

guished French *savant* has never had any hold, it may seem superfluous now-a-days to take up time in the disproof of it. But those who know what a power Elie de Beaumont has been and still is in France, how with all his abilities and knowledge and the excellent service which he has rendered by his map and other publications, he has for many years been a kind of dark shadow on the progress of the newer geology in his country, will thank the Professor at Poitiers for taking such pains to demolish the *réseau pentagonal*.

#### OUR BOOK SHELF

*Handbook of Natural Philosophy.* By Dionysius Lardner, formerly Professor of Natural Philosophy and Astronomy in University College, London. "Hydrostatics and Pneumatics." New Edition, edited, and the greater part rewritten by Benjamin Loewy, F.R.A.S. (London: Lockwood and Co., 1874.)

DR. LARDNER'S treatise on Natural Philosophy is quite familiar to those who studied Science ten or fifteen years ago. Before Ganot and Privat-Deschanel were translated, Lardner was *the* book which everyone used. It was originally almost a translation of Pouillet's "Éléments de Physique," but was added to from time to time, and is still a valuable text-book, especially the new editions of it edited by Prof. G. C. Foster, and (as in the present instance) by Mr. Benjamin Loewy. The value of the book is indeed shown by the fact, that although first published many years ago, it is still deemed worthy of new editions, and of being edited by well-known men. The volume before us has been carefully edited, augmented to nearly twice the bulk of the former edition, and all the most recent matter has been added. The treatment is essentially experimental and elementary; a slight knowledge of mathematics is needful. It is to be regretted that Mr. Loewy has not introduced metrical weights and measures. A few omissions may be noticed: the *action latérale* of Venturi is scarcely alluded to; the theory of the trompe is omitted, as are also the hydrodynamic experiments of Plateau and Magnus, and the account of Dr. Guthrie's experiments on approach caused by vibration. But the book has in the main been carefully edited and improved.

*Les explorations Sous-Marines.* Par Jules Girard. (Paris: Libraire, F. Savy, 1874. London: Dulau and Co.)

No nation surpasses the French in brilliant popular expositions of the various departments of Science. They already possess a large number of works of this kind, several of which have been translated into English, and the present work by M. Girard deserves to take its place among them as an extremely interesting and wonderfully full account of the numerous and valuable results which have of late years been obtained by deep-sea exploration. The two introductory chapters give a rapid *résumé* of the history of deep-sea exploration, with a short description of the interior economy of the *Challenger*, and a clear and pretty full description of the various apparatus used in carrying on the explorations. The subsequent part of the work consists of four divisions, the first of which treats of the characteristics of the sea-bottom looked at in its geographical relations; the second treats of life in the depths of the sea, describing eloquently the various organisms which inhabit the ocean; the third division deals with the waters themselves, pointing out the chemical properties and the physical phenomena which take place in the midst of the ocean; in the last division an attempt is made to depict the seas of ancient geological epochs, and compare them with the discoveries which have been made by recent soundings. The author seems to have fairly mastered the literature of his subject, and has managed to write a book containing a vast deal of infor-

mation conveyed in clear and eloquent language. The work is profusely illustrated with artistically executed, useful, and most attractive woodcuts. The work might well be translated into English.

#### LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

##### The Habits of various Insects

[The following letter on this subject, from Fritz Müller to Mr. Charles Darwin, F.R.S., has been forwarded to us for publication by the latter.—ED.]

I DELAYED answering your kind letter of January 1 till I should have had an opportunity of examining once more some nests of leaf-cutting ants, to which you had directed my attention. In the meantime I received Belt's "Nicaragua," which I have read with extraordinary interest, and for which I must express to you my hearty thanks.

I was much surprised to learn from Mr. Belt's book how closely the far-distant province of Chontales resembles by its vegetation and animal life our own of Sta. Catharina. I am thus enabled fully to appreciate the exactness of many of his statements; he is an excellent observer, and most of his theories are very seducing. As to leaf-cutting ants, I have always held the same view which is proposed by Mr. Belt, viz. that they feed upon the fungus growing on the leaves, they carry into their nests, though I had not yet examined their stomachs. Now I find that the contents of the stomach are colourless, showing under the microscope some minute globules, probably the spores of the fungus. I could find no trace of vegetable tissue which might have been derived from the leaves they gather; and this, I think, confirms Mr. Belt's hypothesis. Here, as in Nicaragua, the Cecropiæ are always inhabited by ants, but, I think, by only a single species. I have cut down hundreds of them and never missed the ants. I wonder that it had never occurred to me that the trees are protected by the ants; but there can be no doubt that this is really the case, for young plants of Cecropiæ, not yet inhabited by ants, are often attacked by herbivorous insects.

A few days ago I caught on the flower of a Vernonia a female moth belonging to the Glaucopidæ, of which family there are here numerous species. When I seized it by the wings nearly the whole body became suddenly enveloped in a large cloud of snow-white wool, which came out of a sort of pouch on the ventral side of the abdomen, and consisted of very thin flexuous hairs 1—2 mm. long, three, four, or five of which used to proceed from the same point. I preserved the moth alive for some time, and as often as I seized her by the wings, by inflating the abdomen, a large naked membrane became visible, and somewhat protruded behind the first (white) segment of the ventral face of the abdomen (the rest of which is black), and a little more wool appeared under the posterior margin of this segment. I am at a loss as to the meaning of this curious contrivance. There is in the males of the same family an interesting secondary sexual character; they are able to protrude from near the end of the abdomen a pair of long hollow hairy retractile filaments, which in some species exceed the whole body in length. In the beautiful *Belemnia inaurata* there is a second pair of shorter filaments which are wanting in all the other species I examined (*Eunomia eagrus*, *Euchromia jucunda*, *Agyrtia cœrulea*, *Eudule invaria*, *Leucopsumis* sp., *Philoros* sp., &c., the names of which I owe to the kindness of Dr. A. Gerstäcker, of Berlin). In some species, most distinctly in *Belemnia inaurata*, I perceived a peculiar odour when the filaments were protruded; this, I think, may serve to allure the females, which in all our species appear to be much less numerous than the males.

I mentioned to you that with our stingless honey-bees wax is secreted on the dorsal side of the abdomen; now this is also the case with some of our solitary bees, for instance, *Anthophora fulvifrons* Sm., and with some species nearly allied to that genus. These solitary bees probably use the wax only to cement the materials with which they build their nests. Our species of *Melipona* and *Trigona* also never employ pure wax in the construction of their cells or of the large pots wherein they guard their provisions; they mix it with clay, resinous substances, &c., so that in some species wax forms hardly 10 per cent. of the material. The only case, as far as I know, in which pure wax is

used, is in the construction of a tube, which *Trigona jaty* Sm. builds at the entrance of its nest.

Among European Apidae, Apis and Bombus are the only genera which wet with honey the pollen they are collecting, and in consequence of this habit the hairs on the outside of the tibiae of the hind-legs have disappeared. This is also the case with our Meliponæ, Trigona, and Euglossæ. Now Centris, Tetrapediæ, Epicharis, and some other bees, collect pollen in the same way; but notwithstanding, in some species, the hairs on the tibiae are developed in an extraordinary degree. This seemed to me rather perplexing, till I lately observed several species of Centris and a Tetrapediæ gathering sand in the large hair-brushes of the hind-tibiae, which accounts for the conservation and excessive development of the hairs.

With one of our smallest Trigona (*T. mirim* n.sp.), of which I have two hives in my garden, I have made a long series of observations on the construction of the combs, in which the young are raised. As in all other species the combs are horizontal and consist of a single layer of hexagonal cells, like those of wasps; but the cells are vertical. There is always in this species (other species behave differently) a set of cells constructed at the same time in the circumference of the two or three uppermost combs. When the cells are ready, they are filled with food, which the bees vomit from their mouths, the queen lays an egg into every cell and these are then immediately shut. The eggs at first lie horizontally; but in the course of the first or second day they assume a perpendicular position, with the thicker end turned upwards, dipping but slightly into the semi-fluid food. The combs are never used more than once; as soon as the young bees have left them (five to six weeks after the laying of the egg) they are destroyed and new ones built in their place.

Once I assisted at a curious contest, which took place between the queen and the worker bees in one of my hives, and which throws some light on the intellectual faculties of these animals. A set of 47 cells had been filled, 8 on a nearly completed comb, 35 on the following, and 4 around the first cell of a new comb. When the queen had laid eggs in all the cells of the two older combs she went several times round their circumference (as she always does in order to ascertain whether she has not forgotten any cell), and then prepared to retreat into the lower part of the breeding room. But as she had overlooked the four cells of the new comb the workers ran impatiently from this part to the queen, pushing her, in an odd manner, with their heads, as they did also other workers they met with. In consequence the queen began again to go around on the two older combs, but as she did not find any cell wanting an egg she tried to descend; but everywhere she was pushed back by the workers. This contest lasted for a rather long while, till at last the queen escaped without having completed her work. Thus the workers knew how to advise the queen that something was as yet to be done, but they knew not how to show her where it had to be done. In the same hive there appeared to be two political parties among the workers, dissenting about the construction of the combs, one destroying what the other had begun to build; but it would require a very long and tedious exposition to give you the details of the case.

Our several species of honey-bees differ as much in their mental dispositions as they do in external appearance and size (the smallest species, called *Trigona lilliput* by my brother, is only about 2.5 mm. long). Some rush furiously out of their nest, whenever an enemy approaches it, attacking and persecuting the offender; others are very tame, and permit close observation of all their work. In one large species I could even observe with a lens the act of their sucking a solution of sugar, which I had given them, and there was no doubt that at least these bees really suck, and do not lap, like dogs or cats, as Milne Edwards, Gerstæcker, and most entomologists think.

There is one species (*Trigona lionda* Sm., named for my brother by Mr. Frederick Smith himself) which never appears to collect honey or pollen from flowers, on which, at least, I have never seen it. It robs other species of their provisions and sometimes takes possession of their nests, killing or expelling the owners. The hives in my garden have often been invaded, and two of them destroyed, by these robbers, and I have seen in the forest several nests, formerly inhabited by other species, occupied by them.

Together with my brother at Lippstadt I intended to publish an essay on the natural history of our stingless honey-bees, but it will probably cost some years to give a tolerably complete account of them.

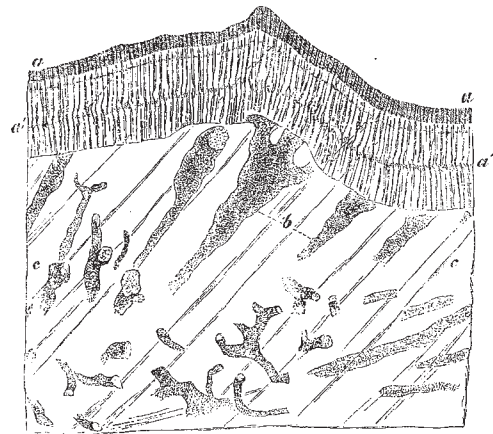
Fritz Müller

Itajahy, Santa Catharina, Brazil, April 20

Eozoön canadense

I DESIRE permission to state, in your journal, my entire agreement with the explanation of the actual structure of this fossil given by Dr. Carpenter in the Ann. Nat. Hist. for April. Though it may not be necessary to corroborate, in any way, the decisions of so great an authority on *Foraminifera*, or to add to illustrations so clear and convincing, my testimony may not be without its value; since, in addition to work in micro-geology extended over more than thirty years, and some familiarity with modern *Foraminifera*, I have, in the original examination of *Eozoön*, undertaken at the request of Sir William Logan, studied larger suites of specimens of typical *Eozoön*, and of materials supposed to resemble it, not only from Canada, but from other localities, than any other person.

I have the more pleasure in bearing testimony to the "tubulated primitive chamber-wall," because this was not manifest in my original specimens, and was first made out by Dr. Carpenter in those submitted to him from *Petite Nation* after my original description was written. I did not, however, take it for granted even on Dr. C.'s testimony, but satisfied myself of the organic nature of the structure by careful examination and comparison with the Chrysotile and other fibrous minerals occurring in connection with some of the specimens.



Part of a Calcareous lamella of *Eozoön canadense*, showing at *a a* the tubulated structure of the proper wall of the chamber or "nummuline layer," perfectly differentiated from the serpentine chamber-cast on which it abuts, and at *a' a'* a line of flexure of the tubuli, corresponding with that often seen in dentine and other tubulated calcareous structures; *b*, origins of the "canal system" in irregular lacunæ of the "intermediate skeleton" on the exterior of the proper wall of the chamber, precisely as in *Calcarina*; *c, c*, "intermediate skeleton," traversed by cleavage-planes, whose extension into the "nummuline layer" proves it to be a part of the calcareous, not of the serpentinous, lamella.—From a figure given by Dr. Carpenter from the Ann. Nat. Hist. for June.

It is not surprising that *Eozoön* meets with some opponents. There are few naturalists who have sufficient familiarity with the structures of modern *Foraminifera*, and with those strange and gigantic representatives of the *Protozoa* found in the Primordial and Silurian rocks, to appreciate the importance of the structures it presents. Still fewer have added to this experience by the study of the structures of the fossils of the more ancient rocks as they appear under the microscope, and of the conditions of mineralisation of such fossils. The intelligent appreciation of the claims of *Eozoön* must, therefore, be of slow growth; and the controversies respecting it will be finally settled only when the other organisms of which traces exist in the Laurentian rocks are better understood, and when the *Protozoa* of the Cambrian and Silurian have been more thoroughly investigated. These desiderata are gradually being supplied; and I venture to predict that before many years have passed, palæontologists will be required to extend their belief to several other Laurentian and Primordial *Foraminifera* besides *Eozoön canadense* and *Eozoön hvaricum*.

J. W. DAWSON

McGill College, Montreal, May 15

Proportionality of Cause and Effect

It does not surprise me that Mr. Hayward gives up in despair the attempt to make Mr. Spencer conscious of the fallacies in his logic. But as from the first I have addressed myself to Mr. Spencer's readers, I must in justice to myself point out to them the true