of contour, will approach much more closely to the calcareous sponges than any hitherto described.

I am well aware that, to many, these dry details will appear unnecessarily and tediously minute; but it must be remembered that, until we are accurately familiar with all the leading types of structure existing in this interesting group of organisms, we cannot be in a condition to arrive at final conclusions respecting their nature and zoological position.

Manchester, May 21*st*, 1851.

Notice of a Diatomaceous Earth found in the Isle of Mull. By WILLIAM GREGORY, M.D., F.R.S.E., Professor of Chemistry in the University of Edinburgh. Communicated by Professor JOHN E. QUEKETT. (Read March 23rd, 1853.)

THIS earth was discovered, about two years ago, by the Duke of Argyll, who gave a short account of its geological position to the Royal Society of Edinburgh. It constitutes a bed, resembling marl in appearance, lying in a rough piece of ground, at Knock, near Aros, between Loch Baa, a fresh-water lake, 3 miles long and 1 mile broad, and the sea. The lake is about 30 feet, the land about 40 feet, above the sea-level, and the lake is surrounded with high mountains on all sides except the west, where its waters flow towards the sea, passing through the rough district, boggy in parts, above mentioned, which is about a mile broad. The marl-bed, as it is called on the spot, lies within 50 yards of the lateral granite rock, and half-way from the lake to the sea. The surface of the land between the lake and the sea is very uneven, covered with large stones, gravel, and sand. At one part there is a hollow, which in winter used to become a small loch, in summer only a stagnant pool, and in draining this the bed of marl was discovered. It was filled in summer by a small stream unconnected with the lake. The bed rests on the gravel, which again rests on the granite of which the whole district is formed. As there is no formation of an epoch between those of the granite and of the gravel, we cannot, from its position, ascertain precisely the geological period at which the bed was deposited. The Duke of Argyll regards the gravel as belonging to the Diluvium, and the Infusorial deposit as comparatively of very recent origin. But there is reason to think, from the character of the species, that the deposit may belong to a more remote epoch. Ehrenberg, to whom I sent a portion of it, writes to me, that he thinks it probably connected with the Tertiary, or at all events, with

the Quaternary period, but he had only been able to make a partial examination of it at the time he wrote.

This deposit must not be confounded with the Leaf-bed, also discovered in Mull by the Duke of Argyll; for that bed, which also contains a large number of Diatomaceous remains, occurs at a place 20 miles from the deposit now under consideration, and is found between two beds of volcanic trap, showing that the Dicotyledonous trees—remains of which abound in it—must have lived before the eruption which gave rise to the upper trap bed, whatever may have been the period of that eruption.

To return to the Infusorial deposit. The Duke of Argyll thinks it possible that the waters of Lock Baa, which now pass to the sea at a distance from the deposit, may, at one period, have flowed through the hollow where the deposit is found. Mr. Campbell Paterson, a gentleman residing on the spot, thinks that the sea at one time communicated with Loch Baa, and that the present barrier is the result of some geological change or convulsion. The gravel and sand, he says, exactly resemble those now forming in the neighbouring sea; and although he has not observed any marine shells in the gravel, he thinks that the rocks at a higher level bear marks of the action of the sea. These are points on which I cannot speak without a personal knowledge of the locality, but the deposit appears to contain only fresh-water organisms.

The Duke of Argyll kindly gave me a small portion of the earth first discovered, which happened to be very pure, and which he stated to contain *Naviculaceæ*. On examining it, I was struck with the variety of forms, and resolved to study it more closely; this I have only been able recently to do, and I think the results may prove not uninteresting to the Microscopical Society.

The Mull earth is, in the purest specimens, when dry, almost white, and much resembles chalk, being light, friable, and adhering to the fingers. But more commonly it has a pale fawn colour, and it is frequently strongly tinged with iron. The lightest and whitest specimens contain hardly anything besides siliceous organic remains, for the most part entire, but with some fragments. Other portions, which are denser, contain also many fragments of quartz of various sizes, and vast numbers of comminuted fragments of loricæ. In the densest and worst, the quartz or sand and the fragments entirely predominate, and these can hardly be cleaned. The specimens of middling quality, as well as the inferior ones which I at present possess, contain a great many minute fragments of loricæ, often exceeding half or three-fourths of

the mass. These fragments form an excellent polishing powder, which may be had of various degrees of fineness. I find it best, except in the case of the very purest specimens, first to ignite the earth over the spirit-lamp in a platinum capsule, till the black colour first caused by the action of the heat on the organic matter present is burned off, and the earth is again nearly white. I then digest it for some hours in strong nitromuriatic acid, which removes the iron, and, after washing away the acid, press the lumps in water gently with the finger till the whole is diffused in the water. It is then elutriated as usual, to separate on the one hand the coarse sand, if any be present, and, on the other, the comminuted fragments. The slides now offered to the Society were prepared in this way from earth of but middling quality, my supply of the purest having been very small and long ago exhausted; while the deposit being at present, and for months past, flooded, it is impossible to procure a fresh supply of the purest earth.

In endeavouring to identify the species present in this earth, I found the greatest difficulty from the want of any work containing figures of all the known species. The only figures I could procure were those of Ehrenberg's Atlas, 1838, and those of the last edition of 'Pritchard's Infusoria.' The former, of course, does not contain the very numerous species added to the list since 1838, and the latter has seldom more than one or two species in each genus. I had also Kützing's 'Species Algarum,' without any figures. But I was able, after studying a good many slides of excellent quality, to distinguish somewhere about 65 forms, although I could not with any confidence name above one half of the number. Under these circumstances, I ventured to apply to the Rev. W. Smith, to whom I was fortunately able to send an excellent specimen of the earth. That distinguished naturalist had the very great kindness, in spite of his absorbing occupations, to examine the earth, and to send me the following list of species which he has detected in the specimens sent. The names are those adopted in his forthcoming synopsis :—

Pinnularia major
,, acuminata
,, oblonga
,, viridis
,, divergens
,, acuta
,, radiosa
,, mesolepta
,, interrupta
,, Tabellaria
,, gibba
Pinnularia gracilis
,, lata
,, alpina
Navicula serians
,, rhomboides
,, ovalis
,, dicephala
,, firma
,, angustata
Gomphonema acuminatum
,, cruciatum

Gomphonema Vibrio
„ capitulatum
Amphora ovalis
Stauroneis Phœnicenteron
„ gracilis
„ linearis
„ anceps
Cymatopleura elliptica
„ apiculata
Cocconeis Thwaitesii
„ Placentula
Surirella Brightwellii
„ biseriata
Cymbella Helvetica
„ maculata
„ sativa
„ affinis
„ cuspidata
Himantidium gracile, Kütz.
„ bidens, W. Sm.
„ pectinale, Kütz.
„ arcus, Kütz.
„ major, W. Sm.
„ undulatum, Ralfs.
Tabellaria frustrata, Kütz.
„ ventricosa, Kütz.
Epithemia turgida
„ gibba
Eunotia gracilis
„ retrorsum
„ Diadema
Synedra capitata
„ biceps
Fragillaria capucina, Kütz.
Orthoseira viridis, W. Sm.
„ ouchalcea, W. Sm.

It will be perceived that Mr. Smith has found, in the specimens sent to him, 59 species of fresh-water Diatomaceæ. As I had made sketches of all those forms which I could not name, I was easily able to identify Mr. Smith's species. I have stated that I had distinguished about 65 forms. I believe that some of these were side-views of species unknown to me at the time, and others, in all probability, accidental varieties. But I also think it probable that there may be a few species in the deposit which do not occur in the portion seen by Mr. Smith. At least, I am quite certain that that portion differs remarkably in some points from that which I had under examination at the same time. For example, in Mr. Smith's specimen, of which he kindly sent me two slides as I had not tested it myself, I find that there are numerous and fine loricæ of *Epithemia turgida*—a species which I had indeed observed in mine, but which I had found remarkably scarce. I have reason to think that hardly any two specimens will be found exactly to agree, and it is quite natural that different parts of the deposit should differ in the prevailing forms. Among the forms which I thought I had observed, but which Mr. Smith did not meet with, are *Melosiera* distans, and possibly *M. nummuloides; Eunotia Triodon*, and *E. Pentodon;* possibly E. fabra, and one or two more. But most of these, if they do occur, are very scarce; and therefore I do not venture to add any names to Mr. Smith's list until I shall be confirmed by him or by some other experienced authority. There are several other forms, also doubtful, which I thought I had seen, but I need not name them.

The Mull earth is characterised by several peculiarities. First, by the abundance of very fine specimens of the Navi-

culaceæ, especially of the genera *Pinnularia* (14 species), *Navicula* (6 species), and *Stauroneis* (4 species). There are many splendid individuals of *Pinnularia major* (some 1-50th of an inch in length), oblonga, virides, divergens, and others; and a few, but these very fine ones, of *P. lata*, and of the rare and beautiful *P. alpina*. *Navicula rhomboides* and *N. serians* are particularly frequent and fine, as is also *Stauroneis Phœnicenteron*. 2ndly. It is characterized by the abundance of *Cymbellæ* of which there are 5 species. 3rdly. There is a remarkable development of the *Eunotiæ*, as *Eunotia Tetraodon*, *E. Diadema*, *Himantidium Arcus*, *H. bidens*, and the 4 other *Himantidia* and *Epithemia turgida*. 4thly. There is a great abundance of *Tabellaria fenestrata* in every stage of development, some specimens being 10 or 12 times as long as others, but not broader, and of *T. ventricosa* which, however, occurs almost always short. 5thly. There is a remarkable abundance of fine specimens of *Gomphonema coronatum*, and fine individuals of *G. acuminatum* also occur. The genera *Amphora*, *Cymatopleura*, *Cocconeis*, *Surirella*, and *Nitzschia* occur less abundantly, and in some cases are very scarce. *Fragilaria capucina*, Kütz., *Orthoseira viridis*, W. Sm., and *O. ouchalcea*, W. Sm., are abundant, as is *Synedra biceps*. I have observed the variety β *recta*, Kütz., of this species.

Besides the 59 species named by Mr. Smith (and I would again remind the Society that the names in the above list are those of Mr. Smith's daily expected Synopsis), there is one form, to which I directed his attention, and which he cannot with certainty refer to any known genus. This form is abundant in all specimens of the earth, and is therefore an additional characteristic of it. It varies from 1-600th to 1-470th of an inch in length, and has usually the form of a plano convex lens, with two notches near the ends of the plane or very slightly concave side. It is broadest in the middle, and has sharp apices (fig. 1). At other times the apices are less sharp and the ends broader (fig. 2). It is finely cross striated, and Mr. Smith has ascertained the number of striæ to be 44 in 1-1000th. It requires a very good glass to make out the striæ, and it is possible that this form, from its abundance in the Mull earth, may be found available as a test object. For a long time I could not make out the striæ (although I felt sure of their existence from the resemblance or aspect to other forms known to be striated) with a glass which had sufficed for all the other forms. But with a first-rate object glass, and good management, the striæ may be shown and counted. It is possible that this form

may be an immature one, but to what are we to refer it? It differs from *Himantidium Arcus* and *Eunotia gracilis* in the number of striæ, and Mr. Smith thinks it must stand near *Eunotia Arcus*, Kütz.= *Navicula Arcus*, Ehr. It is not, however, that species, nor is Mr. Smith sure that it is of that genus. He is to examine it more fully, and the matter is therefore in good hands. I may add, that while it has a general resemblance to small specimens of *Himantidium Arcus*, or of other allied species, it does not commonly occur where these are abundant. I have looked at a number of Diatomaceous earths, in many of which there were all the common species of *Eunotia* and *Himantidium*, but have only seen this form in one, namely, in a slide prepared by Mr. Topping, and labelled "from the banks of the Spey." This slide has many things in common with the Mull earth. Any of the slides sent with this paper will exhibit numerous examples of this form.

I have further to add, that an average specimen of the Mull earth, on being analysed, was found, after being dried at 212°, to be composed of—

Silica - - - - - -	70·75
Protoxide of iron, containing traces of phosphoric acid and manganese - - - -	15·04
Organic matter - - - - -	12·36
Loss, chiefly water - - - -	1·85
	100·00

The iron is here stated as protoxide, but if calculated as peroxide, would amount to 16·69 per cent. Some of it certainly is in the latter form from the action of the air, and the brown colour, and this diminishes the loss, but I have stated it as protoxide, because I believe it to be in that state before the air has access to it. The presence of phosphoric acid, which was easily detected in the oxide of iron, by the use of molybdata of ammonia, is interesting. It is most probably derived from the organic matter of the Diatomaceæ, but I am not aware that its presence has been yet observed in any infusorial earth. I have not determined the proportion of phosphoric acid, which, although small, is appreciable. The earth contains neither lime nor magnesia.

It is probable that this earth may be useful as a manure from the finely divided silica, the organic matter, and the phosphoric acid it contains. Professor Bailey ascribes the fertility of certain districts in America to the abundance of infusorial remains on the soil, so that the experiment is worth trying.

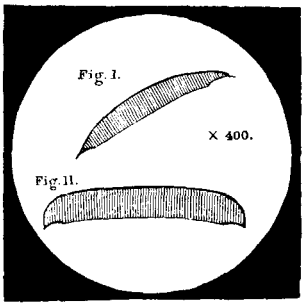
I find I have omitted to notice that, besides the Diatomaceous organisms, the Mull earth contains abundance of the long spicules, and also of the gemmules of *Spongilla fluviatilis* and *S. lacustris*, also a considerable number of siliceous forms, apparently *Phytolitharia*, more particularly *Lithostylidium clepsammedium*, and similar forms. There are also some silicified forms much resembling certain deposits in the cuticle of Gramineæ, &c., besides occasionally silicified pollen grains, belonging both to grasses, and as I believe to Coniferæ. I have also seen some fragments of woody fibre and cells, probably silicified; but I have not the means of determining with any accuracy these various organisms. Probably many members of the Society will be able easily to do this. I think I have seen some forms which resembled very much the Desmidiaceæ, such as *Euastrum*, *Staurastrum*, and *Cosmarium;* but on these points I will not venture to assert anything, although, as Desmidiaceæ occur in flint, and often contains a little silica, this occurrence is possible.

In conclusion, even the imperfect examination to which the Mull deposit has been subjected, proves it to be richer in Diatomaceous species, and I think also in genera, than any other known deposit, so far as I am acquainted with them. I have heard that the deposit at Santa Fiora contains 39 species, and that found near Peterhead, and described by Dr. Dickie, contains 40, but I know of no others which equal these two, whereas in the Mull earth we have at least 60 species and 16 genera. This will of course be interesting in reference to the geographical distribution of fossil Diatomaceæ, and I may add that Ehrenberg, who is preparing to publish a great work on this part of the subject, has been very much interested in the Mull earth, as being the first he had been able to obtain from the Hebrides, and thus filling up a great blank in his work. It is not, however, the first that has been discovered in the Hebrides, as there is a Diatomaceous earth at Raasay, also in the Hebrides. This I have not yet examined, but I presume it has been described.

I beg to offer to the Society a few slides made, as I have stated, from a specimen of only middling quality, such as alone has been in my possession of late, and also a specimen of earth, not yet examined, in its natural state, which may possibly turn out good. I have added a portion of prepared earth in water, which cannot be cleaned from quartz fragments, but certainly contains a good many fine examples of the rare and beautiful *Pinnularia alpina*.

The subjoined figures are rough sketches of the doubtful

form in the Mull deposit. They are represented with a power of 400 diameters. I find the length to vary from 1-470 to 1-600 of an inch. There are, as Mr. Smith first ascertained, 44 striæ in 1-1000 of an inch. It always exhibits the two notches towards the ends of the plane or slightly concave side. Fig. 1 is by far the most usual form; fig. 2 is, however, not unfrequent. The form is very abundant in the Mull deposit, and I have only seen it in one other, also from Scotland, namely in a slide labelled "From the banks of the Spey," which, I had from Mr. Topping. *Himantidium Arcus*, which, when small, has some slight resemblance to the above form, has only 22 striæ in 1-1000 of an inch and its striæ are consequently, *cæteris paribus*, quite easily seen, when those of the doubtful form cannot be made out. Mr. Smith thinks its place must be near *Eunotia Arcus*, Kützing=*Navicula Arcus*, Ehr.; but that it cannot be referred to that species. Indeed it is only very immature specimens of *E. Arcus* (Kütz.) that at all resemble this form, since the mature *E. Arcus* (Kütz.) has a bend or rounded angle in the middle. The doubtful form may be an immature one, but what is its aspect when mature?



On the Binocular Microscope, and on Stereoscopic Pictures of Microscopic Objects. By Professor C. WHEATSTONE, F.R.S. Communicated by Dr. Lankester, F.R.S. (Read April 27, 1853.)

IN Section 11 of my first Memoir on Binocular Vision, published in the Philosophical Transactions for 1838, I have alluded to the illusions to which microscopic observers are liable, from their inability to judge correctly the relief of objects when one eye only is employed. This indetermination of the judgment exists whenever a shadowless object is regarded with a single eye. Frequently an elevation appears as a depression, a cameo as an intaglio, a hollow pyramid (as a crystal of muriate of soda) as a pyramid in relief, &c., and *vice versâ*; but this indecision is entirely removed when the object is viewed with both eyes simultaneously. No mistake, if the object be a near one, can then be made with regard to