On the Post-tertiary Diatomaceous Sand *of* Glenshira. Part II. *Containing an account of a number of additional undescribed species.* By William Gregory, M.D., F.R.S.E., M.R.I.A., &c.; Professor of Chemistry in the University of Edinburgh. Illustrated by numerous figures drawn from Nature, by R. K. Greville, LL.D., F.R.S.E., &c., and engraved by Tuffen West, Esq. (Plate V.)

(Read March 26, 1856.)

In the first part of this communication * I described the peculiar locality in which the Glenshira Sand occurs, and pointed out, that the remarkable mixture of marine and fresh water forms which it contains, was a proof that, when this sand or mud was deposited, the fresh-water lake, then filling the upper part of the valley, and standing, of course, at a higher level than it now does, must yet have occupied the same relative level, compared with the sea, which it now occupies, when it is confined to the lowest part of the valley, and being exactly at the level of half-tide, flows into the sea at low water; while, at high water, the sea flows into the lake. This state of matter produces in the lake, at this moment, a mixture of marine and fresh-water species, not only of diatoms, but also of other tribes, both animal and vegetable. And as the existence of a similar mixture in the sand now under examination, deposited at the higher level, implies that at the period of its deposition the relative levels of the sea and of the lake were the same as now, while we see that the lake now stands at a lower level than formerly, we infer, that since that period the land has risen, or the sea has fallen; a conclusion justified and supported by many other geological phenomena in the estuary of the Clyde, with which Loch Fine, the arm of the sea into which the Dhu Loch of Glenshira flows, communicates.

In the same paper I gave a list of about 215 known species of Diatoms, and nearly 20 undescribed species, which I had found in the deposit; a number of species far exceeding that hitherto found in any other similar deposit, so far as is known to me. This, I conceive, indicates that the circumstances which favoured the mixture and accumulation of species must have been of very prolonged duration.

At the same time I stated that there remained about as many more undescribed forms as those I had been able at that time to figure, and that these should be figured and described on some later occasion. I now proceed to fulfil that promise. I must explain, however, that it is impossible for me to com-

* 'Quarterly Journal of Microscopical Science,' vol. iii., p. 30.

plete the investigation in the present paper. In the first place, the sand is not yet exhausted; for although I have explored about 600 slides of it, new forms are still from time to time occurring. Secondly, it has been found impossible to finish the study even of the whole of those which I had observed in it in 1854, and to prepare figures of them. I propose, therefore, only to describe and figure, at this time, such of the new forms as have been duly studied. This is, no doubt, the majority of them; but it will require a third paper to complete the examination, more especially of the smaller forms, among which, as well as among those of the larger which have not yet occurred entire, much remains to be done.

Before describing the new forms, I must add to the list of known species formerly given the following, many of which were accidentally omitted. Others have since occurred to me, and a few have been pointed out to me by Mr. Okeden, well known as a zealous observer. These I have also myself seen.

Additional List of known Species.

235.* Cymbella sinuata, W. G.
236. Amphora membranacea.
237. ,, salina.
238. ,, hyalina.
239. Amphiprora paludosa.
240. Campylodiscus Ralfsii.
241. Actinocyclus undulatus.
242. Actinocyclus ?
243. Actinocyclus duodenarius, Sm.
244. Nitzschia bilobata.
245. Navicula Westii.
246. ,, obtusa.
247. ,, Hennedii.
248. ,, rostrata.
249. Navicula varians, W. G. (in all its forms).
250. Navicula Pandura, Bréb. (?)
251. Pinnularia megaloptera, Ehr.
252. ,, biceps, W. G.
253. ,, linearis, W. G.
254. ,, subcapitata, W. G.
255. ,, gracillima, W. G.
256. Pleurosigma distortum.
257. ,, intermedium.
258. Gomphonema subtile, Ehr.
259. Orthosira spinosa.
260. ,, mirabilis.
261. Grammatophora Balfouriana.† (See Synopsis, Vol. II. Pl. LXI. fig. 383.)

On this list I would only remark, that the species marked W. G. have been lately described by me, as well as Nos. 248, 251, and 258, the two last as new to Britain;‡ that No. 249, *Navicula varians*, has been also fully described by me elsewhere:§ that No. 243, *Actinocyclus duodenarius*, appears

* These numbers are continued from Part I., in which I gave a list of 234 species.

† I have given a figure of this form, as being little known as yet. At first it seemed to differ from the form figured by Dr. Greville, the interrupted vittæ being less conspicuous, the striæ more so; but I am now satisfied that it is essentially the same form, which varies, however, more than was at first supposed. The figure is not numbered, as it is not intended for engraving.

‡ 'Quarterly Journal of Microscopical Science,' vol. iv., p. 1.

§ 'Trans. Micr. Soc., Quart. Journ. of Micr. Science,' No. X., p. 10, Jan. 1855.

as a British form in Vol. II. of Smith's Synopsis. I have found in Glenshira several forms of this kind, differing only in the number of septa, which varies from 7 or 8 to 14 or 16. I observe in Pritchard's Animalcules, that Ehrenberg makes a species of each number of septa; but to judge by the aspect of these forms in Glenshira, they are all of one species, which I have named *duodenarius*, because 12 is about the average of the septa in those I have seen there. No. 250, *Navicula Pandura*, was last year figured by De Brébisson as occurring at Cherbourg. I mark it with a query, because it is doubtful whether it may not be the same species as *N. nitida*, Sm., (named in my former list,) and also because I have great doubts as to either of these forms being correctly named. They belong to a very striking group, in which the Glenshira sand is somewhat rich, and which I shall have presently to consider more fully.

Of No. 247, *Navicula Hennedii*, I give a figure, because very fine specimens occur in this deposit, and the form has not yet been figured, though it will be described in Vol. II. of Professor Smith's Synopsis. The two *Orthosiræ* are also new forms; *O. spinosa* having been found in Braemar by Drs. Greville and Balfour, and in Auvergne by Professor Smith, and figured both by Dr. Greville and Professor Smith; and *O. mirabilis* having been found last summer in Wales by Mr. Okeden, but not yet figured. I may here mention, that I had observed and sketched both, in my earliest explorations of the Glenshira sand, fully three years ago; but from the number of new forms, I was compelled to postpone the study of them, and had not been able to resume it when the naturalists above named discovered them. But before the account of *O. spinosa* had appeared, I had again found both forms in three or four South American soils. I mention this here, because my observations on these soils have led me to doubt whether *O. mirabilis* be not an abnormal state of *O. spinosa*.

My reasons for thinking so are: 1. That in all the localities in which *O. mirabilis* occurs, it is accompanied by *O. spinosa*. 2. In the Glenshira sand and in the American soils, I was unable to find any discoid or end view, or diaphragm, which I could suppose to be that of *O. mirabilis*, except that of *O. spinosa*; and I believe that Mr. Okeden has been equally unsuccessful. 3. I found one cylinder, one-half of which had the peculiar markings of *O. mirabilis*, namely, two series of curved or sigmoid lines, decussating and crossing the cylinder transversely; while the other half had all the characters of *O. spinosa*. 4. In no specimen of *O. mirabilis* have I seen any appearance of the usual septa, so strongly marked in

O. spinosa, which leads me to suppose that the markings are due to the septa having been removed and replaced by some new internal arrangement. 5. In both forms, the ends of the cylinders exhibit the spines, or appearance of spines, from which *O. spinosa* is named. It was for these reasons that I did not earlier mention *O. mirabilis* as a species; and as for *O. spinosa*, I had postponed it with other forms, otherwise both might long ago have been known.

Let us now turn to the new forms. Here I must premise that a few of those new figures were described and figured in my former paper. I have figured these again, in some cases, because the former figures were accidentally erroneous; or in others, on account of additional peculiarities, or because I now understand the forms better than I was at that time able to do. By far the greater part of the forms now given are figured for the first time.

1. *Navicula rhombica*, n. sp. In my former paper are two figures of this species, which is very frequent in the sand. I now give two more figures, to complete the history of it.

Length from 0·001″ to 0·0025″. Form rhombic, with somewhat acute apices as in the former figures, or elliptic lanceolate, with obtuse extremities, as in fig. 1. Striæ fine, but easily seen with a good 1-4 or 1-5, about 45 in ·001″, but those near the middle of the valve much more distant, so as to be almost conspicuous; the striæ slightly inclined. Median line strong; nodule large and well marked. Valve colourless, or pale yellow.

The above characters sufficiently distinguish this species from *N. rhomboides*, which, in the typical form, is always acutely rhombic, of a much darker colour, and has no definite central nodule, the two halves of the median line ending in sharp triangular points. The striæ in *N. rhomboides* are so fine, that I have never yet been able to see them with a 1-5 of extraordinary goodness, and they are indeed hardly to be resolved by the 1-8; they are also parallel. All these things unite to give to *N. rhombica* an aspect so entirely different from that of *N. rhomboides*, that it is impossible to confound the two forms, where, as in the present deposit, they occur together. I may add that the variations of *N. rhomboides*, viz., *N. crassinervia* and *N. interrupta*, W. G., are quite distinct from those of *N. rhombica*. I state this, because some who have only seen the figures of *N. rhombica* in my former paper, have supposed that it is only *N. rhomboides*. Those who have seen the forms will admit that it is not possible for two species of the same genus to differ more thoroughly; but it is impossible, in all cases, to represent in drawing, characters which, in the forms, are perfectly satisfactory.

Since writing the former paper, however, I have observed an additional mark of distinction, which has even led me to doubt whether the form under consideration be a *Navicula* at all; for it frequently occurs in what I may call packs, like packs of cards, in which six, eight, or more are laid flat and close on each other. I have represented one of these in fig. 1.* This is a character which I have not observed in any *Navicula*, although it is easy to imagine that some species of the genus may occur in such groups. From the fact of these packs being so frequent in a deposit like this, so long water-tossed, it may be inferred, that the forms composing them are very firmly attached together in the living state. I must leave to better authorities to decide whether this be a *Navicula* or not, merely observing that it is a well-marked and beautiful species.

I believe *N. rhombica* to be a marine form, having seen it, with other marine species, in a recent gathering from the coast near Tantallan, Haddingtonshire. There were also some fresh-water, or rather brackish-water forms, derived from the mouth of a small brook near the spot. If it be marine, this will be another point of distinction between it and *N. rhomboides*. I have seen no trace of it in all the very numerous fresh-water gatherings I have studied, though *N. rhomboides* is one of the commonest forms (222.)†

2. *Navicula maxima*, n. sp. This was also figured in my former paper, but I now give some additional figures of it, both because I have since found much finer specimens, and in order to show its usual varieties.

Form linear, broad, usually a little incurved at the middle, with broadly acuminate apices, as in fig. 2. Also linear, narrow and long, without constriction, as in fig. 2*. Some of this variety are very long and narrow; and there are also forms intermediate between 2 and 2*, as in fig. 2**. Length from 0·0035″ to 0·0065″. Median line strong, usually somewhat bent towards the central nodule, at least in the broader variety. Striæ transverse, parallel, reaching the median line; fine and close, about 50 in 0·001″ in the broader, considerably finer in the narrower variety. Colour of the valve in balsam, clear straw yellow. The valve is thick and convex, so that, when not lying quite flat, the edges become black. It is a very striking form, and frequent in the coarser densities of the prepared sand.

From the figure formerly given, some have supposed it to be identical with *N. firma* β, Sm. As that form was not

† This is the number attached to the species in the list given in Part I.

figured in the Synopsis, Vol. I., and I was at the time little acquainted with it, I was at first inclined to adopt this view. But a further examination of both forms has satisfied me that they are distinct. *N. firma* β has, even in balsam, a strong brown colour; its striation is coarser, and far more conspicuous, and is also slightly inclined; and it forms several well-marked varieties, which have been described and figured by Ehrenberg as distinct species, such as *N. dilatata*, *N. amphigomphus*, and others. Now, so far as I can see, *N. maxima* exhibits no other varieties than those here figured, which I give for the purpose of comparison. Moreover, while in *N. firma*, in all its forms, we have a side line on each side of the median line, *N. maxima* has usually two such lines on each side. Lastly, both forms occur in this deposit, and are easily distinguished by their general aspect, even under a low power. (225.)*

3. *Navicula Hennedii*, Sm. I give a figure of this beautiful species, because no figure of it has yet been published, and because the finest specimens I have seen occur in the Glenshira sand. As it will be fully described in the Synopsis, Vol. II., I need only say here, that fig. 3 represents a very fine one, although I have a specimen one-half larger even than this. (247.)†

4. *Navicula latissima*, n. sp. This is another very fine species, which occurs very well developed in our deposit.

Form very broadly elliptical, with very obtusely acuminate apices, having usually a very slight constriction before the extremities. The sides are occasionally parallel in the middle. Length from 0·002″ to 0·005″, or even 0·006″. Some of the shorter individuals, from the great breadth, are nearly orbicular. Nodule very large, median line doubly conical, the bases of the cones meeting at the nodule. This appearance is due to the striation, which does not reach the middle, and recedes farthest from it near the central nodule. Striæ rather coarse, finely moniliform, highly radiate, and not reaching the true inner median line. Colour of the valve, in balsam, a strong straw yellow, occasionally light brown.

I understand that some are disposed to refer this form to *N. granulata*, Bréb., which, as I stated in my former paper, also occurs here. But I cannot do this; for in *N. granulata*, not only are the striæ much less numerous, even though it is a considerably smaller form, but they are composed of large granules, so distant as to give a special character, from which the name is taken. In *N. latissima*, the striæ are indeed

* So numbered in Part I.

† So numbered in the list of known forms, given at page 34.

moniliform, as in many other naviculæ, but this character is far from being conspicuous. Moreover, the invariable and decided colour of the valve distinguishes it from *N. granulata*, which is colourless. Neither have I ever seen in *N. latissima* the produced or apiculate apices of *N. granulata*. I consider *N. latissima* to have very well marked characters, and the aspect of the larger individuals to be entirely peculiar.

Fig. 4 represents one of the shorter, and fig. 4* one of the longer forms of this fine species. (262.)

5. *Navicula quadrata*, n. sp. (= *N. humerosa*, Bréb.) This form is allied to the preceding, and is equally frequent in the deposit.

Form rectangular or nearly square, the ends suddenly contracted to short produced apices. Length from 0·0015″ to 0·005″ or even more, the breadth not increasing with the length in the longer individuals. The usual length is about 0·0025″ or 0·003″. Striæ radiate, much finer than in *N. latissima*, minutely moniliform, coming nearer to the median line. Fig. 5 represents an example rather below the average size.

When I first observed this form, and sent it to de Brébisson, he told me that he had then just found it at Falaise, and had named it *N. humerosa;* but he preferred my name as having been the earlier, and as more characteristic. Subsequently, Professor Smith referred it to *N. granulata*, Bréb., with which it agrees in form, while it differs from it remarkably in striation and aspect. De Brébisson, having found it quite unmixed with *N. granulata*, still, I believe, regards it as a distinct species.* For this reason, I give it here as such, adding, however, that I think it probable that it may prove to be a variety, not indeed of *N. granulata*, but of *N. latissima*, from which it differs, indeed, both in form and in number of striæ, but which it resembles considerably in general aspect. In my paper on *Navicula varians*,† I have shown that neither outline nor number of striæ are to be relied on, in certain cases, as specific characters, and I shall take an early opportunity of directing attention to other facts of the same kind which I have since observed. I may add that in this deposit there occur forms which, both as regards outline and striation, are intermediate between this one and the preceding, *N. latissima*. Even as a variety, however, it requires to be noticed and figured, in order to give a correct idea of the species as we find it. (263.)

I may here state that all the three forms, *N. latissima*,

* It appears as such, I find, in Vol. II. of the Synopsis, p. 93, as *N. humerosa*. Of course I shall withdraw my name, and adopt that of de Brébisson, to avoid confusion.

† 'Quart. Journ. of Micr. Science,' No. X., p. 10, Jan. 1855.

N. quadrata, and *N. granulata*, are marine forms, and that they all occur in recent gatherings on our coasts.

6. *Navicula formosa*, n. sp. This is a very beautiful form, and is frequent in the coarser densities of the deposit.

Form, an elegant linear elliptic, or elliptic lanceolate, with somewhat obtuse extremities. Nodules large and definite; median line like that of many *Pinnulariæ*, such as *P. viridis*. Striæ slightly inclined, about 35 in ·001″, not reaching the median line. There is, on each side of the median line, a side line, parallel to it. Length from 0·003″ to 0·0065.″ At one time I referred *N. maxima* β and this form to one species, but in *N. formosa* the striæ, besides being inclined, and not reaching the median line, are much more conspicuous, giving to the form a peculiar and well-marked aspect. I had also some doubts, whether it should not be referred to *Pinnularia*, rather than *Navicula*, but I have preferred the latter, because I believe the striæ to be moniliform, though very minutely so.

Fig. 6 represents a specimen, nearly of the average size; it is, however, often considerably longer. I have not yet seen it elsewhere. (264.)

7. *Navicula pulchra*, n. sp. This very pretty form is not so frequent in the deposit as most of the preceding species.

Form, elliptic lanceolate, almost rhombic, with a slight inflexion towards the extremities; not very broad. Length about 0·003.″ Striæ not very fine, very highly radiate, and very strongly moniliform, which gives to it a very peculiar aspect. Fig. 7 represents what appears to be the typical form, which I have only seen in this deposit. (265.)

8. *Navicula angulosa*, n. sp. This very beautiful form is frequent in the medium densities of the sand.

Form elliptic lanceolate, rather broad, with acute apices. Length from 0·0025″ to 0·0045.″ Striæ conspicuous, marginal, and bounded, internally, by an angular, rhombic space. Nodules definite, median line sharp and distinct. It is represented of the average size in fig. 8. I understand from Mr. Bleakley, that he has found this form on our eastern coasts.

Var. β. Rather smaller. Form linear, sides parallel, ends acuminate, striæ more distant; otherwise agreeing with α. Represented in fig. 8*. This also seems to have occurred to Mr. Bleakley.

Perhaps this species ought to be referred to the genus *Pinnularia*, but it is not easy to define these two genera. We shall see presently that moniliform or costate striæ are not always to be depended on, although Professor Smith distinguishes them by these characters. I was at one time persuaded to refer this form to *N. palpebralis*, but having carefully studied authentic specimens of that species, I am satisfied that

they are distinct. Indeed *N. palpebralis* is a very small form, while *N. angulosa* is generally large and conspicuous. But the angular space in the middle in both varieties of *N. angulosa*, is a good and permanent mark of distinction. (266.)

9. *Navicula Macula*, n. sp. This is a very remarkable form, which is not rare in the lighter densities of the deposit; but I have never seen it elsewhere as yet.

Form elliptic in the middle, short, contracted, and again slightly expanding to very obtuse, almost truncate apices. In shape it is not unlike the larger specimens of *Cocconeis flexella* (*Thwaitesii*, Sm.). Length, 0·0015″ to 0·002″. Median line straight, abruptly terminating at two points some way on each side of the centre. There is no central nodule, but only a large blank space, the length of which lies across the middle of the valve, and which looks like a stain. Beyond this, towards each end, the valve is very finely striated. Striæ about 70 in 0·001″, transverse and parallel.

The peculiar blank central space, which is not at all like an expanded nodule, differs from anything I have seen in any other form. I have examined not less than 100 specimens, and in none of them could I see any appearance of a central nodule, nor could I trace the median line farther than the margin of the blank, as we can do in so many forms where the nodule is expanded.

Fig. 9 is a very accurate representation of this form, which is remarkably uniform in its characters. (267.)

10. *Navicula solaris*, n. sp. This is a very pretty and well-marked form, frequent in the middle densities of the deposit. It is represented in fig. 10.

Form rhombic, long and narrow, with obtuse extremities. Length from 0·0015″ to 0·0045″. The striation is fine, but very distinct, even conspicuous, very much inclined towards the ends, and in the centre, where there is a small circular blank spot, so highly radiate as to present the appearance of a sun with rays. Striæ 36 in ·001″. The valve is usually of a brown colour, more or less deep, even in balsam. There is some resemblance between the shorter individuals and *P. radiosa*; but *N. solaris*, besides having finer striæ, and those more inclined, is usually much longer. As both forms occur in the deposit, they are easily seen to differ very materially in aspect. I have not yet observed it elsewhere. (268.)

11. *Navicula Pandura*, Bréb.? In the course of last year a very beautiful form was described and figured under this name by de Brébisson as occurring in sea water at Falaise. I have here given under this name, as a British form, that which is represented in fig. 11, although it does not appear to be in all points identical with that of de Brébisson. But the Glen-

shira sand is particularly remarkable for the occurrence in it of several different forms of the same general type, which I figure that they may be compared with others from different localities.

That which I have named, doubtfully, *N. Pandura*, is in shape panduriform, very deeply constricted in the middle, with the extremities nearly triangular, broad, with somewhat acute apices. Nodule square; median line strong, double, straight, with two dark lines, parallel to it, and close to it on each side, converging at the ends. These lines are shades, caused by elevations in the striæ, and similar to those in *N. elliptica*, Kutz (*ovalis*, Sm.), and in *N. didyma*. Length 0·004″ to 0·005″. Striæ coarse, very conspicuous, costate. Indeed, had not de Brébisson named his form *Navicula*, I should have called it *Pinnularia*, as the costæ resemble those of *P. alpina*. It will be seen that the next form has the same character. (269.)

12. *Navicula nitida*, Sm.? I have named this form, represented in fig. 12, also doubtfully, as no description of the species has yet appeared. It is represented in fig. 12. Form like that of the preceding, but less deeply constricted, and the ends longer in proportion. Length 0·003″ or 0·004″. Striæ not quite so coarse as in the last, costate. I have been repeatedly informed that this is Professor Smith's *N. nitida*, but I cannot reconcile this with his definition of *Navicula* as having moniliform, *Pinnularia* as having costate striæ. (270.)

13. *Navicula incurvata*, n. sp. This form, which belongs to the same group, is a true *Navicula*, if that generic name imply moniliform striation.

Form approaching to that of the two preceding species, but much more gently constricted, narrower in proportion, and with the extremities very uniformly rounded. Median line straight, with the dark-shaded lines on each side. Striæ much finer than in the two last, about 30 in ·001″, and minutely moniliform. It is perfectly uniform in its character, and a well-marked species. Length 0·003″ to 0·004″. (271.)

14. *Navicula splendida*, n. sp. This very fine species is also a true *Navicula*, but still belongs to the same group.

Form panduriform, much constricted, very broad at the shoulders, ends triangular and obtuse. Length 0·005″ to 0·006.″ Median line straight, nodule square. Striæ rather fine, compared with the two first forms of the group; but distinctly moniliform; not reaching the median line, and leaving on each side of it a long narrow blank space, which adds to its apparent breadth. The aspect of this form, as may be seen in the figures, is very different from that of the other forms of the group. It is the rarest of them in this deposit, and, as yet, has not occurred elsewhere. (272.)

15. *Navicula didyma*, var. γ. To the four preceding forms I add one more, which I do not venture to erect into a new species. It has the form and size of a very frequent form of *N. didyma*, but with the entire or costate striæ of Nos. 11 and 12. This character would lead us to make it a *Pinnularia*, were it not that de Brébisson, and even Professor Smith himself, who gives it as a character of *Pinnularia*, have referred, in *N. pandura* and *N. nitida*, costate forms to the genus *Navicula*. At least I am so informed as to *N. nitida*, for I have not seen Smith's description of it, nor an authentic specimen named by him. De Brébisson's figure of *N. pandura* speaks for itself.

I have figured the costate form, which, for these reasons, I refer for the present to *N. didyma*, in fig. 15. No detailed description of it is necessary, and I need only say here, that I frequently meet with it in the Glenshira sand, along with the other forms of this group, which I have figured, and that, besides the two common forms of *N. didyma*, well figured by Smith, our deposit contains one, if not two other varieties which have moniliform striæ, and which I refer also to *N. didyma*, a species which, like *N. elliptica*, Kütz. (*ovalis*, Sm.) and *N. elliptica*, Sm. (*Smithii*, Bréb.), appears to vary much both in outline and general aspect.

16. One of these is represented in fig. 16. It is frequent in the deposit. I call it *N. didyma*, δ.

It is evident that all these constricted forms belong to one group, but how they are to be classified it is not easy to say. The following questions naturally occur:—1. Do the costate forms constitute one or more species? 2. Are the moniliform types of this group to be referred to one or more species? 3. Is it possible that all these forms, whether moniliform or costate, belong to one and the same species? and if so, how is that species to be defined?

If we refer them all to one species, or even if the form, fig. 15, be referred to *N. didyma*, or figs. 11 and 12 to *Navicula*, what becomes of Professor Smith's definition of *Pinnularia*, and how is that genus to be distinguished from *Navicula*? I do not pretend here to answer these questions; but I may state, that the form fig. 15 has every appearance of being a variety of *N. didyma* (agreeing precisely, as it does, in form and size with the commonest small form of that species, which is very abundant in the deposit); and if that be so, then we have moniliform and costate striæ in the same species. I may add that I have made observations on *N. elliptica*, Kütz. (*N. ovalis*, Sm.), a common fresh-water form, which tend to show that it passes into *N. didyma*,

equally well known as a marine form.* And I have also observed, that *N. elliptica*, which varies remarkably in all obvious characters, sometimes acquires a nearly, if not a perfectly costate striation, though usually strongly moniliform. As I propose soon to lay these observations before the Society, I shall not here go farther into the subject.

17. *Navicula clavata*, n. sp. This very fine form, represented in fig. 17, has at first sight some resemblance to *N. Hennedii;* but on close inspection, it presents remarkable characters.

Form elliptic, broad, with broad rounded projecting masses at the apices, which are the extremities of the median line. Striation marginal, as in *N. Hennedii*, but the inner bounding line of the striated band, instead of being purely elliptic, as in that form, becomes towards the extremities, nearly straight, so as to form a kind of angle, giving to the included blank space between it and the median line, a very remarkable form. Median line complex. First there is in the middle, as in *N. Hennedii*, a narrow line proceeding from each end, and terminating on each side of the centre, and at a short distance from it, in long rounded expansions; the other extremities are also rounded, but larger. Between the two central knobs lies a rectangular white space, extending in its length at right angles to the median line, and rather narrow. It reaches beyond the general width of the middle part, that is, the striated portion now to be mentioned, expands at the middle. On each side of the proper median line is a transversely striated band, which, near the ends, touches the median line, but near the middle, recedes a little from it on both sides. The striated band expands into large round heads, projecting beyond the true elliptical outline of the valve, and it also expands a little in the middle. The white blank across the centre appears to have at each end a small striated patch placed transversely to it. The large swollen ends of the complex median line, not only project, forming short snouts, but stand out strongly from the surface of the valve. The striæ appear rather coarser than those of *N. Hennedii*, about 20 in ·001″, and are very distinctly moniliform. Length of the valve, 0·0034″.

I may here mention that Dr. Greville has found in the same Trinidad sand which I have alluded to elsewhere in this

* I observe that in Vol. II. of the Synopsis, Professor Smith gives, as *N. elliptica*, Kütz. var. *β*, the form which I found in Lochleven, and which resembles *N. didyma*. I admit that it seems to be a variety of *N. elliptica*, Kütz., but I cannot find any essential difference between it and certain forms of *N. dydyma*. Is it possible that *N. elliptica*, Kütz. may take the form of *N. dydyma* in sea water, and that some other local cause may have produced the same modification in the fresh water of Lochleven?

paper, and which has yielded so many fine new forms, a still larger and finer *Navicula*, to which he has paid me the compliment of attaching my name. In this form also, we find the projecting, rounded, club-like snouts to the valve, standing out from it in the same manner. It is quite distinct from the form here figured, although, no doubt, the two forms belong to the same group. I think I have seen, in the Glenshira Sand, indications of a tendency in the larger forms of *Navicula Smithii*, Bréb. (*elliptica*, Sm.), to pass into snouted varieties, with the snout rising in relief from the surface of the valve.

I have not met with *N. clavata*, except in this deposit. (273.)

18. *Pinnularia longa*, n. sp. This remarkable form, of which an average example is represented in fig. 18, is not rare in the deposit, but, on account of its slenderness, is seldom found entire.

Form rhombic, very long and narrow, with acute terminations. Costæ very conspicuous, distant, inclined or radiate, about 12 in 0·001″. Length from 0·004″ to 0·008″, but usually about 0·006″. The only known form to which it has any resemblance is *P. directa*, Sm. But in *P. directa*, the form is rather lanceolate than rhombic, while the striæ are much more numerous, and are also parallel, reaching the median line, which those of *P. longa*, in the middle, at least, do not reach. Moreover, *P. directa*, so far as I have seen, is a much smaller form. *P. longa* has another peculiarity, which is, that the median line, as seen in the figure, is generally twisted. The valve appears very thick. (274.)

19. *Pinnularia fortis*, n. sp. This is a very pretty little form, and frequent in the lighter densities of the deposit. It is well represented in fig. 19.

Form nearly rhombic, or rhombic lanceolate, rather short, apices somewhat obtuse. Length from 0·002″ to 0·0035. Costæ conspicuous, about 16 in ·001, and apparently projecting from the surface of the valve, for on the edge view they seem to stand out, and the valve has, in consequence, a very peculiar aspect. The valve is also very convex towards the extremities, but concave in the middle, which gives to the F. V. a constricted form. There is a blank space at the centre, round which the costæ radiate. There is something about the form very difficult to reproduce in a drawing. The costæ appear very distant, yet when counted, we find them much more numerous than we expected; and if we give in the figure the real number, the whole character of the form is lost. This character is well represented in the figure, but there are fewer costæ there than in the original. It is a very well-marked form. (275.)

20. *Pinnularia inflexa*, n. sp. This is a remarkably neat little form, well marked, and frequent in the lighter densities. Form elliptic lanceolate, ends acute. Striation conspicuous. Costæ subdistant, highly radiate, leaving in the centre a rather large round blank space, about 26 in 0·001″. Near each apex is a strong black cross-bar across the valve, which I believe to be caused by a depression in the valve, and I have named it from this character. Length 0·0014″. It is very uniform in its characters, and is well represented in fig. 20. (276.)

21. *Pinnularia acutiuscula*, n. sp. This is another well-marked species, frequent in the finer densities. Form long, almost lanceolate, with the sides parallel in the middle, and slowly converging to the acute apices. See fig. 21. Length from 0·002″ to 0·0026″. Striæ distinct and conspicuous in the middle part, from being more widely separated. They are also radiate, but less strongly so than those of the two preceding forms. They are finer than in these forms, and are about 30 in ·001″. The only form to which this one has any resemblance is *P. acuta*, but its peculiar form and aspect are quite sufficient to distinguish it. Both forms occur here, and when seen together appear quite different. (277.)

22. *Pinnularia Ergadensis*, n. sp. I have given this name, from *Ergadia*, Argyll, to the species represented in fig. 22. Form nearly linear, or linear elliptic, ends rounded, obtuse, almost truncate. Length from 0·002″ to 0·0045″, or more. Striation finer than in *P. fortis*, but conspicuous; costæ about 25 in 0·001″, sub-distant, not quite reaching the median line, somewhat inclined. It is frequent in the lighter densities, and has a perfectly distinct aspect, so that it cannot be confounded even with *P. fortis*, the form which it most resembles, but in which the character of the striation is totally different.

As yet, I have met with none of the species of *Pinnularia* here figured, except in the Glenshira sand. (278.)

23. *Stauroneis amphioxys*, n. sp. This curious form is not unfrequent in the lighter densities, and is well represented in fig. 23. Form nearly rhombic, tending to lanceolate, with acute apices. Valve highly convex, so as very often to present the dark appearance of an air-bubble, and, even in the best position, showing the margin as a broad black line. Stauras broad, reaching the margin, very transparent, so as often to be seen with difficulty, if in the least out of focus. At other times it is black, from the general convexity. Striæ fine, very nearly parallel, transverse, nearly 60 in 0·001″, not conspicuous, often apparently irregular, from the convexity of the valve. (279.)

(*To be continued.*)

DESCRIPTION OF PLATE V.,

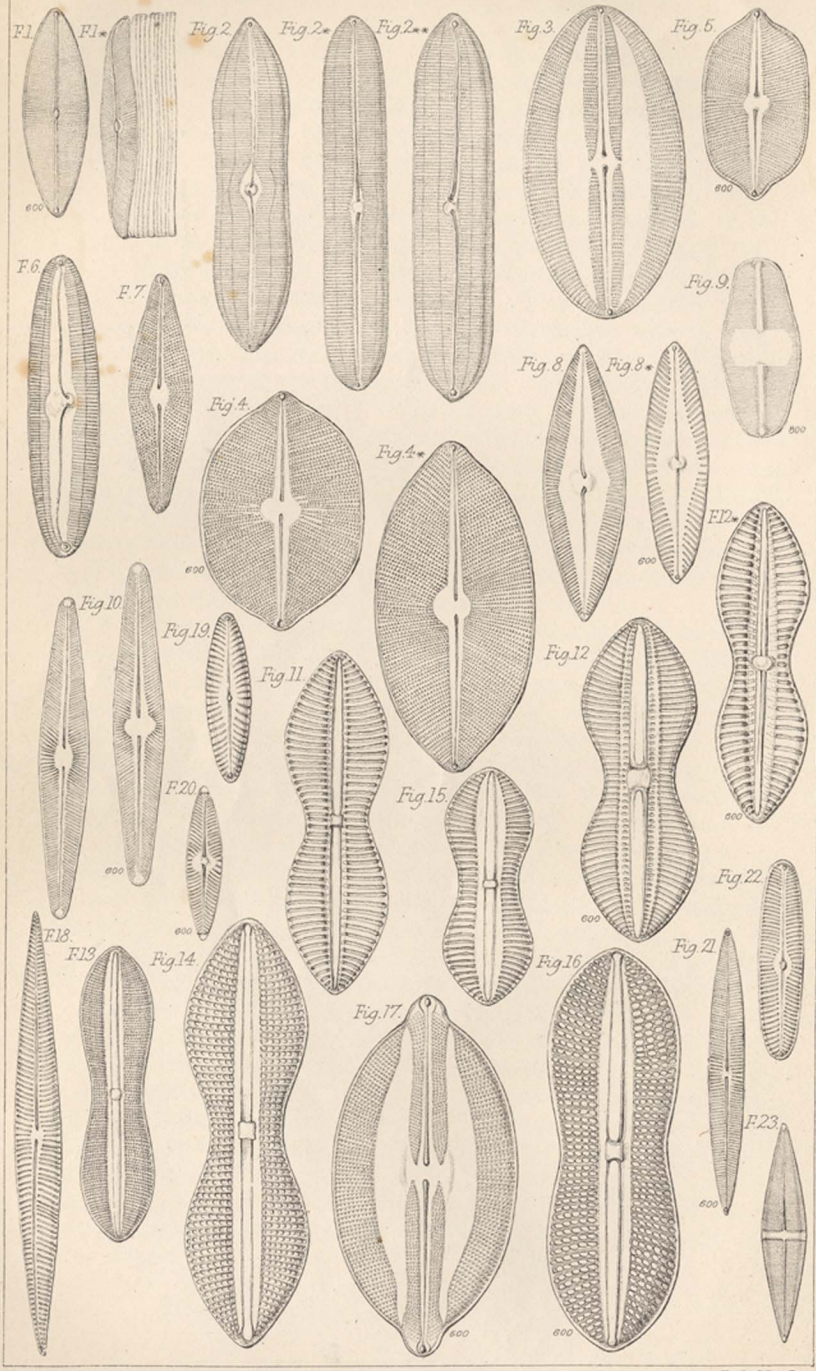
Illustrating Dr. Gregory's paper on the Glenshira Sand.

Fig.

1.—*Navicula rhombica*, n. sp. A frequent variety; S. V.
1*.— „ „ Front view, showing several grouped in a pack.
2.—*N. maxima*, n. sp. 2*.—Ditto, narrow variety. 2**.—Intermediate form of *N. maxima*.
3.—*N. Hennedyi*, Sm. (Not figured in Synopsis, vol. ii.)
4.—*N. latissima*, n. sp. 4*.—Ditto, longer variety.
5.—*N. quadrata*, n. sp. (= *N. humerosa*, Bréb.)
6.—*N. formosa*, n. sp.
7.—*N. pulchra*, n. sp.
8.—*N. angulosa*, n. sp.
8*.— „ β.
9.—*N. Macula*, n. sp.
10.—*N. solaris*, n. sp. 2 figures.
11.—*N.? Pandura*, Bréb. (?).
12.—*N.? nitida*, Sm.
12*.— „ ?
13.—*N. incurvata*, n. sp.
14.—*N. splendida*, n. sp.
15.—*N. didyma*, γ. Costate striæ.
16.— „ , δ. A new variety.
17.—*N. clavata*, n. sp.
18.—*Pinnularia longa*, n. sp.
19.—*P. fortis*, n. sp.
20.—*P. inflexa*, n. sp.
21.—*P. acutiuscula*, n. sp.
22.—*P. Ergadensis*, n. sp.
23.— *Stauroneis amphioxys*, n. sp.

The figures in this plate represent, for the most part, full-sized or large individuals under a power of 400 diameters. No. 9, *Navicula Macula*, is represented under a somewhat higher power; but I believe there are individuals of equal size under 400 diameters.

The remainder of the new forms which I have described in the Glenshira Sand, and several of which are very curious, will be figured in the next Number of the Journal.



Dr Greville del. Tuffen West sculp.

Ford & West Imp.