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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

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 opus*, 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 coll 'on. This charming little falcon is rare in South Africa, and . . y 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 austr 'lis 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

* 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 *Corduites* 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
Oxyger,	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 composi tion, 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.

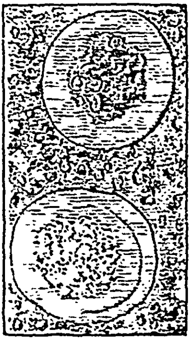


Fig. 2.

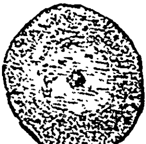


Fig. 3.

Fig. 4.

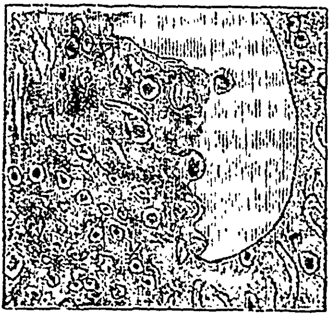


Fig. 1.—Part of a slice of shale from Kettle Point, shewing two spore-cases and remains of spores; 70 diameters.

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 antennæ 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 of 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 $\frac{1}{26}$ 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.

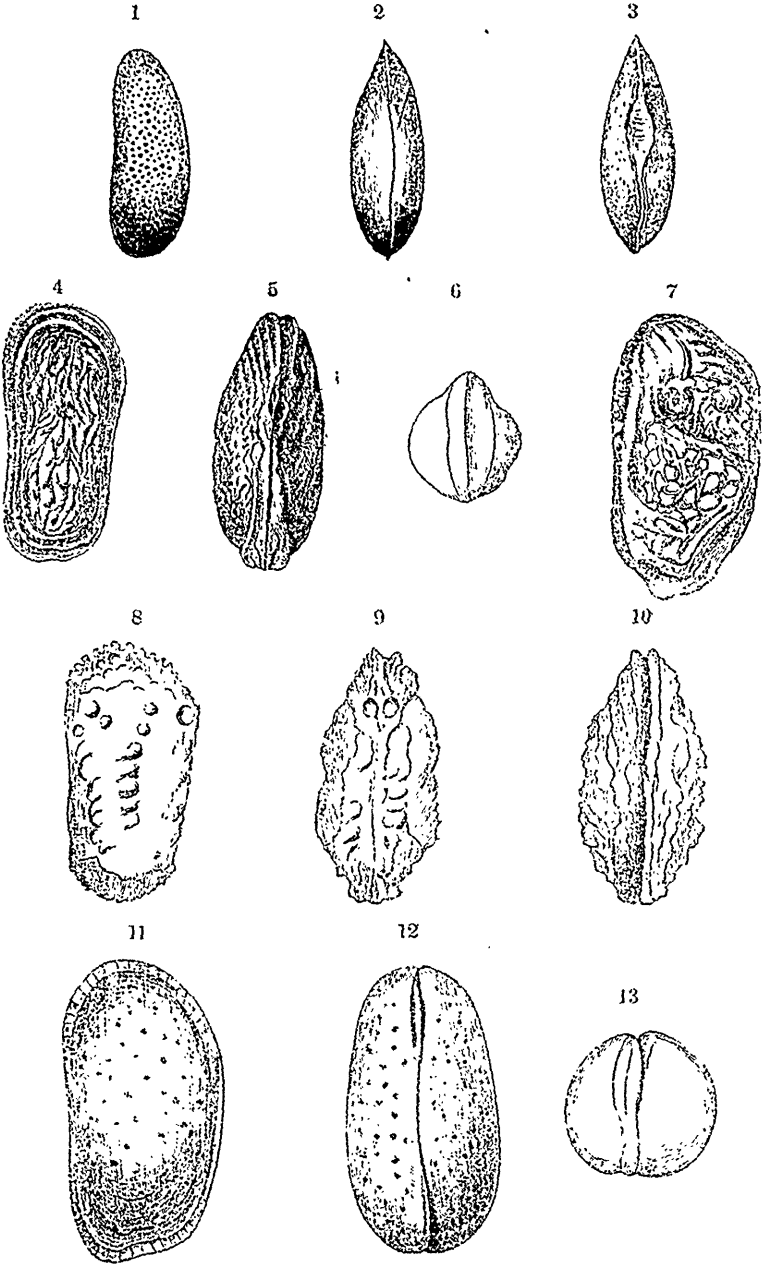
Carapace elongate, compressed; seen from the side, siliquose, slightly depressed in front; greatest height situate about the middle, and equal to rather more than one-third of the length; extremities rounded, the anterior much the narrower; superior margin almost straight, inferior slightly sinuated 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.		
Fig. 2. The same, seen from above.	}	x 40.
Fig. 3. The same, seen from below.		
Fig. 4. *Cythere canadensis*, carapace, seen from the left side.		
Fig. 5. The same, seen from above.	}	x 50.
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.		
Fig. 9. The same, seen from above.	}	x 50.
Fig. 10. The same, seen from below.		
Fig. 11. *Cythere leioderma*, carapace, seen from the left side.		
Fig. 12. The same, seen from above.	}	x 40.
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.	Cytheridea Sorbyana (Jones).
" Dawsoni Brady.	Cytherura Robertsoni Brady.
" globulifera Brady.	Cytheropteron complanatum, nov. sp.
" Logani, nov. sp.	" inflatum B., C. and R., MS.
Cytheridea papillosa Bosquet.	" angulatum B., C., and R. MS.
" punctillata (Brady).	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.	Cytheridea papillosa.
" lutea.	" punctillata.
" emarginata.	Eucythere argus.
" concinna.	Xestoleberis depressa.
" dunelmensis.	Cytherura undata.
" Dawsoni.	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.

CONTENTS OF SECTIONS.—§1-2, Definitions of granite and syenite; § 3 Structure of granitic and gneissic rocks; § 4-5, Felsites and felsite-porphyries; § 6, Gneisses and granites of New England; § 7, Granitic dykes and granitic vein-stones; § 8, Scheerer's theory of granitic veins; § 9-10. Elie de Beaumont on granites and granitic emanations; § 11, Granitic distinguished from concretionary veins; §12, Von Cotta on granitic veins; § 13-14. The author's views on the concretionary origin of granitic veins; § 15. The banded structure of granitic veins; § 16, Granitic veins of Maine, Brunswick; § 17, Topsham, Paris; § 18, Westbrook, Lewiston; crystalline limestones; § 19, Danville, Ketchum; § 20, Denuded granitic masses; § 21. Banded veins; Biddeford, Sherbrooke; § 22, Veins at various New England localities; § 23, Mineral species of these veins; § 24, Veins in erupted granites; § 25, Geodes in granites; § 26, Veins distinguished from dykes; § 27. Volger and Fournet on the origin of veins; § 28, 29, Certain fissures and geodes distinguished from veins opening to the surface; § 30, 31, Temperatures of crystallization of granitic minerals.

§ 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

* 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 varities 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.

* 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, A'c ı 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

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* 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 confinued 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 those 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 deoxidized, 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, be 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 npward 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 expressson 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 chemicæ Plantarum*, 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 equivalent of the impact. The specific heat of iron being ·1138, this amount of heat would raise the temperature of one pound of iron 215,-191°F., (24,489×·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 more 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 from 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 pendunele 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, pyroselerite, 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 New Brunswick 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

* 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*, *Noœra obesa*, *Anonyx Holbollii* Kroyer, *Ampelisca aquicornis* Bruzel, *Munna* 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 mutandis*, 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 verv 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 whitebait 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.*

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J. F. W.

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