforward known as Count Rumford. And at his death, by founding a professorship in Harvard College, and donating a prize-fund to the American Academy of Arts and Sciences at Boston, he showed his interest in her prosperity and advancement.[37] Nor has the field of vital forces been without earnest workers belonging to our own country. Professors John W. Draper[38] and Joseph Henry[39] were among its earliest explorers. And in 1851, Dr. J. H. Watters, now of St. Louis, published a theory of the origin of vital force, almost identical with that for which Dr. Carpenter, of London, has of late received so much credit. Indeed, there is some reason to believe that Dr. Watters's essay may have suggested to the distinguished English physiologist the germs of his own theory.[40] A paper on this subject by Prof. Joseph Leconte, of Columbia, S. C., published in 1859, attracted much attention abroad.[41] The remarkable results already given on the relation of heat to mental work, which thus far are unique in science, we owe to Professor J. S. Lombard, of Harvard College; [42] the very combination of metals used in his apparatus being devised by our distinguished electrical engineer, Mr. Moses G. Farmer. Finally, researches conducted by Dr. T. R. Noyes, in the Physiological Laboratory of Yale College, have confirmed the theory that muscular tissue does not wear during action, up to the point of fatigue; [43] and other researches by Dr. L. H. Wood have first established the same great truth for brain-tissue.[44] We need not be ashamed, then, of our part in this advance in science. Our workers are, indeed, but few; but both they and their results will live in the records of the world's progress. More would there be now of them were such studies more fostered and encouraged. Self-denying, earnest men are ready to give themselves up to the solution of these problems, if only the means of a bare subsistence be allowed them. When wealth shall foster science, science will increase wealth—wealth pecuniary, it is true: but also wealth of knowledge, which is far better.

In looking back over the whole of this dicussion, I trust that it is possible to see that the objects which we had in view at its commencement have been more or less fully attained. I would fain believe that we now see more clearly the beautiful harmonies of bounteous nature; that on her many-stringed instrument force answers to force, like the notes of a great symphony; disappearing now in potential energy, and anon reappearing as actual energy, in a multitude of forms. I would hope that this wonderful unity and mutual interaction of force in the dead forms of inorganic nature, appears to you identical in the living forms of animal and vegetable life, which make of our earth an Eden. That even that mysterious, and in many aspects awful, power of thought, by which man influences the present and future ages, is a part of this great ocean of energy. But here the great question rolls upon us, Is it only this? Is there not behind this material substance, a higher than molecular power in the thoughts which are immortalized in the poetry of a Milton or a Shakespeare, the art creations of a Michael Angelo or a Titian, the harmonies of a

Mozart or a Beethoven? Is there really no immortal portion separable from this brain-tissue, though yet mysteriously united to it? In a word, does this curiously-fashioned body inclose a soul, God-given and to God returning? Here Science veils her face and bows in reverence before the Almighty. We have passed the boundaries by which physical science is inclosed. No crucible, no subtle magnetic needle can answer now our questions. No word but His who formed us, can break the awful silence. In presence of such a revelation Science is dumb, and faith comes in joyfully to accept that higher truth which can never be the object of physical demonstration.

NOTES AND REFERENCES.

1. Humboldt, Views of Nature, Bohn's ed., London, 1850, p. 380. This Allegory did not appear in the first edition of the Views of Nature. In the preface to the second edition the author gives the following account of its origin: "Schiller," he says, "in remembrance of his youthful medical studies, loved to converse with me, during my long stay at Jena, on physiological subjects." * * * "It was at this period that I wrote the little allegory on Vital Force called the Rhodian Genius. The predilection which Schiller entertained for this piece, which he admitted into his periodical, *Die Horen*, gave me courage to introduce it here." It was published in *Die Horen* in 1795.

2, Humboldt, *op. cit.*, p. 386. In his *Aphorismi ex doctrina Physiologiæ chemicæPlantarum*, appended to his *Flora Fribergensis subterranea*, published in 1793, Humboldt had said "Vim internam, quæ chymicæ affinitatis vincula resolvit, atque obstat. quominus elementa corporum libere conjungantur, vitalem vocamus." "That internal force, which dissolves the bonds of chemical affinity, and prevents the elements of bodies from freely uniting, we call vital." But in a note to the allegory above mentioned, added to the third edition of the Views of Nature, in 1849, he says: "Reflection and prolonged study in the departments of physiology and chemistry have deeply shaken my earlier belief in peculiar so-called vital forces. In the year 1797, * * * I already declared that I by no means regarded the existence of these peculiar vital forces as established." And again: "The difficulty of satisfactorily referring the vital phenomena of the organism to physical and chemical laws depends chiefly (and almost in the same manner as the prediction of meteorological processes in the atmosphere) on the complication of the phenomena, and on the great number of the simultaneously acting forces, as well as the conditions of their activity."

3 Compare Henry Bence Jones, Croonian Lectures on Matter and Force. London, 1868, John Churchill & Sons.

4 Ib, Preface, p. vi.

5 RANKINE, W. J. M., Philosophical Magazine, Feb. 1853. Also Edinburgh Philosophical Journal, July, 1855,

6 ARMSTRONG, Sir WM. In his address as President of the British Association for the Advancement of Science. Rep. Brit. Assoc., 1863, li.

7 GROVE, W. R., in 1842. Compare "Nature" i, 335, Jan. 27, 1870. Also Appleton's Journal, iii, 324, March 19, 1870.

8 Id., in Preface to The Correlation of Physical Forces, 4th ed. Reprinted in the Correlation and Conservation of Forces; edited by E. L. Youmans, p. 7. New York, 1865, D. Appleton & Co.

9 Id., ib., Am. ed., p., 33 et seq.

10 JOULE, J. P., Philosophical Transactions, 1850, p. 61.

11 See American Journal of Science, II, xxxvii, 296, 1864.

12 The work (W) done by a moving body is commonly expressed by the formula $W=MV^2$, in which M, or the mass of the body, is equal to $\frac{w}{2g}$; *i. e.*, to the weight divided by twice the intensity of gravity. The work done by our cannon-ball then, would be $\frac{1\times(1100)^2}{2\times64\frac{1}{3}}=9,404{\cdot}14$ foot-tons. If, further, we assume the resisting body to be of such a character as to bring the ball to rest in moving $\frac{1}{4}$ of an inch, then the final pressure would be $9,404{\cdot}14\times12\times4=451,398{\cdot}7$ tons. But since, "in the case of a perfectly elastic body, or of a resistance proportional to the advance of the centre of gravity of the impinging body from the point at which contact first takes place, the final pressure (provided the body struck is perfectly rigid) is double what would occur were the stoppage to occur at the end of a corresponding advance against a uniform resistance," this result must be multiplied by two; and we get $(451,398{\cdot}7\times2)=902,797$ tons as the crushing pressure of the ball under these conditions. [The author's thanks are due to his friends Pres. F. A. P. Barnard and Mr. J. J. Skinner for suggestions on the relation of impact to statical pressure.]

13 The unit of impact being that given by a body weighing one pound and moving one foot a second, the impact of such a body falling from a height of 772 feet—the velocity acquired being $222\frac{1}{4}$ feet per second $(=\sqrt{2sg})$—would be $1\times(222\frac{1}{4})^2=49,408$ units, the equivalent in impact of one heat-unit. A cannon ball weighing 1000 lbs. and moving 1100 feet a second would have an impact of $(1100)^2\times1000=1,210,000,000$ units, Dividing this by 49,408, the quotient is 24489 heat-units, the epuivalent of the impact. The specific heat of iron being ·1138, this amount of heat wonld raise the temperature of one pound of iron 215,-191°F., $(24,489\times{\cdot}1138)$ or of 1000 pounds of iron 215° F. 24489 pounds of water heated one degree, is equal to $136\frac{1}{2}$ pounds, or 17 gallons U. S., heated 180 degrees; *i. e.*, from 32° to 212° F.

14 Assuming the density of the earth to be 5·5, its weight would be 6,500,000,000,000,000,000,000 tons, and its impact—by the formula given above — would be 1,025,000,000,000,000,000,000,000,000,000 foot-tons.

Making the same supposition as in the case of our cannon-ball, the final pressure would be that here stated.

15 TYNDALL, J, Heat considered as a mode of Motion, Am. ed., p. 57, New York, 1863.

16 RANKINE (The Steam Engine and other prime Movers, London, 1866) gives the efficiency of Steam-engines as from 1-15th to 1-20th of the heat of the fuel.

ARMSTRONG, Sir WM., places this efficiency at 1-10th as the maximum In practice, the average result is only 1-30th. Rep. Brit. Assoc., 1863, p. liv.

HELMHOLTZ, H. L. F., says; "The best expansive engines give back as mechanical work only eighteen per cent. of the heat generated by the fuel." Interaction of Natural Forces, in Correlation and Conservation of Forces, p. 227.

17 THOMSEN, JULIUS, Poggendorff's Annalen, cxxv, 348, Also in abstract in Am. J. Sci., II, xli, 396, May, 1866.

18 American Journal of Science, II, xli. 214, March, 1866.

19 In this calculation the annual evaporation from the ocean is assumed to be about 9 feet. (See Dr. BUIST, quoted in Maury's Phys. Geography of the Sea, New York, 1861, p. 11.) Calling the water-area of our globe 150,000,000 square miles, the total evaporation in tons per minute, would be that here given. Inasmuch as 30,000 pounds raised one foot high is a horse-power, the number of horse-powers necessary to raise this quantity of water 3½ miles in one minute is 2,757,000,000,000. This amount of energy is precisely that set free again when this water falls as rain.

20 Compare ODLING, WM., Lectures on Animal Chemistry, London, 1866, "In broad antagonism to the doctrines which only a few years back were regarded as indisputable, we now find that the chemist, like the plant, is capable of producing from carbonic acid and water a whole host of organic bodies, and we see no reason to question his ultimate ability to reproduce all animal and vegetable principles whatsoever." (p. 58.)

"Already hundreds of organic principles have been built up from their constituent elements, and there is now no reason to doubt our capability of producing all organic principles whatsoever in a similar manner." (p, 52.)

Dr. Odling is the successor of Faraday as Fullerian Professor of Chemistry in the Royal Institution of Great Britian,

21 MARSHALL, JOHN, Outlines of Physiology, American Edition, 1868, p. 916.

22 FRANKLAND, EDWARD, On the Source of Muscular Power, Proc, Roy. Inst., June 8, 1866; Am. J. Science, II, xlii, 393, Nov. 1866.

23 LIEBIG, JUSTUS VON, Die organische Chemie in ihrer Anwendung auf Physiologie und Pathologie, Braunschweig, 1842. Also in his

Animal Chemistry, edition of 1852 (Am. ed. p. 26), where he says "Every motion increases the amount of organised tissue which undergoes metamorphosis."

24 Compare DRAPER, JOHN WM., Human Physiology.

PLAYFAIR LYON, On the Food of Man in relation to his useful work Edinburgh, 1865. Proc. Roy. Inst., April 28, 1865.

RANKE, Tetanus eine Physiologische Studie, Leipzig, 1865.

ODLING, *op. cit.*

25 VOIT, E., Untersuchungen über den Einfluss des Kochsalzes, des Kaffees, und der Muskelbewegungen auf den Stoffwechsel, Munich, 1860.

SMITH, E., Philosophical Transactions, 1861, 747.

FICK, A., and WISLICENUS, J., Phil. Mag., IV, xxi, 485.

FRANKLAND, E., *loc. cit.*

NOYES, T. R., American Journal Medical Sciences, Oct., 1867.

PARKES, E. A, Proceedings Royal Society, xv, 339, ; xvi, 44.

26 SMITH, EDWARD, Philosophical Transactions, 1859, 709.

27 Authorities differ as to the amount of energy converted by the steam-engine. (See Note 16.) Compare MARSHALL, *op. cit.*, p. 918. "Whilst, therefore, in an engine one-twentieth part only of the fuel consumed is utilized as mechanical power, one-fifth of the food absorbed by man is so appropriated."

28 HEIDENHAIN, Mechanische Leistung Wärmeentwickelung und Stoffumsatz bei der Muskelthätigkeit, Breslau, 1864.

See also HAUGHTON SAMUEL, on the Relation of Food to Work, published in "Medicine in Modern Times," London, 1869, Macmillan & Co.

29 HEIDENHAIN, *op. cit.* Also by FICK, Untersuchungen über Muskelorbeit, Basel, 1867. Compare also "Nature," i, 159, Dec. 9, 1969.

30 DU BOIS-RAYMOND, EMIL, On the time required for the transmission of volition and sensation through the nerves, Proc. Roy. Inst. Also in Appendix to Bence Jones's Croonian lectures.

31 MARSHALL, *op. cit.*, p. 227.

32 MELLONI, Ann. Ch. Phys., xlviii, 198.

See also NOBILI, Bibl. Univ., xliv, 225, 1830; lvii, 1, 1834.

33 The apparatus employed is illustrated and fully described in Brown-Sequard's Archives de Physiologie, i, 498, June, 1868. By it the 1-4000th of a degree Centigrade may be indicated.

34 LOMBARD, J. S., New York Medical Journal, v. 198, June, 1867. [A part of these facts were communicated to me directly by their discoverer.]

35 WOOD, L. H., On the influence of Mental Activity on the Excretion of Phosphoric Acid by the Kidneys. Proceedings Connecticut Medical Society for 1869, p. 197.

36 On this question of vital force, see LIEBIG, Animal Chemistry. "The increase of mass in a plant is determined by the occurrence of a decomposition which takes place in certain parts of the plant under the influence of light and heat."

"The modern science of Physiology has left the track of Aristotle. To the eternal advantage of science, and to the benefit of mankind it no longer invents a *horror vacui*, a *quinta essentia*, in order to furnish credulous hearers with solutions and explanations of phenomena, whose true connection with others, whose ultimate cause is still unknown."

"All the parts of the animal body are produced from a peculiar fluid circulating in its organism, by virtue of an influence residing in every cell, in every organ, or part of an organ."

"Physiology has sufficiently decisive grounds for the opinion that every motion, every manifestation of force, is the result of a transformation of the structure or of its substance; that every conception, every mental affection, is followed by changes in the chemical nature of the secreted fluids; that every thought, every sensation is accompanied by a change in the composition of the substance of the brain."

"All vital activity arises from the mutual action of the oxygen of the atmosphere and the elements of food."

"As, in the closed galvanic circuit, in consequence of certain changes which an inorganic body, a metal, undergoes, when placed in contact with an acid, a certain something becomes cognizable by our senses, which we call a current of electricity; so in the animal body, in consequence of transformations and changes undergone by matter previously constituting a part of the organism, certain phenonamena of motion and activity are perceived, and these we call life or vitality."

"In the animal body we recognise as the ultimate cause of all force only one cause, the chemical action which the elements of the food and the oxygen of the air mutually exercise on each other. The only known ultimate cause of vital force, either in animals or in plants, is a chemical process."

"If we consider the force which determines the vital phenomena as a property of certain substances, this view leads of itself to a new and more rigorous consideration of certain singular phenomena, which these very substances exhibit, in circumstances in which they no longer make a part of living organisms."

Also OWEN, RICHARD, (Derivative Hypothesis of Life and Species, forming the 40th chapter of his Anatomy of Vertebrates, republished in Am. J. Sci. II, xlvii, 33, Jan. 1869.) In the endeavour to clearly comprehend and explain the functions of the combination of forces called 'brain,' the physiologist is hindered and troubled by the views of the nature of those cerebral forces which the needs of dogmatic theology have imposed on mankind." * * "Religion pure and undefiled, can best answer how far it is righteous or just to charge a neighbour with being unsound in his principles who holds the term 'life' to be a sound expressing the sum of living phenomena; and who maintains these phenomena to be modes of force into which other forms of force have passed, from potential to active states, and reciprocally, through the agency of these sums or combinations of forces impressing the mind with the ideas signified by the terms 'monad,' 'moss,' 'plant,' or 'animal.'"

And HUXLEY, THOMAS H., "On the Physical Basis of Life." University Series, No. 1. College Courant, 1870.

Per contra, see the Address of Dr. F. A. P. Barnard, as retiring President, before the Am. Assoc. for the Advancement of Science, Chicago meeting, August, 1868. "Thought cannot be a physical force, because thought admits of no measure."

GOULD, BENJ. APTHORP, Address as retiring President, before the American Association at its Salem meeting, Aug., 1869.

BEALE, LIONEL S., "Protoplasm, or Life, Matter, and Mind." London, 1870. John Churchill & Sons.

37 For an excellent account of this distinguished man, see Youmans' Introduction to the Correlation and Conservation of Forces, p. xvii.

38 DRAPER, J. W., *loc. cit.*

39 HENRY, JOSEPH, Agric. Rep. Patent Office, 1857, 440.

40 WATTERS, J. H., an Essay on Organic or Life-force. Written for the degree of Doctor of Medicine in the University of Pennsylvania, Philadelphia, 1851. See also St. Louis Medical and Surgical Journal, II, v, Nos. 3 and 4, 1868, Dec., 1868, and Nov., 10, 1869.

41 LECONTE, JOSEPH, The Correlation of Physical, Chemical, and Vital Force, and the Conservation of Force in Vital Phenomena. Amer. Journal of Science, II, xxviii, 305, Nov. 1859.

42 LOMARBD, J. S. *loc. cit.*

43 NOYES, T. R., *loc. cit.*

44 WOOD, L. H., *loc. cit.*

NATURAL HISTORY SOCIETY, MONTREAL.

MONTHLY MEETINGS FOR THE SESSION 1870-71.

First Monthly Meeting, October 31st, 1870, the President, Principal Dawson, in the chair.

The following donations were announced and exhibited:

TO THE LIBRARY.

Hooker's Himalayan Journals, 2 vols., illustrated; and Gould's Monograph of the Partridges of North America, with 32 colored plates, of life size. Both from Major G. E. Bulger F.L.S., F.R.G.S., &c.

Catalogue of Fishes, vol. 8. From the Trustees of the British Museum.

TO THE MUSEUM.

Pair of Eider Ducks, one Black-backed Gull, and one Red-breasted Merganser, from Labrador. Presented by W. D. B. Scott, Esq. Twenty-three species of Fossils from the United States; from Principal Dawson.

A series of seventeen specimens of English Game Birds; from A. Jewitt, Esq., of Manchester, England.

Seven rare birds from British India; also a series of East Indian woods, seeds, and miscellaneous objects. From Major G. E. Bulger, F.L.S., F.R.G.S., &c.

One Snowy Heron, one Raven, and one Buffon's Skua, also an extensive series of North American birds; from the Smithsonian Institute, Washington.

PROCEEDINGS.

Mr. A. S. Ritchie read a paper entitled Aquaria Studies, part 2nd, which will be found at pages 165-171 of the present volume.

Mr. Billings then made a communication on the bones of a Whale lately discovered at Cornwall, Ont., of which the following is an abstract kindly furnished by the author:

" Several months ago, Mr. Charles Poole, of Cornwall, wrote to the Secretary of the Society that a large skeleton, resembling that of an Icthyosaurus, had been found in that neighborhood, by the men engaged in excavating clay for brick. In another letter he stated that Mr. T. S. Scott, architect, of this city, had procured the lower jaws. On receipt of this information, Mr. Billings called upon Mr. Scott, who very liberally presented the jaws to the Geological Museum. Mr. Billings then went up to Cornwall, and obtained from Mr. Poole the bones which were in his possession. These were discovered in the Post-pliocene clay about sixteen feet below the surface. They are those of a small whale closely allied to the White Whale, *Beluga leucas*, which lives in the Northern seas, and at certain seasons abounds in the Gulf and lower parts of the St. Lawrence. The lower jaws are nearly perfect. The skull and upper jaws are much damaged and some of the parts lost. Thirty-five of the vertebræ, the two shoulder blades, most of the ribs, and a number of small bones were collected. The length of the animal was probably about fifteen feet. The lower jaws have the sockets of eight teeth upon the right side and of seven on the left. The number of teeth in the upper jaw could not be ascertained. In the head of a White Whale belonging to the cabinet of McGill College, there are nine teeth in the right lower-jaw and eight in the left. The teeth of the fossil, judging from the size of the sockets, were longer than those of the White Whale. In 1849 a small whale was discovered in Vermont about twelve miles south of Burlington, in a railway cutting through a deposit of clay of the same formation as that of Cornwall. Judging from the figures and description published in Silliman's Journal by the late Professor Thompson, there can be little doubt that ours is the same species as the one described by him under the name *Beluga Vermontana.* Another specimen consistig of about half of the back bone was discovered several years ago near the city of Montreal, and is now in the Museum of the Geological Survey. The Cornwall locality is about half a mile from the railway station, sixty feet above the St. Lawrence, and over two hundred feet above the level of the sea."

A paper on Canadian Diatomaceæ, by W. Osler, was then read by the Recording Secretary. This will be found at page 142.

The President, in inviting a discussion on the phenomena observed during the recent earthquake, said that there were records published or preserved of the appearances observed during 83 earthquakes in Canada, and neighbouring parts of N. America. A severe shock was felt in Canada in 1860, an account of which might be found in the Canadian Naturalist for that year. Many of the phenomena noticed in 1870 were observed in the shock of 1860. Judging from the facts on record, there would seem to be a periodicity in earthquakes. They seem to occur much oftener in autumn and winter than in spring or summer and between the 60th or 70th years of a century. On this ground he had stated that the shock of this year might prove to be the beginning of a series, if the law of periodicity holds good. A slight shock was however felt in Canada in the spring of 1864. The President next referring to the causes which produce earthquakes, said that here there are no centres of active igneous agencies as in Southern Italy and elsewhere. He suggested the idea that large masses of sediment are drained off by rivers from this continent and deposited on the Atlantic coast, and when, in addition to this, a pressure amounting to many millions of tons of atmospheric air is removed from the denuded portion, vibrations occur from long continued tension of the earth's crust, and finally a break takes place. It was found that during the last earthquake, the mercury in the barometer was an inch lower than the average.

Dr. Smallwood gave a description of peculiar phenomena observed in the heavens before and after the earthquake. Among these were noticed several clusters of spots on the sun's disc in connection with peculiar auroral displays. He exhibited diagrams shewing the barometrical and thermometrical appearances presented before and during the shock. During the continuance of the vibration the descent of the mercury was most marked in this respect, confirming Dr. Dawson's view. From telegrams received by the courtesy of Mr. Dakers it would appear that the first shock was observed at Owen Sound, at 10.52 a. m. local time, and the latest at St. John's, N. B., at 11.45 a. m. local time. Accounts were received also from Toronto, Montreal, Quebec, and intermediate places. Judging from the telegrams received, the extent of the vibration thus recorded would appear to have been from S. W. to N. E., and the shock to have occupied fifty-three minutes of time in traversing the 840 miles, without calculating for the difference of longtitude between the places. This would give a rate of about sixteen miles per minute, but if the differences of longtitude were calculated, the rate would be about thirty-two miles per minute. This last estimate agrees nearly with that given by Humbolt and Mallet. The width or amplitude of the vibration, judging only by telegrams received by the speaker would appear to have been some 340 miles. After remarks by several members, the meeting adjourned.

2nd Monthly Meeting, held November 28th, 1870, Principal Dawson in the chair. Messrs. G. T. Kennedy, B. A. and M. H. Brissette were elected members of the Society. Mr. Gordon Broome, F. G. S., read a paper on Canadian Phosphates with special reference to their economic value. The essay will be found at pages 241–163 of the present volume.

At the conclusion of the paper, Dr. Hunt, Mr. Macfarlane and Dr. Dawson made comments upon the subject.

Dr. Hunt read a paper by Mr. Kinahan, of the Irish Geological Survey, on the Origin of Granite. A paper on Foraminifera from the River and Gulf of St. Lawrence, by G. M. Dawson, was presented by the Secretary. Dr. Smallwood read one on the coming eclipse, and Dr. Dawson made some remarks upon the recent earthquake.

Dr. Hunt, Vice-President of the Society then referred in a feeling manner to the loss sustained by science in Canada, and by the members of the Natural History Society in particular, by the death of Mr. Hartley, late of the Geological Survey, who, though only twenty-three years of age, was one of the most promising young men in the country; he moved, seconded by Dr. Smallwood, the following resolution :

Whereas—In the death of Mr. Edward Hartley, this Society has lost a member, who although young had by his remarkable attainments, his zeal in study and his untiring industry and devotion to scientific pursuits, given promise of great usefulness, and of eminence in the career which he had chosen,

Resolved therefore—That the members of the Natural History Society, of Montreal, hereby testify their deep sorrow at his early death, and tender their warmest expressions of sympathy and condolence to his afflicted parents.

3rd. Monthly meeting, held Decr. 19th, 1871, the President (Principal Dawson) in the chair.

After the minutes of the previous meeting had been read and confirmed, the President alluded to the loss the society had sustained by the death of the Chairman of its Council, Mr. A. S. Ritchie, and called on the Secretary (Mr. Whiteaves) to read an obituary notice which he had prepared, as follows.

" The late Mr. A. S. Ritchie, whose loss we have so much reason to deplore, was born at Pittenweem, a small town on the coast of Fifeshire. His father, Mr. Robert Ritchie, was a magistrate of that place. Accompanied by his cousin, Mr. David Ritchie, who now resides in Brantford, Ont., he left Scotland for Canada, in 1853. He remained in Montreal one year, during which time he was in the employ of Messrs. Morrison, Cameron & Empey. He then removed to Brantford, where he resided several years, and where he appears to have been very highly respected. Finally, he returned to Montreal in 1860 or 1861. where he remained until the time of his death. In the month of May, 1864, he was elected a member of this Society, and from May, 1866, to the present year, he was, as many here well know, an active member of the Council, of which, in 1867 and the present year, he was unanimously elected chairman. He was also a member of the editing committee of the Canadian Naturalist. During the six years of his connection with this Society, he brought before us seven papers, six of which are printed in the Naturalist.

The following are the titles of the papers, and the dates at which they were read.

March, 1865.—On the structure of insects, illustrated by microscopical preparations.

March, 1866.—On the "Walking Stick" Insect, *Spectrum femoratum.*

Nov. 1868.—On the Beetles of the Island of Montreal.

Oct. 1869.—On the White Cabbage Butterfly, *Pieris rapæ.*

Feb. 1870.—Why are insects attracted to Artificial lights.

April 1870.—Aquaria Studies, No. 1.

Oct. 1870.— do do No. 2.

His favourite study was entomology, and this he pursued in a philosophic spirit, studying the habits of insects in their native haunts by day, and examining the details of their anatomy under the microscope at night. He was also well acquainted with other departments of Zoology, especially with the infusoria. A little before his decease he was preparing a lecture, "On the Inhabitants of a drop of water" for the young men connected with Erskine Church, and for this Society, a paper on a curious ichneumon parasite of the white cabbage butterfly. He died on the 13th December, 1870, at the early age of 34.

Rev. A. De Sola, LL.D., spoke of Mr. Ritchie, as a most enthusiastic member who had devoted all his spare time to the study of science, which it would be to the advantage of business men to cultivate, and he trusted that many others would follow his example. He moved the following resolution which was unanimously adopted.

Moved by Rev. Dr. De Sola, seconded by Mr. J. Ferrier, and

Resolved—That this Society would desire to express its sincere sympathy with the widow of the late Alexander S. Ritchie, Esq., in her bereavement, and also thus publicly to state their high estimation of the value of the services of Mr. Ritchie to the Society as one of its most indefatigable members, and a contributor of interesting and valuable papers to its meetings and journal, and more recently as the chairman of its Council.

That this resolution be published in the proceedings of the Society, and communicated by the Secretary to Mrs. Ritchie.

Mr. Whiteaves announced the following among the recent donations to the Museum:

A large and fine series of English game birds, from Mr. Albert Jowett, of England; through Mr. Champion Brown, "Alaska and its resources," by Dall, presented by Mr. John Paiton; and from Hon. Thomas Ryan, a wooden tally.

The Secretary then read a paper by Major G. E. Bulger, F. L. S., F. R. G. S., entitled, Notes on Vegetable Productions. This will be found at page 66 of the present volume.

Professor Bell's paper on the various species of deer inhabiting the Dominion was read. This paper was illustrated by maps, showing by means of colours, the geographical distribution of the four species of deer referred to, namely, the Moose, the Wapiti, the Caribou, and the Red Deer. The author said he would not describe the characters or habits of these animals, but would refer principally to their geographical distribution, and to the necessity which exists for their better protection from destruction. The writer on the Mammals of America had not pointed out the geographical range of each species of deer with as much precision as would be desirable. The range of the Moose and the Wapiti had been greatly contracted since the settlement of the continent by white men, and since firearms had been placed in the hands of Indians. At the present time the Moose was said to be confined principally to the region between the Ottawa and the Saguenay and James' Bay, the northern part of Maine, the Gaspe Peninsula, New Brunswick and Nova Scotia; while the Wapiti is found only in the Western States and North West Territories, although at one time it ranged from the Atlantic to the Pacific, and from Canada to Virginia. The encroachments of civilization had not affected the distribution of the Caribou and Red Deer nearly as much as that of the other two species. This was owing to the circumstance that the region of the Caribou was not of such a character as to invite the white man, and in the case of the Red Deer to the fact, that they are not driven away by the settlement of the country but rather increase in numbers if afforded shelter and protection. Caribou were said to be found across the whole breadth of the continent from Canada, northward to the Arctic Ocean, while the Red Deer ranged southwards from the St. Lawrence to the Gulf of Mexico.

Mr. Bell next referred to the evils arising from the too frequent changes which are being made in the Game Laws of Ontario and Quebec, and to the still imperfect nature of these laws. It was only very recently that the practice of snaring and trapping deer by the most destructive contrivances had been put a stop to in these Provinces. Among the improvements which it would be desirable to effect in the existing Game Laws, especially in reference to deer, the author suggested the following : To shorten the open season, during the next few years at any rate ; to prevent foreigners trespassing, particularly in making a trade of hunting our deer for foreign markets ; to limit the number of deer which any one may kill in a season, even by fair means, as is said to have been done with good results in regard to Moose in Nova Scotia, or to compel hunters to take out a licence ; to prohibit the use of "jacks" and all kinds of artificial lights ; and above all, to put a stop to the barbarous and unsportsmanlike practice of driving the deer into lakes and rivers with dogs, and killing the defenceless creatures when in the water.

A proper and permanent revision of the Game Laws could be based only on a complete knowledge of the habits of the animals, and the variations of these habits, according to locality, &c., and of the various abuses and practices which it is desirable to prevent

Messrs. Marler and McKay spoke of their knowledge, for years past, of the haunts of some species of deer.

Mr. Alfred Rimmer regretted that a Bill was before the Legislature, limiting the close season to the 1st March. It was very easy to kill fawns and deer, at this season, by running them down and despatching them with clubs. Such sportsmen had aptly been called "pot-hunters." He protested against the Bill, as it would sanction a wholesalesale destruction of deer, at a season when they were not fit for food. He hoped this Society would take some action in the matter. Another alteration made in this Bill was one fixing the opening of duck shooting on the 1st August, at which time the birds were only flappers, and could not fly. He had learned that an immense business was done in duck, which were largely consumed, and if killed this way, would soon, like other birds, be extinct.

Dr. Dawson said there were three aspects to this matter ; one was the extinction of species, another was that in which this Society was most particularly concerned, the collection of information about the habits of animals, and further what would be done to protect wild animals. He suggested the appointment of a committee to enquire into the subject.

The meeting being in favour of the appointment of a Committee, Messrs. Bell, Marler and Rimmer were appointed, with power to add to their number.

Dr. Carpenter read a paper on the Natural and Unnatural History of Man. He suggested the formation of a Social Science Association, in which all the different subjects at present occupying the attention of so many societies, could be considered, and thus a saving of much valuable time could be effected. He thought a committee might be appointed to consider the subject.

Dr. Dawson believed that action on this proposal should be spontaneous, and proffered the use of the Hall of the Society for a preliminary meeting, should it be deemed advisable to have one.

Dr. De Sola was of opinion that the question of a Social Science Association required most mature deliberations, as there were so many societies now in existence.

Dr. Dawson suggested that it be referred to the Council, who could talk the matter over with any persons interested.

On motion of Mr. Ferrier, seconded by Mr. Bulmer, the subject was left to the consideration of the Council.

4th monthly meeting, held January 30th, 1871, the President in the chair.

Prof. R. Bell presented a preliminary report on behalf of the committee appointed to examine into the present state of the laws for the protection of game.

The committee was authorized to prepare the report for publication.

Mr. J. F. Whiteaves read a paper on Canadian Foraminifera. The author stated that in his dredging excursion to Gaspé in the summer of 1869 he had preserved large quantities of sand, mud, etc., obtained at various depths from ten different localities. Mr. G. M. Dawson had examined portions of six of these dredgings for Foraminifera; and the writer, with Mr. D. B. Scott, had carefully gone over the rest of the material. The species found by the writer and Mr. Scott agreed very closely with those in Mr. Dawson's published list, but some additional forms were observed. A large series of specimens was exhibited and the subject was copiously illustrated by the members of the Montreal Microscopic Club.

5th monthly meeting, held Feb. 27th, 1871, the President in the chair.

Messrs. C. McNab, John Robertson, and Scott Barlow, were elected ordinary members, and Prof. J. Wajeika, of St. Petersburgh, Russia, a corresponding member of the Society.

Principal Dawson exhibited some new specimens in Fossil Botany. The following is an abstract of his remarks on them.

The first point mentioned was the occurrence of spore-cases in the Devonian Shales of Kettle Point, Lake Huron, and in several coals. Details of this part of the communication have been already printed in this volume.

The author next referred to the discovery of specimens indicating the existence of three or four species of Tree-ferns in the Devonian of New York and Ohio. He had described last year in memoir contributed to the Royal Society of London two kinds of stems surrounded with aerial roots, which he believed to be tree-ferns. They were from the collection of Prof. Hall, of Albany. More recently he had received from Prof. Newberry of New York, a specimen collected by Rev. Mr. Lockwood from the same locality with Prof. Hall's specimens, which shewed the upper part of a stem with five leaf stocks attached to it. This he had named *Caulopteris Lockwoodi.* Three other specimens collected by Prof. Newberry in Ohio indicated the existence of three distinct species belonging to two genera. The two most important had been named by Prof. Newberry, *Caulopteris antiqua* and *Protopteris peregrina.* They are fiom the carboniferous limestone, and thus carry down tree-ferns to the bottom of the middle Devonian. One of them has the cellular structure and vascular bundles in such preservation as to show their microscopic structure, which is precisely similar to that of modern ferns. Descriptions of these plants will probably appear in the proceedings of the Geological Society of London, and in the forthcoming Report on the Geology of Ohio, by Prof. Newberry.

After the reading of the paper, Dr. T. Sterry Hunt made some remarks on the subject, and gave an interesting account of the chemical composition of spore cases, and of the cuticle and cortical layer of plants generally.

Mr. A. R. C. Selwyn, Director of the Geological Survey of Canada, read a paper "On the Occurrance of Diamonds in New South Wales," by Mr. Norman Taylor, late of the Geological Survey of Victoria, and Professor Thompson, of the University of Sydney.

The authors state that the diamond drifts are on hills above the present river bed, and are overlaid by from 30 to 40 feet of basalt. These hills greatly resemble the basaltic hills in some gold districts in Victoria. The underlying rock is Upper Silurian or Devonian, intersected by greenstone dykes, and the whole watershed to the Cudgegong Valley is carboniferous, resting in places on granite. The carboniferous rocks are full of Glossopteris, Sphenopteris, etc. The authors are of opinion that the diamonds are not of drifted origin, but that they have been formed where they are now found. There is no Itacolumite or Psammite. The works were commenced in 1869, and 6,000 diamonds have been collected in one district, extending about seven miles along the valley of the Cudgegong River, in latitude 33° south. The view of the diamond having been formed in the tertiary drift deposits coincides with the view expressed by Dr. Hartt on this subject in his recent work on the Brazils.

Dr. Hunt gave a succinct account of what is known up to the present time with regard to the geological history of the diamond. In India, Brazil, Virginia, North Carolina, Oregon and Europe, diamonds have been found, associated with other gems, and with gold, in drift deposits. He said that the original matrix of the gem was not clearly ascertained, but that he was inclined to the view that it would be found to be in the oldest geological formations, possibly in veins in granite. He stated that he had carefully examined many samples from the Chaudière gold regions, but had failed to detect diamonds in any of them.

6th ordinary monthly meeting, March 27th, 1871, Dr. Smallwood in the chair.

After the reading of the minutes of the last meeting, it was moved by G. L. Marler, seconded by A. T. Drummond, and resolved:

"That the thanks of the Society be voted to those gentlemen who kindly gave their assistance at the Annual Conversazione lately held."

Dr. R. T. Godfrey and Mr. T. C. Weston, were elected members of the Society.

Prof. E. S. Morse (of Boston, Mass.), made a communication on the structure and affinities of the Brachiopoda. Until quite recently the Brachiopoda, which have a special interest to the student of organic remains, as being by far the oldest of existing animals, were thought to be aberrant bivalve molluscs. Through the polyzoa and the tunicates, their affinities were supposed to be with ordinary bivalves, such as the oyster, mussel, cockle, or clam.

Prof. Morse has carefully examined the anatomy of several species of Brachiopoda, and has been struck with the close structural resemblance existing between them and the marine worms. The so-called hearts of the Brachiopods, according to Prof Morse, are really ovaries, and what were thought to be arteries turn out to be nerves. An elaborate account was given of the minute points in the anatomy of brachiopods and of marine worms illustrated by graphic diagrammatic sketches on the black board, and it was shown that the structural affinities of these two groups were very close. In conclusion, the lecturer stated that the brachiopods, in his judgment, should be removed from the mollusca, and grouped near to the marine worms.

Mr. Billings said that the trilobites and echinoderms of the primordial zone had a very worm-like character, and that in the Black River limestone he had obtained a specimen of Lingula, with its penduncle silicified; also a bivalve with parts of its adductor muscle preserved in the same way.

Mr. Whiteaves made some remarks on the anatomy and affinities of the Brachiopoda, and exhibited a series of rare exotic species from his own cabinet; also alcoholic preparations of the Canadian species, dredged by himself in Gaspé

Dr. Carpenter said that he had the pleasure of seeing the living Lingula which Prof. Morse had collected in South Carolina and of observing their habits, and expressed his belief that Prof. Morse's views would ultimately meet with general acceptation.

A vote of thanks to the lecturer, having been moved by Dr. Edwards, and seconded by Mr. Cotte, was unanimously adopted, after which the proceedings terminated.

7th ordinary meeting, held April 24th; the President in the chair.

The Lecture and Conversazione Committee submitted a report to the Society, of which the following is an abstract.

With reference to the conversazione, the report stated that although it had been productive of more than ordinary interest in consequence of the introduction of some new features, it had yet not proved successful pecuniarily. The price of admission had been lower than heretofore; but even at the reduced rate it was thought a different result could be attained on future occasions by a little exertion on the part of members. An enumeration of the winter course of lectures followed. They had been very successful, the lecturers being Principal Dawson, Dr. T. Sterry Hunt, Dr. J. B. Edwards, Professor Bell, Messrs. C. Robb, A. T. Drummond and Professor Goldwin Smith. The lecture of the latter gentleman had been remarkably well attended, and had resulted in an addition of $134 to the society's funds. In consequence of discussions that had arisen, the committee recommended that in future the public lectures of the society be restricted as far as possible to purely scientific subjects. The report concluded with expressions of acknowledgment to the lecturers, and to the chief contributors to the conversazione.

The following donations to the Museum were announced:

Twenty-two specimens of English birds, from Albert Jowett, Esq., of Sheffield, England.

Cast of an Indian pipe, found at Port Hope, Ont., from H. G. Vennor, Esq.

Dr. W. G. Beers was elected a member of the society.

A communication on a Mineral Silicate injecting Paleozoic Crinoids was then made by Dr. T. Sterry Hunt, F.R.S.

The author described a gray granular paleozoic limestone from New Brunswick, which had been examined by Dr. Dawson, and found to consist almost entirely of the comminuted remains of brachiopod and gasteropod shells, crustacea, and the joints and plates of crinoids, cemented with a little calcareous spar. The crinoidal remains were, however, found to have their pores filled with a peculiar silicate, which is exposed in relief when the surface of the limestone is attacked by an acid, and then appears as a congeries of small cylindrical rods or bars, anastomosing and forming a beautiful net-work which, under a magnifying glass, exhibits a frosted crystalline surface, and resembles the variety of aragonite known as *flos ferri*. This silicate, which also fills small interstices among the other calcareous fragments making up the limestone, is greenish in color, and forms about five per cent. of the rock. Though insoluble in dilute acids, it is completely decomposed by strong acids, and is found to be a hydrous silicate of ferrous oxide and alumina, with some magnesia, and a little alkali, closely allied to fahlunite and to jollyte. The results of its analysis will appear in Silliman's Journal for May.

Dr. Hunt remarked that this process of infiltration, by which the minute structure of these paleozoic crinoids has been preserved, was precisely similar to that seen in the glauconite casts of more modern foraminifera, and in the Eozoon of older times. This ancient calcareous rhizopod though most frequently preserved by serpentine, had been shown, both by himself in Canada and by Hoffmann in Bohemia, to be in some cases injected by silicates related in composition to that of these crinoids. He then proceeded to speak of the great class of silicates of which serpentine, loganite, pyrosclerite, fahlunite and jollyte are members and which are generally described as the results of pseudomorphic changes of pre-existing silicated or carbonates, but which he, since 1853, has maintained to be original aqueous depositions, similar in their origin to the related mineral glauconite; a view now adopted by such investigators as Naumann, Scheerer, Gümbel and Credner. He noted in this connection the bearing of these facts on the *Eozoon Canadense*, the organic nature of which, though almost universally admitted by zoologists and mineralogists, was nevertheless still questioned by Messrs. King and Rowney. These gentlemen object that the ancient rocks in which Eozoon is found are what are called metamorphic strata, which have been, according to them, subjected to pseudomorphic changes, and therefore the Eozoon may be the result of some unexplained plastic force, which has fashioned the serpentine and other mineral silicates into forms so like those of foraminiferal organisms as to deceive the most practiced observer. This, said Dr. Hunt, was going back to the notions of those who rather than admit that mountains had been formed beneath the sea, imagined that the fossil shells which they often contain were not the real shells of animals, but the result of some freak of nature. The argument of Messrs. King and Rowney that the Eozoon rock is a result of pseudomorphic alteration because it contains serpentine, is a begging of the question at issue, by asking us to admit that the presence of serpentine is an evidence of metamorphic change, which is denied. He then remarked that the specimens of this organic limestone, with its injected crinoids, differed from Eozoonal rock only in containing at the same time recognizable fragments of other organic remains, and in presenting in its injected portions the differences which distinguish the minute structure of a crinoid from that of a calcareous rhizopod. In conclusion, he again adverted to the views which he had long maintained as to the origin of great masses of silicated rocks by a direct process of deposition from watery solutions, in which they were formed by chemical re-actions.

Dr. Dawson spoke, confirming the observations of Dr. Hunt, which he had verified by microscopic examinations. He alluded to the structure of crinoids, which in the fossil state were generally filled with carbonate of lime, so as to obliterate their pores and to give them a highly perfect crystalline structure. The infiltrating silicate in the present case however showed, especially in delcalcified specimens, that these ancient crinoids closely resembled in their minute structure the modern forms lately studied by Dr. W. B. Carpenter and Professor Wyville Thompson, especially *Comatula*. Figures of these delcalcified specimens were exhibited and will be published. Dr. Dawson alluded farther to the process of filling up the porous calcareous skeleton of the crinoids, which was clearly shown to be prior to the cementing and consolidation of the fragmentary limestone.

A letter from Mr. John Mozer, giving an account of the discovery of tamarack (*Larix Americana*) stumps under the surface in marshes at Upper Sackville, N.B., was read by the Recording Secretary.

Principal Dawson stated that remains of submarine forests had been described by him in his Acadian Geology as occuring more than twenty feet below high-water mark on the coast of Nova and that these and Mr. Mozer's observations tended to corroborate the view that a gradual subsidence of the land had taken place and was still being effected over a considerable area in Nova Scotia and New Brunswick.

Mr. J. P. Clark exhibited and presented to the Society a series of engravings of incised rocks found in Northumberland and Argyleshire. A discussion ensued as to the meaning of the markings figured in the drawings. Some members thought they were intended to commemorate funeral rites, or other religious ceremonies; others thought they were ground plans of villages or camps.

Public Lectures.

The following is a list of the Somerville lectures, with the names of the authors and the dates at which the lectures were delivered.

1. Jan. 19th, 1871. On the Primordial Period in Geology. By Principal Dawson, LL.D., F.R.S.

2. Feb. 2nd, 1871. On Astronomy and Geology. By Dr. T. Sterry Hunt, F.R.S.

3. Feb. 16th., 1871. On Applied Science, illustrated in the manufacture of Glass. By Dr. J. B. Edwards, F.C.S.

4. Feb. 23rd, 1871. On the wonders of the Glacial Period. By Prof. R. Bell, F.S.G.

5. March 2nd, 1871. On Tides and Currents, especially on the Acadian Coast. By C. Robb, C.E.

6. March 16th, 1871. Sketches of Plant life in Canada. By A. T. Drummond, B.A., LL.B.

7. March 23rd, 1871. On the Thirty Years War. By Prof. Goldwin Smith.

Annual Conversazione.

The 9th Annual Conversazione was held at the Rooms on Thursday evening, March 9th, 1871. The Committee had decided to make exhibition of as large a series of specimens illustrative of Canadian and aboriginal antiquities as could be brought together, the special feature of the evening.

The proceedings commenced with an address by the President, Principal Dawson, LL.D., F.R.S., which we subjoin.

The President's Address.

Ladies and Gentlemen,—The ordinary work of this Society is of a very unobtrusive character. It seeks to keep alive in the community a taste for the study of nature; to record and illustrate new facts as to the natural history and resources of Canada; to provide a place of safe keeping for such objects as appear of any value to the progress of science; and to afford in its museum and lectures the means of pleasant and profitable recreation and improvement to all classes of our citizens. Once a year only we open our rooms to this annual conversazione, and it affords me much pleasure on the ninth of these occasions to welcome here so large an assemblage of our friends, who, we hope, will enjoy with us the present improved aspect of our collections, and the special attractions which we have gathered for this evening.

On the present occasion we have made a special effort to collect as many objects as possible in illustration of the arts and antiquities of the aboriginal tribes of Canada, and I cannot conceive a collection more fitted to interest any thoughtful mind than that now before us. You have here the specimens accumulated by the Society; considerable collections from the museum of McGill College; collections made by the Numismatic and Antiquarian Society; a selection of very interesting objects kindly lent to us by the Principal of Queen's College, Kingston; a number of antique implements from the Geological Survey; plates illustrating American antiquities from the library of the Seminary; and a variety of objects of interest exhibited by Mr. Barnston, Mr. Vennor, Mr. Whiteaves, Mr. Murphy, Prof. Bell, Mr. Bagg, Mr. Mott, and other members of this Society.

These objects are not only curious as illustrations of the rude but often ingenious and tasteful arts of a primitive people, but some of them are relics of tribes which have passed away. Among these none have greater interest than those which represent the ancient Hochelaga of Cartier, the predecessor of our modern Montreal, and of which many memorials have been found in the excavations for the foundation of our modern city. In one case you see specimens of the pottery of these people arranged in accordance with its patterns, on which the Indian women of the olden time bestowed so much skill and taste. In my own collections I have from the ancient site fragments which represent 165 distinct vessels; and the patterns worked on these may be arranged under the heads of the "corn-ear" pattern representing the rows of grain in the ear of corn; the "basket-pattern;" the "ring" or bead pattern, usually combined with the last, and the simpler "crimped" pattern. With this you may see a few specimens of ancient British pottery, which, in material and style, might have been formed by the same artists, and on which the old potters made ornamental marks, by impressing the points of their fingers on the clay, exactly in the manner of our old potters of Montreal.

You will also find, besides our collections of stone implements of this country, others from the British Islands, and proving the absolute identity of the primitive weapons and tools of these widely-separated regions. Perhaps, however, nothing in the curiosities exhibited this evening is more worthy of interest than some of the smaller objects, especially the beads of wampum. Beads are ancient and universal ornaments, and among many rude nations they exist also as currency, and as public records and pledges of treaties. I believe we have the earliest instance of them in that strange and archaic passage of Genesis describing the Edenic Paradise, in which it is said of the Land of Havilah, that it has "gold and bdellium and the onyx stone," an expression which might fairly be read "gold, and wampum shells, and flints or implements"—the three great treasures of aboriginal man. In the collections before you there are several forms of these ornaments. Some are spiral shells, with a hole ground in one side. Such beads are common to various parts of Europe and America, and they constituted the wampum of several tribes of this country. Others are laboriously ground out of larger shells. Some on our tables, from Newfoundland, are made of the large *Mactra solidissima* Others from NewBrunswick are made of the white and blue portions of the coast wampum shell, the *Venus mercenaria*; and one from the old Hochelaga, an ornament of some dusky belle of Montreal three or four hundred years ago, is made of the hinge of a fresh-water mussel. Others from the same site are discs of clay, crimped on the edges, and burned in the fire. Others, from Ontario, have been hammered out of native copper. A string from Brockville presents a curious example of the transmission of objects of value from place to place, and of the way in which even rude peoples make distant regions tributary to their tastes. It consists partly of copper beads from Lake Superior, and partly of shells of *Purpura lapillus* from the Atlantic coast, localities which must have been the very ends of the earth to the chief who possessed these precious ornaments. Some beads from the river Tobique, New Brunswick, in one of our cases, were taken from the grave of an Indian child, buried in those forest solitudes by some bereaved mother, who expressed her grief, and perhaps her hopes and fears as to the welfare of her darling in the spirit land, by winding around its little corpse her precious strings of wampum, which, to her simple faith, had, perhaps, some value even on that unknown shore. Her gift was not wholly in vain. It reminds us to-night of that light of nature by which the invisible things of God and of a future life are manifested even to the rude children of the forest; of the future tribunal before which we and the poor Indian must alike stand, to be judged according to that which was given to us; and of those common affections and hopes and fears, which prove the kinship of man in all times and conditions.

But I shall not turn this address of welcome into a lecture; and I must now invite you to inspect for yourselves the treasures which we have collected, and some of the more minute of which Dr. Edwards has kindly consented to exhibit with the lime-light. I may also commend to your attention the objects which the members of the Microscopic Club are prepared to exhibit in the

Library; and have merely, in conclusion, to express in your presence the thanks of the Society to those who have contributed from their collections to the entertainment of this evening; and our acknowledgment to the committee who have superintended the arrangements; and more especially to Dr. De Sola, Mr. Shelton, Dr. Smallwood, and Mr. Bagg, who have been especially active in the matter.

During the evening Dr. J. Baker Edwards gave illustrations of coins and antiquities, also of various microscopical preparations, by the lime-light. The members of the Montreal Microscopic Club exhibited a large series of specimens of insect structure, some good music was provided, and the Society's museum was thrown open as usual.

A large and interesting series of Canadian and aboriginal antiquities was collected, probably the most extensive one ever brought together in Montreal. We give a condensed list of the objects exhibited, with the names of the contributors.

The Numismatic Antiquarian Society exhibited an interesting collection of medals and coins, amongst which may be mentioned a series of medals connected with the history of Canada.

1. Medal to commemorate the defeat of Sir William Phipps in 1690. " Francia in novo orbe victrix. Kebeca Liberata" Struck in Paris by order of the King, Louis XIV.

2. Foundation of Louisburg 1720. Struck in Paris by Louis XV.

3. Brass Medal. Laureated Bust of George II. Reverse Shield bearing an inverted *fleur de lis* and inscribed with names of Battles and Commanders, 1759.

4. Bronze. Capture of Quebec " Quebec taken 1759" " Saunders, Wolfe."

5. Capture of Montreal "Conquest of Canada completed, 1760."

6. Large Silver Medal. George III. (young head)). Reverse, a Lion (England) and a Wolf (France); probably struck at the cession of Canada, about 1760, for distribution to the Indian chiefs.

7. Large Silver Medal. George III. (old head) 1814, for distribution amongst the Indian Chiefs at the close of the war between England and the United States. This medal weighs 4¼ ounces.

8. Bronze. Treaty of Ghent, December 24th, 1814. Figure of Peace with olive branch and cornucopia. Legend " On earth peace, good will to men."

Also, a complete collection (so far as known) of the Educational Medals of Canada.

In miscellaneous medals may be recorded a large one in silver commemorative of the Acquittal of the seven Bishops (temp. James II); a copy of the Medal struck by order of the Parliament after the Battle of Dunbar; and a copy in bronze of the Gold Medal struck by the U. S. Congress for presentation to Mr. Cyrus Field on the completion of the Atlantic Cable.

A Castorland Half Dollar, 1796. "Franco Americana Colonia." Reverse "Salve magna parens frugum." Figure of plenty, with cornucopia and maple tree tapped with sugar pan.

Fac simile of a Medal (Photograph) to commemorate the great fire at Montreal, May 1765. The only known record of this medal was discovered in the Parliamentary Library at Ottawa.

Communion Token of the first Protestant Church in Montreal Rev. James Somerville, minister.

The Canadian series of coins was probably the finest and most complete ever exhibited; and the general series was large and beautiful, from the fact, that in addition to the best specimens from the collection of the Numismatic Society, several members of the Society, had lent for the occasion the finest and most interesting pieces, from their private cabinets.

The following relics of Indian manufacture were exhibited by Principal Dawson:—Several stone hammers, round polishers or grinding stones, gouges, axes, chisels, flint knives and arrow heads; a tray of flint chips from the manufacture of arrows, etc.; stone hammers, flint arrows and porcelain beads, from Nova Scotia; Wampum, and ivory implements made from walrus' teeth, and clay beads, from New Brunswick; flint arrow-heads from Maryland, United States, for comparison. Besides the above, there were also various bone implements, from the supposed site of the ancient Indian village of Hochelaga, in Montreal, consisting of skewers or borers, and a portion of a human skull, probably used as a scoop, or drinking vessel; a series of fragments of Indian pottery of various styles, showing the corn, basket, ring, pitted, and rim patterns; also examples of clay pipes and beads; and charred specimens of corn, beans, and acorns from the same place.

The following is a list of objects, kindly lent by Principal Snodgrass, from the collection of Queen's College, Kingston:—Six stone scrapers, of different shapes and sizes; one grooved axe; one gouge; three large spear heads; one large and two small stone arrow heads; one round pointed arrow head; one hair supporter; two carved pipe bowls; one semicircular concavely cut stone; three copper ornaments; five large and twenty small copper beads. A fine series of aboriginal stone implements was sent by the officers of the Geological Survey. Mr. E. Murphy contributed a number of objects, dug up nearly opposite Prince of Wales Terrace, Sherbrooke street, as follows:—Twenty-five specimens of pottery; five pipes, and six pipe stems; one figure of a human head, in baked clay; one stone hatchet; jaw and tooth of beaver; fragment of human skull; one iron nail and a knife blade, and ten bone implements of various kinds. He also sent a number of curious Irish manuscripts. Mr. G. Barnston exhibited a number of Esquimaux and other Indian objects of interest. Among them were two dressers, or leather coats, of a Blackfoot chief and of a Niscawpie Indian; a Blackfoot bow and arrows; a Red River hunter's horn and shot bag, with beaded belts and leggings; an Esquimaux dog whip; three pronged dart or harpoon and socket; small model fish kettle in serpentine; walrus: ivory comb; pickers; ornaments, such as necklaces and ear pendants, and needle cases; range of snares of whalebone for taking ptarmigan, etc., etc. Messrs. Smith & Co. sent three very old musical instruments—two violins and a violincello—which were used in the convent choir of the nuns of the General Hospital, Quebec, before the appearance of pianos or organs in the New World, and which bear date 1720, 1734, 1743. Numerous specimens of Indian work and aboriginal and other antiquities, were exhibited by Prof. Bell, and Messrs. Vennor, Bagg, Whiteaves and others. The Gentlemen of the Seminary sent a volume of plates illustrating the travels in North America of the late unfortunate Prince Maximilian.

Among the more miscellaneous objects exhibited, Mr. Laggatt contributed a case of fine native minerals, and Mr. Passmore lent a series of rare Canadian mammals and birds, among the last were specimens of the duck-hawk, American avocet, marbled godwit, and American swan.

MISCELLANEOUS.

Deep Sea Explorations.—In the Report before us* are given the preliminary proceedings and equipment, the narrative of the three cruises performed during 1869, the general results so far as they relate to Physics and Chemistry, and, in an appendix, a summary of the observations upon, and analysis of, samples of sea water and deep sea bottom collected during the cruise. Passing over the first portion for the sake of brevity, (though there is much, especially in the description of the equipment, to interest all naturalists), we learn that the Porcupine, with Mr. Jeffrey's and Mr. W. B. Carpenter on board, left Woolwich, May 18th, and after coaling at Galway, on the west coast of Ireland, cauised, dredging at intervals, to the southward and westward. The greatest depth reached was 808 fathoms and an essentially northern fauna was discovered throughout. Among the collections, were *Nucula pumila*, *Verticordia abyssicola*, "*Fusus*" n.sp. like "*F.*" *Sabinii*, *Phakellia ventilabrum*, *Gonoplax rhomboides*, *Ebalia* n.sp., *Ethusa* n.sp, *Geryon tridens* and many small crustaceans. The next dredgings were taken in a line eleven degrees of longitude due west from Galway, and reached a depth of 1230 fathoms. All the mollusca except *Aporrhais Serresianus* were northern (the temperature of the bottom being 37° 8 Fahr.); several new species and two new genera of the family *Arcidæ* were found, as well as *Trochus minutissimus* Mighels (which has two conspicuous eyes), a species of *Ampelisca*, an eyed crustacean, and numerous gigantic foraminifera. A third trip, from Killebegs to the Rockall Bank was then made, and dredgings as deep as 1746 fathoms succeeded in obtaining an abundance of life. Among the species were an imperforate brachiopod with a septum in the lower valve, which Mr. Jeffreys calls *Atretia gnomon*, *Kelliella abyssicola* Sars, *Cumecea* n.sp., several small new crustaceans; *Pourtalesia*, probably *P. miranda*, A. Ag. and many fine foraminifera, including an *Orbitolites* of the size of a sixpence. The vessel reached Belfast at the end of her cruise on the 13th of July, 1869. The second cruise, under Prof. Wyville Thompson

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* Preliminary Report of the Scientific exploration of the Deep Sea in H. M. Surveying Vessel Porcupine, during the summer of 1869. Conducted by Dr. W. B. Carpenter, V.P.R.S., J. Gwyn Jeffreys, F.R.S., and Prof. Wyville Thompson, L.L.D,, F.R.S., (Proc. R. Soc. No. 121).

and Mr. Hunter, was undertaken for the purpose of getting a haul of the dredge in 2500 fathoms of water and thus affording a reasonable ground for belief that, if life existed at that depth, it could have no bathymetrical limits. In Lat. 47° 38 north, and Lon. 12° 08 W. Gr. a depth of 2435 fathoms was obtained, and a dredge weighing 225 lbs. was sent down with a heavy weight attached to the line five hundred fathoms from the dredge, in order to make it bite the bottom. This apparatus, attached to 3000 fathoms of line, was ten minutes in running out. When hauled in, the dredge contained 150 lbs. of pale gray ooze, containing 23 per cent. of silica, 61 per cent. of carbonate of lime, with some alumina, carbonate of magnesium, and oxide of iron. The animals brought up were, among others, *Dentalium* n.sp. (large), *Pecten fenestratus*, *Dacridium vitreum*, *Scrobicularia nitida*, *Noæra obesa*, *Anonyx Holbollii* Kroyer, *Ampelisca æquicornis* Bruzel, *Mnnna* n.sp., several annelids; *Ophiocten Kroyeri* Lutken, *Echinocucumis typica*, Sars; a stalked crinoid allied to *Rhizocrinus*; *Salicornaria*, n.sp., two fragments of a hydriod Zoöphyte; numerous foraminifera, with a branching flexible rhizopod having a chitinous cortex studded with *Globigerina*, enclosing a sarcodic medulla of olive green hue; several small sponges belonging to a new group, etc., etc. Another subsequent haul brought up a *Pleurotoma* n.sp., *Dentalium* n.sp., and *Ophiocantha spinulosa*, besides others previously mentioned. Many of the animals were brilliantly phosphorescent and the eyes in species of all classes were well developed, showing that in these abysses light of some kind must exist. The temperature at the bottom in this case was 36° 5 Fahr. against 65° 6 Fahr. at the surface.

The third cruise in charge of Dr. W. B. Carpenter, Prof. Wyville Thompson and Mr. P. Herbert Carpenter, was devoted to the exploration of the *warm* and *cold* areas which had previously been shown to exist between the north of Scotland, the Hebrides, and the Faroe Islands. Space will not admit of even a condensed exhibit of the valuable results obtained on this cruise.

The most important and valuable of the results of these dredgings, due to the great liberality of the British Government, may be succinctly stated as follows.

1. It has been practically proved that there is no limit to the existence of animal life as far as depth is concerned, and that the difference in the specific gravity of the water at the surface and

at 2500 fathoms is less than that between salt and fresh water.

2. That there is a constant interchange between the carbonic acid gas from the bottom and the oxygen at the surface, by which the animals at great depths are provided with means of respiration.

3. An abundant supply of dilute protoplasm in the water serves as food for the protozoic inhabitants of the deep sea, upon which latter the higher animals subsist.

4. A glacial *submarine* climate may exist over any area, without reference to the *terrestrial* climate of that area.

5. Cold and warm areas may exist in close juxtaposition, at great depths, and at the same time present quite distinct faunal characters.

6. The bottom, as analysed by David Forbes, F.R.S., differs essentially in composition from the chalk rock (cretaceous) of England, and no evidence whatever has accumulated to sustain the hypothesis of Dr. Carpenter that the Cretaceous period is at present progressing in the Atlantic sea-bed; indeed, that gentleman, in a late letter in "Nature" has practically abandoned this theory.

7. *Temperature* is the great agent which determines the distribution of submarine animals; a view previously maintained by many eminent naturalists and now permanently established by these, and other dredgings in the Atlantic, and by the researches of American naturalists in the North Pacific.

It is to be regretted that the views of Mr. Jeffreys in regard to the specific and generic limits of animals, differ so widely from those of the majority of modern naturalists. In the present report he unites animals belonging to different genera under the same specific name; e. g., *Waldheimia septigera* and *Terebratella septata*, and those who have had occasion to critically examine his British Conchology, find in it many similar cases. Such determinations, of course, will tend to invalidate any conclusions which may be drawn from his report, and will undoubtedly throw a certain amount of confusion upon the whole subject.—W. H. Dall, in The American Naturalist.

On Astronomy and Geology.—The following is an abstract of a Somerville lecture, bearing the above title, delivered by Dr. T. Sterry Hunt, F. R. S., in the Hall of the Natural History on the 2nd of February, 1871:—The lecturer explained the reason for coupling together celestial and terrestrial science by remarking, that astronomy had shown us that the planetary bodies are worlds like our earth. This has its astronomical history, and the others have doubtless their geological one. Having briefly defined the province of geological science, and shewed that it investigates the developement of our planet in obedience to physical, chemical and biological laws, the lecturer proceeded to argue that these laws were doubtless applicable, *mutatis mùtandis*, to the other bodies of this and other solar systems. The nebular hypothesis, which sought to explain the derivation of a solar system from the condensation of a vaporous mass, was briefly explained; and the history of the nebulæ, as made known to us by the telescope and spectroscope, was noticed. The sun is to be looked upon as a partially condensed mass of nebulous matter, in which we have by spectroscopic examination been able to detect most of the chemical elements of our own earth.

The history of cooling and condensing nebulous matter and its conversion into solid matter, like our globe, was explained: as was also the doctrine of the internal heat of the earth, and its inevitable slow refrigeration and final reduction to the temperature of the interplanetry spaces. The moon is conceived from its small size to have already reached that condition, or at least to have arrived at such a point that the air and ocean which once surrounded it had been absorbed into the cold and porous mass. The question of the probable identity of chemical and vital phenomena in other worlds than ours was then touched upon, and the history of uranolites or meteoric stones briefly noticed. It was contended that in their chemical and and mineralogical constitution we see evidence that they were found under conditions very like those of crystalline rocks of our own globe, and that we have every reason to conclude that vegetable and probably animal life played a part in the celestial bodies from which these uranolites have been derived. These matters are generally crystalline, but we shall possibly find one day among them uncrystalline sedimentary rocks, in which we may hope to find organic forms. Such materials, however, make up but a very small proportion of the mass of our planet, and have, moreover, much less resistance than the harder crystalline rocks, so that the chances of finding them among uranolites are comparatively small. The history of the seemingly earthy and hydrocarbonaceous meteoric stones was then briefly noticed. The intense heat which is developed in the flight of these bodies through our atmosphere afforded the lecturer occasion for explaining the nature of force and heat, and the intense temperature which would be developed by collision among the celestial bodies, sufficient as has been calculated to reduce them once more to the vaporous state, ready, as may be supposed, to pass again through the various phases of condensation, thus perpetually renewing the miracle of the universe. The thought of a cooling globe, a frozen moon and a gradually dying-out sun, is lost in the contemplation of the fact that these are but phases in the life of the Cosmos, and of its evolution in obedience to the laws impressed upon it by the Great First Cause, creating from the ruin of the present order of things a new heavens and a new earth.

Dredging of the Gulf Stream.—We are much gratified to learn from *Harper's Weekly* that preparations are now being made, under the direction of the Superintendent of the Coast Survey, for a very complete and thorough investigation of the deep-sea bottom, and especially of the channel of the Gulf Stream off the eastern coast of America, with an examination also of the Straits of Magellan and of a part of the Pacific Ocean. A steamer is now being built, which will shortly be launched, with the special object of continuing the deep-sea dredgings which, under the direction of Count Pourtalès, have given the Survey so much reputation.

It is expected that the arrangements will be completed by the end of August, and that the whole matter will be specially in charge of Prof. Agassiz, assisted by Count Pourtalès, whose experience eminently qualifies him for the post.

The plan of operations is, first, to run a line of dredging across the Gulf Stream between New York and Bermuda, and, if necessary, far enough eastward to completely cross the Gulf Stream current. The course will be thence to Trinidad, where a careful examination will be entered into to ascertain whether there is any difference in the deep-sea fauna of the adjacent waters and that of the coast of Florida. The expedition will then probably proceed to San Paulo for the purpose of examining the deepest known portion of the Atlantic, reaching to, at least, five thousand fathoms. From San Paulo it will again cut across the Brazilian current, and after possibly spending some time on the coast between Buenos Ayres and the Straits of Magellan will proceed by a zigzag course to the Falkland Islands, in the neighbourhood of which the expedition will remain for some time, for the purpose of solving certain important problems relating to both the deep-sea fauna and to that of the coast. It is next proposed to spend at least a month in the Straits of Magellan during the summer season of that portion of the globe. The work at the Straits being completed, the party expect to pass up along the western coast of Chili, next to the island of Juan Fernandez, and thence across to Callao. From this point the course will be to the Gallapagos, and thence across the Chillian current to some point on the west coast of Mexico—possibly to Mazatlan. The Revillagigedo Islands will next be visited, whence the party will proceed to San Francisco.

The entire exploration will probably occupy ten months, and bids fair to be the most important attempt ever made, at determining the character of the fauna of the deep seas. The experience gained in all the former American and foreign expeditions of this kind will be freely used on this occasion; and no pains will be spared in the way of outfit to render the whole undertaking an entire success.

The fact that this expedition is under the direction of the Coast Survey is a sufficient guarantee that nothing will be neglected to secure satisfactory results in the way of investigations upon the physics of the ocean, as well as its natural history, as it is intended to make use of the most approved apparatus for the determination of depths, temperatures, chemical composition of the waters, etc.—*Nature.*

A Cruise in a Whitebait Boat.—I know of nothing more disagreeable than having the traditions one has clung to from boyhood nipped in the bud by the practical hand of some seeker after science. Who, I should like to know, cares to be told that turtle soup is a decoction of cold-blooded reptile, or that venison hung the right time to acquire tenderness and flavour is simply animal matter undergoing a chemical change, and that the silvery whitebait we, at this time, so thoroughly enjoy when nicely cooked with just a dash of cayenne, are neither more nor less than the 'fry' of the herring. I have always eaten and enjoyed these tiny dainties, in the pleasant belief that a whitebait was a whitebait, and my own impression has always been that it was quite as well known, and every bit as easy to recognize, as a salmon, a cod, or a turbot; but far from it, for the learned in fish at once upset my creed by positively stating that there exists no such "fish" as a whitebait, so called by Yarrell (*Culpea alba*), who, in writing about its habits, thus says: "The whitebait differs materially from all the British species of *Clupea* that visit our shores or our rivers. From the beginning of April to the end of September this fish may be caught in the Thames as high up as Woolwich or Blackwell every flood tide in considerable quantity. During the first three months of this period neither species of the genus *Clupea*, of any age or size, except occasionally a young sprat, can be found and taken in the same situation by the same means." But there are other writers of more recent times who now maintain that the so-called whitebait is made up of the young of other fish, while there are those again who say they are herring fry. To satisfy my own mind upon this vexed question, I have recently made expeditions in the boats employed in catching whitebait for the market. When we reached the fishing-ground the tide was ebbing fast, and the whitebait net was set. The net employed is about twenty feet in length, gradually tapering from the mouth to the small end, or "purse," which is not more than three inches in diameter, and so fine in the mesh that a shrimp cannot get through it. The mouth of the net—about four feet wide—is nearly square, and ingeniously 'rigged' to crossbeams of timber that keep it extended to its full width. Whilst fishing, the boat is anchored in the tideway, the net is lowered to a depth of about four feet, and the purse then is drifted back astern of the boat, and every living thing that enters at the net's mouth is impounded in the purse. By the aid of a boat-hook the fisherman hooks the purse into the boat, unties its end, and empties its contents upon a kind of shelf erected for the purpose. This process is repeated about every ten minutes so long as the fishing continues. The proceeds of one haul will be sufficient for description. First come the silvery little fish the fishers so carefully select and designate 'bait,' and regarding the paternity of which so much discrepancy of opinion exists. These fish varied much in size, from six inches long to one-twelfth of an inch. These very minute fish were evidently not long from out the egg. It was only the small and intermediate sized fish that were retained, the larger ones being again returned alive to the Thames. Those picked out for sale are called 'smig-bait.' Then we caught sprats, but it was very easy to distinguish them from the 'bait,' sticklebacks, 'pole-wigs' (so the fishermen call them, but properly the speckled goby), shads, flounders, and lamperns. It will be of interest if I note the contents of the stomach of one of the whitebait I opened, which was about five inches in length. The greedy fellow had devoured twenty-one squillæ or 'mantis crabs,' and three small shrimps. So far so good. Now it may be asked what I have to adduce in support of my assertion that a whitebait is a whitebait. They are not young shads certainly, for the shad we caught could as easily be picked out from amongst the 'bait' as a pig from a flock of sheep. And this applies with equal force as a regards the sprat. If they be young herrings how comes it that great proportion of the 'bait' caught had only just escaped from the egg? Surely no one believes that herrings have just spawned in the muddy Thames? And if they have not, whence come these baby herrings, if such they be? Is is impossible to believe that fish so young and fragile could have made their way up the Thames as high as Greenhithe from the sea. Hence the fair deduction is that they were hatched from the egg near where they were caught. Granting this then they are most assuredly not young herrings, but the young of mature whitebait that had spawned early in the year. My experience, acquired 'aboard' the white-bait boat, has but the more firmly convinced me that the whitebait is a distinct species, entitled to its name (*C. alba*), and not the young of the herring, or any other fish.—J. K. Lord, in *The Leisure Hour.*

A New Species of Erythronium, by Professor Asa Gray.—Ordinarily it is hardly worth while to make a separate article for a single new species of plant, even when discovered in a district in which a new flowering plant is unexpected. But the species of *Erythronium* are so few, and the present one is so peculiar, and its habitat so closely bordering the region included in my Manual of the Botany of the Northern United States, that I need not apologize for bringing it at once to notice.

The specimens before me, accompanied by a colored drawing, are just received from Miss S. P. Darlington (a daughter of the late Dr. Darlington, long the Nestor of American botanists and one of the best of men), and were collected at Faribault, Minnesota, by Mrs. Mary B. Hedges, the teacher of Botany in St. Mary's Hall, a school of which Miss Darlington is Principal.

The flower is much smaller than that of any other known species, being barely half an inch long; and its color, a bright pink or rose, like that of the European *E. Dens-Canis*, reflects the meaning of the generic name (viz. red), which is lost to us in our two familiar Adder-tongues, one with yellow, the other with white, blossoms. The most singular peculiarity of the new species is found in the way in which the bulb propagates. In *E. Dens-Canis* new bulbs are produced directly from the side of the old one, on which they are sessile, so that the plant as it multiplies forms close clumps. In our *E. Americanum* long and slender offshoots, or subterranean runners, proceed from the base of the parent bulb and develop the new bulb at their distant apex. Our Western *E. albidum* does not differ in this respect. In the new species an offshoot springs from the ascending slender stem, or subterranean sheathed portion of the scape (which is commonly five or six inches long), remote from the parent bulb, usually about mid-way between it and the bases or apparent insertion of the pair of leaves: this lateral offshoot grows downward, sometimes lengthening as in the foregoing species, sometimes remaining short, and its apex dilates into the new bulb.

This peculiarity was noticed by Mrs. Hedges, the discoverer of this interesting plant, to whom great credit is due. Most lady botanists are content with what appears above the surface; but she went to the root of the matter at once. I learn that *E. albidum* abounds in the same locality. *E. Americanum* is also found in the region, but is scarce.

It is not easy to find or frame a specific name which will clearly express the most remarkable characteristic of this new species. But I will venture to name it

Erythronium propullans;—E. scapo infra folia pullultane; foliis oblongo-lanceolatis acuminatus parum maculatis; perianthio roseo-purpureo (semipollicari), segmentis acutis basi luteo tinctis omnino planis (nec calloso-dentatis nec sulcatis); antheris oblongis; stylo fere equabili integerrimo; stigmate parvo vix tridentato; ovulis in loculis 4–6.

Scape bulbiferous from its sheathed portion below the developed leaves, these oblong-lanceolate, acuminate, slightly mottled; perianth rose-purple or pink (half an inch long); the segments acute, all with a yellow spot but plane at the base, the inner like the outer destitute of either groove or tooth-like appendages, but a little more narrowed at base; anthers merely oblong; style hardly at all narrowed downward, entire, the small stigma even barely three-lobed; ovules few (4–6) in each cell.
—*The American Naturalist.*

INDEX.

J. F. W.

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